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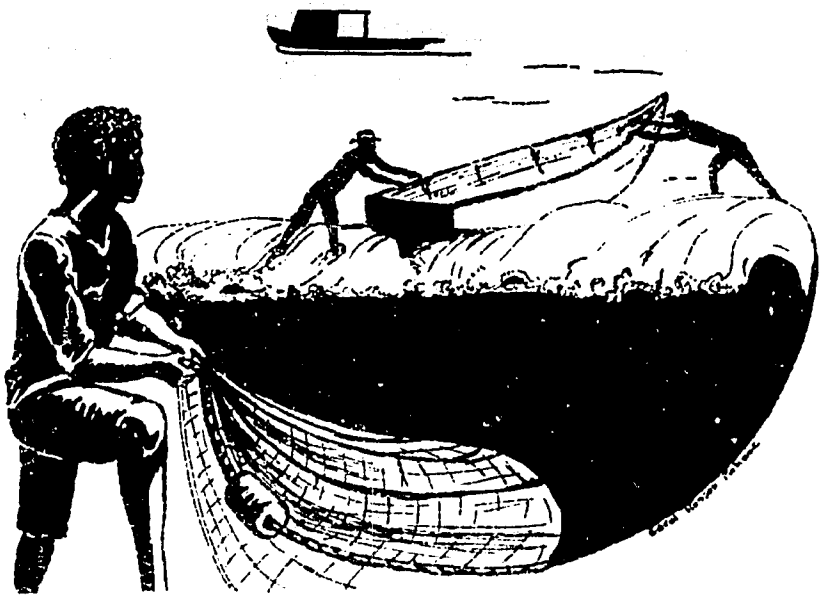
SMALL SCALE FISHERIES IN CENTRAL AMERICA: ACQUIRING INFORMATION FOR DECISION MAKING.



ICMRD

International Center for Marine Resource Development

University of Rhode Island

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FORWARD

Small-scale fisheries clearly have the potential for playing a more significant role in improving the quality of life in many nations, as well as making a major contribution in alleviating the world hunger problem.

The production of marine food fish in developing countries grew at annual rates of 5.1 and 3.9 percent during the 1960s and 1970s. The United Nations Food and Agricultural Organization (UNDP/FAO) estimates that the production of conventional marine fish species can be further increased by 35 to 50 percent, and most of this gain would be realized off the coast of these same countries.

Fish, furthermore, is an important source of food. It is rich in high quality protein and is an excellent supplement to high grain diets. Fish now provides well over 30 percent of the animal protein intake in several African and Asian countries.

The international acceptance of the extended marine economic zones during the 1970s has provided new opportunities and challenges. For example, many countries in West Africa can now utilize the rich marine resources along their coasts which were previously exploited by developed countries. Presently, many of these countries have neither the human nor technical capabilities to effectively manage and exploit their fish resources. Hence, the need for outside assistance in many instances. Yet it is unlikely that the best experts and the most advanced technology will successfully resolve all the difficult problems being encountered in fisheries development without further research.

The small-scale fishery is an extremely valuable economic and social resource. It often provides the vast majority of fish for local consumption. For example, in West Africa it amounts to about 75 percent. yet, while the men and women of this industry are usually among the poorest of the poor, they are employed in greater numbers than they are by large-scale fisheries industries (e.g. shrimp and tuna).

Experience has demonstrated that by its very nature the small-scale fishery is very difficult to affect or to influence successfully. Small-scale operations in fishing, processing, distribution and marketing are typically decentralized and run by individuals with little formal education and who are often guided by an ethos foreign to officialdom. To be able to successfully affect the small-scale fishery and to be able explain and predict behavior within it, there must be an understanding of its complex nature. To achieve this monumental yet primary task, an extensive information base is required. The development of such an information base and how it should be obtained are concerns of all who work in fisheries development.

To address these concerns the International Center for Marine Resource Development (ICMRD) at the University of Rhode Island assembled a team of investigators and, with financial support from USAID, launched a four year project. The project results and interpretations are presented in this book. As with many investigations, the work herein perhaps raises more questions than it answers. In my opinion, the main achievement is a rigorous formulation of the problem, a unique sensitivity to local situations, and a concerted search for answers using the best available techniques.

Unquestionably, further research is required, but the information base has been expanded. This volume should provide both researchers and practitioners with new and useful insights in their search for successful fisheries development strategies.

G.A. Donovan, Dean and Director
International Center for Marine
Resource Development

PREFACE

The purpose of this volume is to present the findings of a multi-disciplinary investigation of small-scale fisheries development in less-developed countries. While the field research was conducted in Costa Rica, El Salvador and Guatemala, the results have implications for small-scale fisheries development and management programs in other parts of the world.

The research findings reported in this volume span the disciplines of fisheries biology, food science, resource economics, anthropology, and development administration. The central theme that ties together this diverse set of disciplines is the problem of providing decision-makers with useful information for small-scale fisheries development programs.

Part I establishes the context of the research by describing in Chapter 1 the structure and role of information systems and the general nature of small-scale fisheries in less-developed countries. Chapter 2 describes the setting of the small-scale fisheries for the research conducted in Costa Rica, El Salvador and Guatemala.

Part II contains the results of the field tests of alternative methods for acquiring data on each salient sector of the fishery. These include biological surveys for assessment of the fisheries resources, economic and anthropological surveys of the harvesting sector, food science and technology surveys of handling and processing methods, economic surveys of marketing and consumption, and a survey of fisheries administrators in government.

Part III contains results of the analyses of the collected data. These several chapters represent our attempt to transform the data into useful information by applying the analytical tools of fisheries biology, economics, anthropology, food science and technology, and political science.

Part IV contains some conclusions and recommendations regarding data acquisition, a discussion of some policy implications and some suggestions for future research.

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ACKNOWLEDGEMENTS

We should like to acknowledge, first of all, the collaboration of individuals and institutions in Central America for their assistance with the extensive field work conducted for this study. The principal individuals and institutions in each country were: Milton Lopez G., Departmento de Pesca y Caza Maritima, Ministerio de Agricultura Y Ganaderia, Costa Rica; Dr. Jose Cabrero H., Direccion General de Recursos Naturales Renovables, Ministerio de Agricultura y Ganaderia, El Salvador; Alain Burtonboy and Luis Martinez A.. Proyecto de Pesca Maritima y Artesanal, Guatemala. Many of the other individuals who participated in the research are listed below. In Costa Rica, where most of the field work was conducted, the fisheries department provided support far beyond our initial expectations. During one year the department devoted some 125 man-months of its staff's time to the project. Each individual assiged to the project was highly skilled and motivated, and the quality of their work was of the highest calibre.

In addition to the authors of various chapters, Phil Logan, Jan Johnson and Pauil Medeiros (Graduate students in the Department of Resource Economics, University of Rhode Island), and David Hughes (Auburn University) directed day-to-day data collection efforts in Costa Rica and El Salvador.

While our study was financed by the Agency for International Development (Grant AID/CSD 2455), the findings and conclusions are solely those of the authors.

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CHAPTER I. INTRODUCTION AND OVERVIEW

By J.G. Sutinen and R.B. Pollnac

Large numbers of the world's population continue to be poor and malnourished. In response, development programs large and small, national and international, public and private, have been organized to combat the complex problems of poverty and hunger in less-developed countries. This volume addresses a small but not unimportant set of such problems. It concerns small-scale fisheries. The small-scale fishery in a less-developed country is a microcosm of the larger poverty and hunger problem because small-scale fishermen are among the poorest of the poor, yet the fish they catch has the potential for adding significant quantities of protein to the diets of the malnourished segments of the population.

The purpose of this chapter is to establish the proper context for the research findings discussed in subsequent chapters. To this end, we describe the structure and role of information systems in the fisheries development process and the general nature of small-scale fisheries in less-developed countries. This chapter concludes by defining the scope of the study.

I. FISHERIES DEVELOPMENT AND INFORMATION

A. The Information Systems Paradigm

According to the information systems paradigm (Bonnen, 1975), the small-scale fisheries development problem can be viewed as a fundamental problem of information processing. To successfully address the fisheries development problem, one must first solve the associated implicit information system problem. That is, fisheries development actions require making decisions and making decisions requires information. Providing information, on the other hand, is primarily a problem of devising a system within which data can be collected, analyzed and acted upon by decision makers.

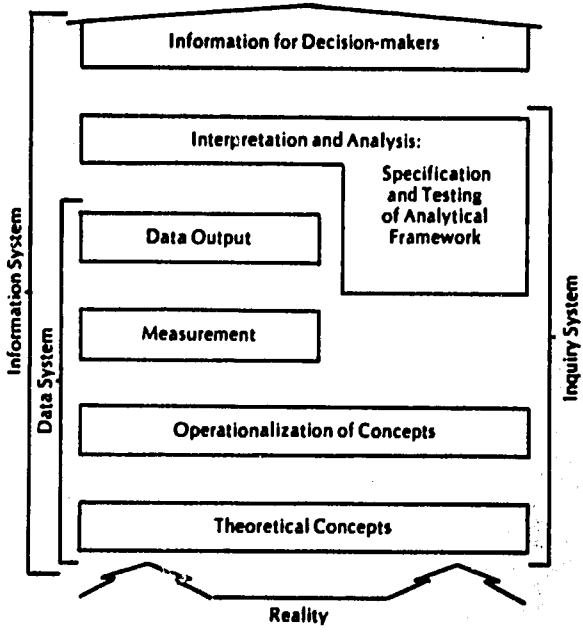
The general structure of an information system can be seen in Figure 1. Every decision requires an understanding of some part of reality. But since reality is too complex for a complete understanding, we typically develop a set of theoretical concepts to explain reality in a manner that is appropriate for the problem at hand and capable of being grasped by the human mind. Since concepts cannot be measured directly, we operationalize them by devising a set of variables (empirically observable phenomena) which correspond to that part of reality under study. The indentified phenomena are then observed and the variables measured. The resulting set of measured variables repreaents the data output. To this point we have a data system, but data are not information.

To generate information, the data are subjected to analysis and interpretation for a particular decision-making context. That is, the data must be given form and meaning in order to become information that is useful for decision-making.

The establishment of such an information system, of course, must be preceded by a process of analytical inquiry. That is, a body of theory is operationalized, matched with data, and the resulting analytical framework is tested, refined and retested. Through repetition of both the analytical and empirical process, reliability is enhanced. In fact, three types of reliability can be identified: measurement reliability, operational reliability and conceptual reliability.

In the present context, we should assess the measurement, operational and conceptual reliability of various approaches for producing information on fisheries development problems. We should determine where the information

Figure 1


Information for Decision-makers
Interpretation and Analysis:
Specification and Testing of Analytical Framework
Data Output
Measurement
Operationalization of Concepts
Theoretical Concepts
Reality
Information System
Data System
Inquiry System

system is breaking down. Is it inadequate theory? Is it the lack of operational concepts? Is it poor measurement? Has the analytical framework been suitably tested and defined? Unfortunately, the information system for fisheries development falls short in all of these areas.

The information system can also be viewed as a producing system: one that supplies information to decision-makers. The worth of any information system, of course is properly judged by its contribution to the decision-making process it is supposed to serve. Therefore, we must determine the nature of the information to be provided decision-makers. At the abstract level, the nature of the information desired by decision-makers is derived from (1) the nature of the fisheries development problems they face, and (2) the nature of the decision-making process in effect. If we were to know the exact nature of the fisheries development problems and the decision-making process, we could derive the set of information that should be produced.

Deriving the set of information to be produced is not a straight-forward task, however. While the general nature of fisheries development problems are well-known (see below) and some specific cases are well-documented, the nature of the decision-making processes actually in effect is not sufficiently understood for this purpose.

B. Decision-Making and Fisheries Development

Ideally, one would like fisheries development to involve rational decision-making. Rationality is the process of selecting the best possible alternative given relevant preferences and constraints. A rational decision-making process for fisheries development would be something like the following:

> First, an inventory would be taken to identify all salient facts and constraints that are expected to govern the selection of means to achieve an identified set of objectives.
>
> Second, the development potential of the fishery would be assessed and a variety of actions identified that could achieve the development objectives.
>
> Third, a set of possible projects would be designed and evaluated for their expected social benefits (in terms of the objectives) and costs.
>
> Fourth, the project(s) is then monitored and evaluated during implementation for the actual net social benefits realized.

To the extent that this process is followed, one could derive a set of "information demands" at each stage.

To some extent this process is followed in practice. However, those who have studied decision-making behavior in other contexts inform us that rational decision-making is rarely used (e.g., see Simon, 1979; Kinreuther, 1974; and Day, 1971). In the real world of incomplete and imperfect information, of severe time constraints and conflicting objectives and interests, it becomes impossible to behave in a fully rational manner. Instead, the decision-making process is "partially rational". Extending the argument of this view implies that we must know the actual decision-making process used in fisheries development in order to derive the information demands we are asked to respond to.

We list a set of possible decision-making modes that may apply to the fisheries development decision-making process, each of which could imply different information characteristics and most certainly would imply a different analytical framework.

1. Safety Principles
   a. Decision-makers seek to minimize the probability that some set of variables (e.g., catch and employment) will not fall below some "given disaster" level over time.
   b. Decision-makers seek an "optimum" yield but it is subject to the constraint that the probability of disaster (e.g., overexploitation) is below a certain level (e.g., 15%).

2. Maximin
   Decision-makers select the best of all possible worst cases. More precisely, they maximize minimum benefits that can be obtained with some given level of probability.

3. Satisfacing
   Decision-makers set an arbitrary level to be attained (e.g., of catch or income).

4. Cautious Suboptimizing
   Decision-makers move, each period, in the right direction, but no more than some distance perceived as "safe."

These are but some of the possible "partially rational" decision-making modes that have been identified. The point we wish to make here is that each mode demands a different informational content--the fully rational mode being the most demanding. Until we understand the actual decision processes used, we probably cannot supply information that effectively serves the fisheries development process.

C. Some Characteristics of an Information System for Fisheries Development

Earlier we argued that we seek to explain reality by constructing an analytical framework based on some appropriate theoretical concepts. We might ask what should be the nature of an appropriate analytical framework? What part or parts of reality do we seek to explain? More generally, what should be the nature of a stock assessment information system for fisheries development and management?

The reality of the fishery and related sectors is vast and complex. The fishery is composed of several components and is interconnected with other, nonfishery sectors.

In most LDCs the fishery typically consists of two sectors; a small-scale fishery sector that uses low level technology, generates low incomes and produces fish for local human consumption; and an industrial fishery that is capital intensive, produces higher incomes for a relatively small number of people and generates products for export or industrial use. Our primary concern here is with the small-scale fishery which we separate into five levels of sub-sectors: (1) the resource and its habitat, (2) capture or harvesting, (3) processing, (4) distribution and marketing, and (5) consumption. These levels are convenient divisions for a variety of analyses.

The industrial fishery sector is relevant to the development of the small-scale fishery for a number of reasons, the major reason being the potential for conflict between the two fisheries, where the industrial fishery dominates and negatively affects the small-scale fishery. Conflicts can arise over exploitation of the same or interdependent fish stocks (as in the South China Sea), or where the by-catch of the industrial fleet dominates the local fresh fish market (as in Central America) with sometimes adverse effects.

The agricultural sector is also relevant to small-scale fisheries development since many, if not most, fishing families raise crops and livestock. In some areas fishing is viewed as the employment of last resort, where people

fish only when farming is not feasible (e.g., East Africa). The agricultural sector may dominate the regional distribution and marketing network and thereby define the possibilities for expanding the distribution and marketing of fish.

Similarly, the existing infrastructure defines the possibilities for expanding the small-scale fishery. If port facilities and harbors have not been developed to support the general economy, it is unlikely that small-scale fishery needs will justify their construction. The same is true for roads and other major components of the physical infrastructure.

Institutions and laws too can be critical to realizing the potential for fisheries development. Since implementation of development projects typically rests with LDC institutions, the structure, organization and legal power of fisheries administrations and related agencies determine the efficacy of any development program. Other institutional and legal aspects which condition the process of fisheries development include interagency conflict and coordination, credit availability, subsidies, training and extension programs (e.g. see Doucet, et al., 1974; Crutchfield, et al., 1974; Woodland, 1976).

Government actions often affect, both directly and indirectly, many aspects of the fishery. Policies concerning the use of the ocean and its shoreline can have significant impact on the structure of the fishery. Decisions made concerning species to be exploited or controlled can benefit some groups of fishermen while harming others. The political power of groups affected often influences future action concerning impacts. Government regulations can also affect processing, distribution, and marketing. For example, regulations concerning sanitary procedures during the processing and marketing stages, which are aimed at improvement of public health, may place excessive economic burdens on the existing system, especially in the initial stages. In some cases, direct government intervention is necessary to improve the distribution of fish to insure that the product reaches populations with animal protein dietary deficiencies.

Figure 2 diagrams the components of a fishery and its inter-relationships with the socio-economic and political context.

FIGURE 2

GOVERNMENT	THE FISHERY
	RESOURCE & HABITAT
OTHER PRODUCTIVE	HARVESTING
SECTORS	PROCESSING
AGRICULTURE	DISTRIBUTION & MARKETING
INDUSTRY	CONSUMPTION
COMMERCIAL	
ETC.	

SOCIETY AS A WHOLE

As can be seen in Figure 2, the fishery, which is composed of clearly separated component parts, is related to government and other productive sectors and forms part of society as a whole. A complete information system should be concerned with both the components of the fishery and related aspects in its socio-economic and political context. For example, the behavior and performance of the fishery is clearly related to the significance of the fishery in national plans, proposals for fishery management, the structure of fishery related institutions and their position in government

(e.g., extension services regulatory bodies, etc.).

Clearly all aspects of the development of the small-scale fishery depend on accurate and timely information concerning the resource, harvesting, distribution, marketing and consumption sectors, as well as the other related sectors discussed above. Faulty or missing information concerning any relevant aspect of the small-scale fishery or related sectors can lead to inadequate development program design resulting in unanticipated problems and possible failure. The small-scale fisheries development literature contains many examples of such failures which need not be repeated here. The remainder of this report is involved with illustrating the development of methods and techniques for generating information to be used in small-scale fishery development, management, and decision-making.

The findings of a multidisciplinary investigation of aspects of the small-scale fisheries of Costa Rica, El Salvador, and Guatemala and a discussion of implications for fisheries development, management and decision-making in both the specific areas where research was conducted and in LDCs in general are presented here. These investigations have focused on the development, testing and evaluation of information systems for obtaining data on selected aspects of the fishery ranging from the resource base through harvesting, processing, distribution and marketing to the consumer. Data collected is also analyzed to demonstrate the utility of the systems used and to provide information necessary for the development of the small-scale fishery in Central America.

The general research approach was to identify aspects of the small-scale fishery where the development and implementation of information systems could most effectively aid in fishery development. Once these aspects were identified, data collection and analysis systems were developed. In some cases, multiple systems were identified to be tested and evaluated as a means of selecting the most appropriate for the situation in LDCs. Finally, representative research sites were selected on the basis of (a) familiarity of the URI staff with the region, (b) language facility of URI staff, (c) indications of interest on the part of the governments to be involved, and (d) the regional need for this type of research. On the basis of these criteria, Central America was selected as the research area, with an emphasis on Costa Rica.

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CHAPTER 2. THE SETTING: COSTA RICA, EL SALVADOR, AND GUATEMALA

By W. Kolberg, R. Pollnac, D. Stevenson, J. Sutinen,
with R. Coslit, B. Epler, A. Scheid and M. Shank

This chapter provides the setting within which the various studies in this volume were conducted. The research in Costa Rica ranged from studying the resource itself through harvesting, processing, distribution, and the retail market level. Thus the description of the setting in Costa Rica covers a broader range than that of Guatemala, where the focus was on retailing and the consumer in Guatemala City, and that of El Salvador. In each case the information provided is essential to arrive at an understanding of the implications of the studies in this volume.

I. Costa Rica

The Republic of Costa Rica is the second smallest country in Central America with an area of approximately 50,000 square kilometers. It is located between Nicaragua and Panama and is comprised mainly of high rugged mountains and hills drained by numerous streams and rivers. Extensive foresta cover about two thirds of the area. There is a relatively wide coastal plain in the east and a narrower plain on the Pacific coast. The coastline covers 1,020 kilometers on the Pacific side and 210 kilometers on the Caribbean.

The climate of Costa Rica is influenced strongly by its tropical location and by adjacent warm ocean waters. While mean maximum temperatures are usually in the 70's (20° - 25°C) in the mountains, along the coasts they range in the 80's and 90's (30°C). Costa Rica has only two seasons; the wet season (May-November) and the dry season (December-April). The eastern Caribbean plain, however, receives heavy rainfall throughout the year.

In 1976, the population of Costa Rica was estimated to be 2.01 million, composed mainly of Spanish and Mestizo but also including blacks (30,000), other European ethnic groups, Central American Indians (10,000), Chinese, and Americans. Most of the population lives in rural areas (57%) and San Jose (550,000) is the only city of over 10,000. Population density is a low 39.3 persons per square kilometer; and the population growth rate is 2.8%.

The quality of life is good in Costa Rica relative to Latin America. The physical quality of life index (PQLI) is a high 85, compared with 70 for all of Latin American and 95 for the United States. The Physical Quality of Life Index is a composite index based on life expectancy at age one, infant mortality and literacy at ages 15 and over. The relative high value for Costa Rica undoubtedly is reflecting achievements of the country's progressive health and education systems.

A. Economy (General)

The Gross Domestic Product for Costa Rica in 1976 was estimated at $2.07 billion (in constant 1976 dollars), representing a 5.5% increase over 1975. Costa Rica claims Central America's highest per capita GDP (1.030) and most evenly distributed national income. Agriculture predominates the economy employing 35% of the labor force, utilizing 50% of the land area of the country, and comprising 20% of GDP (1976). Principal products include coffee, bananas, livestock, cocoa, sugar, basic grains, and forestry. Industry employs 21% of the labor force (15% excluding construction). Principle products include processed foods, pharmaceuticals, beverages, wood products, chemicals, textiles, and tourism. Principal natural resources include forests, bauxite, and sulphur. Export trade totalled $590.8 million in 1976

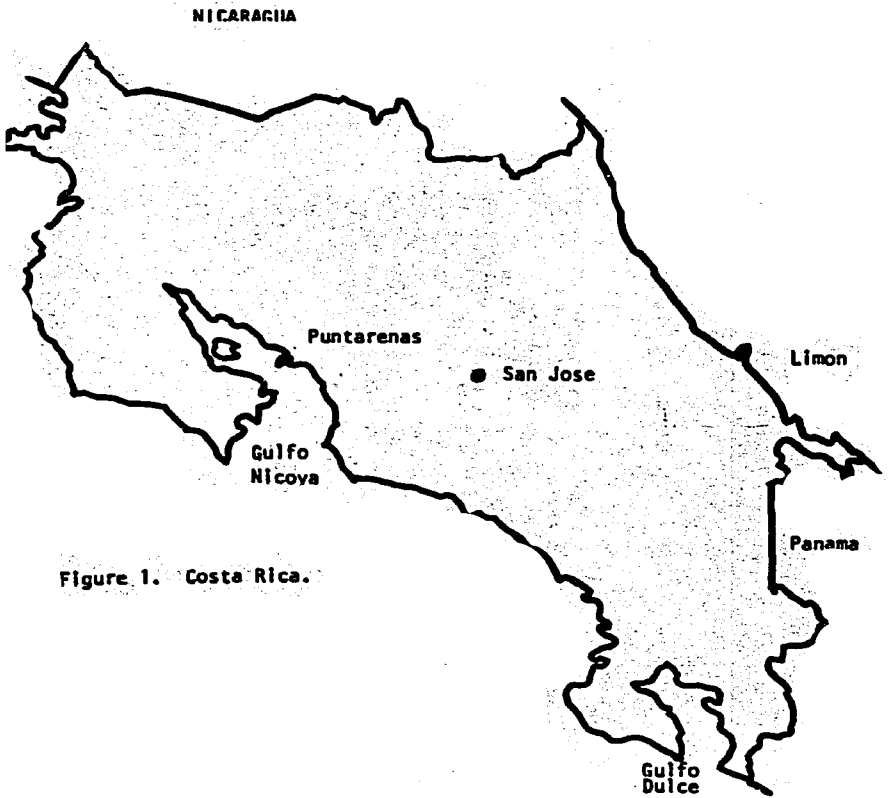

Figure 1. Costa Rica.

and included coffee ($160.1 million) bananas ($144.9 million), beef ($36.4 million) and sugar ($24.4 million) as principal products. Imports accounted for $775.8 million and included transport equipment, machinery, paper products, petroleum, and electrical machinery.

B. The Fishing Sub-Sector of the Economy.

Total trade in fisheries commodities reached $4.7 million in 1976, ten percent of GDP in agricultural goods. Good estimates of total employment in this subsector are difficult to find. Total primary (harvesting) sector employment was estimated at 3,200 in 1973. This does not account for secondary industry or processing and marketing. In 1976, for comparison, 19,731 persons were reported employed in the primary agricultural sector.

Shrimp production has been very erratic, but recent declines in production have been offset by increasing prices. While most of the production of the shrimp fleet is exported, virtually all the fresh fish produced by the artisanal fleet and the shrimp fleet is consumed domestically. There are three major shrimp packing plants operating in Puntarenas and two additional firms which harvest and process sardines and tuna. A third, smaller sardine plant operates in Golfito, also on the Pacific coast.

Fishing activity has developed in recent years as a result of the introduction of investment capital, new techniques and a series of measures implemented by the government which are aimed at improving the management of marine resources. The objective of these measures is the rational exploitation of fishing resources in order to obtain maximum possible benefit from them over the long run.

The growth of fishing activity has been achieved primarily as a consequence of changes in the industrial fishing sector. Changes in the artisanal sector have been characterized by the expanded use of nets and larger motorized vessels. Much of the improvement in artisanal production in recent years is due to the expansion of the fishery to new fishing grounds off the Pacific northwest coast.

From 1971-1978, the proportion of total finfish catch from the Pacific coast accounted for by the artisanal fleet increased from 40% to 66% of total Pacific finfish landings -- although this may be overstated due to earlier under reporting.

The components of this volume devoted to Costa Rican fisheries concentrate on the artisanal fishing activity of the Pacific coast of the country and centers on the Gulf of Nicoya, where most of this activity takes place. The following section describes the Gulf of Nicoya fishery in some detail, looking at the characteristics of the Gulf as a fishing resource, the fishermen, patterns of fishing activity, and harvest technique. In addition, sections on wholesale and retail activity as related to the "primary" or harvest sector are included.

1. The Physical Setting. Coastal waters on the Pacific coast of Costa Rica are highly productive and support active tuna and sardine fisheries. Much of the continental shelf is also trawled for shrimp. But the principal directed effort for finfish is concentrated in the relatively protected waters of the Gulf of Nicoya.

The Gulf of Nicoya is separated from the open ocean on the North and West by the mountains of the Nicoya Peninsula, sheltered on the East by the low coastal mountains of the mainland provinces of Guanacaste and Puntarenas, while the southward facing mouth of the Gulf is partially closed by a long sand-spit. The result is a lake-like gulf of seawater totally protected from the ocean waves but, due to the high tides, rather well supplied with nutrients from the open ocean and the large number of surrounding estuaries. The total area of the gulf, including the area south of Puntarenas, is 1500 km^2.

Much of the commercial transactions of the region, especially those

involving fishing, are channeled through the principal town, Puntarenas, which occupies the very tip of the sandspit guarding the entrance to the Gulf. In addition to being an administrative, transportation and supply center, Puntarenas is valued by Costa Ricans for its beaches in summer, and its harbor facilities which make it Costa Rica's largest Pacific port.

2. Fishery Resources in the Gulf of Nicoya. The fishery resources of the Gulf of Nicoya are principally demersal estuarine species typical of the tropical soft-bottom habitats. Exploited demersal species belong to the families sciendae (corvina), Ariidae (cola), Centroponidae (robalo) and Lutjanidae (pargo). More transient, oceanic species are mackeral (macarela) and sharks (cazon or posta). The distribution of some of the more important species varies considerably between the interior and exterior zones of the Gulf and there are marked changes in the seasonal availability of some species, especially the transient ones. Several of the most important species of corvina, for example, are largely confined to the interior of the Gulf. Approximately twenty-five species make up the bulk of the artisanal landings, although the total number of exploited species exceeds fifty. Variations in the distribution of fishing effort and, to some extent, gear usage, are influenced by seasonal climatic factors as well as changes in the distribution of the exploited species. High winds in the dry season (December - April) produce unfavorable working conditions, especially for the smaller boats and force the larger gill-net vessels to fish in protected areas of the Gulf nearer to home villages.

Many species are harvested by both the artisanal and shrimp fleets, although the shrimp and sardine vessels are prohibited from operating in the interior of the Gulf. The quantity of undersized and unmarketable finfish caught and discarded by the shrimp fleet far exceeds the quantity landed.

3. Landings. Total Costa Rican landings for the years 1952-1976 are given in Table 1. Between 1969 and 1976, Atlantic coast landings accounted for 4% or less of the annual totals. Table 2 shows the breakdown of finfish catch between commercial and artisanal fleets (both coasts) in 1976. The artisanal landings have increased from 700 tons in 1971 and reached 2680 tons in 1978. Seventy-three percent of the reported 1978 artisanal harvest was from the Gulf of Nicoya and 76% of the reported catch from the Gulf was landed in Puntarenas.

4. Fishing Activity in the Gulf of Nicoya. The Gulf of Nicoya fishery is apparently quite old, and has benefited greatly from the protected nature of the waters which allows small dugout canoes to fish over most of the area. The oldest and simplest fishing technique is handlining followed by longlining. The fishermen are not certain when the first nylon gill-nets appeared, but place the event within the last 10 or 15 years coinciding with the motorization of the local boats. These boats range from 18 to 35 feet in length.

Most of the fishing villages and towns around the Gulf of Nicoya are located on or near all-weather roads. Those not near all weather roads have arrangements to ship their catch by water to collection points with good road access. The majority of the fishermen live in Puntarenas, the villages of the eastern shore of the gulf, and on the string of islands along the western shore. Only a few fishermen live on the western shore which is mostly mangrove swamp. Many fishermen who live in Puntarenas are gillnetters operating from 20-30 foot diesel powered launches. The gillnetters set their nets either at the surface or on the bottom, depending on conditions and types of fish present, and capture a large variety of species. Mesh size varies from 3 1/2 to 6 inches and affects the species and size composition of the catch. Since multi-filament nylon nets are visible to the fish during the day, nets are usually fished at night. Nets must be checked and emptied at least once during the night to prevent dead fish from decaying in the warm water. The use of block ice is common among gillnet fishermen for preservation of catch prior to sale.

TABLE 1

Total Landings of Finfish and Non-Finfish Products

by Coastal Zone, Costa Rica: 1952-1976

(Peso en kilos)

YEAR	PACIFIC COAST LANDINGS (Kilos)	ATLANTIC COAST LANDINGS (Kilos)	TOTAL LANDINGS (Kilos)
1952	188,605	115,079	303,684
1953	385,368	29,503	414,871
1954	401,637	7,389	409,026
1955	596,899	6,647	603,546
1956	736,207	53,140	789,347
1957	766,657	212,426	979,083
1958	992,079	99,278	1,091,357
1959	1,281,533	67,744	1,349,277
1960	1,250,159	1,437,224	2,687,383
1961	1,704,972	1,018,676	2,723,648
1962	1,709,878	321,267	2,031,145
1963	1,596,378	129,987	1,726,365
1964	1,930,781	802,357	2,733,138
1965	5,298,215	391,456	5,689,671
1966	3,080,099	1,192,442	4,272,541
1967	2,376,984	250,739	2,627,723
1968	3,142,396	383,275	3,525,671
1969	5,012,418	39,382	5,051,800
1970	6,993,649	100,343	7,093,992
1971	8,207,290	131,918	8,339,208
1972	10,767,002	92,498	10,859,500
1973	10,804,272	49,879	10,854,151
1974	13,381,049	134,669	13,515,718
1975	13,590,869	424,644	14,015,513
1976	12,329,088	452,921	12,782,009

TABLE 2

LANDINGS, COSTA RICA, 1976

(metric tons)

Shrimp	1,500
Sardines	6,300
Fresh Fish	
Shrimp Fleet	1,550
Artisanal Fleet	1,930
Tuna	
Foreign Vessels	3,600
National Vessels	900
TOTAL LANDINGS	15,800

Groups of gillnetters also operate from Manzanillo on the Eastern shore, Nispero-Puerto Moreno at the head of the gulf, and La Bocana on the island of Chira. Traditionally, gill nets used by these fishermen are smaller with reduced mesh sizes.

Most longliners live in and around Puntarenas. There is very little longline fishing in the interior of the Gulf. Longline boats are usually small and often unpowered, although a few longliners have boats which are large enough to use for gillnetting. Several of the longliners with larger boats have indicated that they would convert to gillnets if they had the money to invest. Longlines are fished on the bottom with 75-150 baited hooks on each line. Common species captured with longlines are corvina agria, sharks, (cazon and posta) and cola. The higher priced species of corvina prefer live bait and are not caught with longlines.

Although a few handline fishermen live in Puntarenas, most of them are diatributed up the Gulf, with heavy concentrations at Costa de Pajaros, the northern edge of Manzanillo, and the islands, especially the communities of Jicaro and Palitos on the island of Chira. In most areas the handliners are quite poor, and often own no more gear than a dugout canoe, some paddles, and a few handlines. A notable exception is found at Costa de Pajaros, where fishing teams are built around large diesel powered dugouts which tow from 2 to 7 small dugouts to and from the fishing grounds and act as a transport ship for the catch. The support launch is paid a fixed charge per pound of fish landed by crews of the towed dugouts. It is common in Costa de Pajaros for the diesel boat to be owned by the head of an extended family, while the actual operation of the support boat and the fishing from the small dugouts is done by the sons, other relatives, and friends of the family. Many of these fishermen are now in the process of switching to gill nets.

The number and distribution of fishermen, and types of vessels and gear are given in Table 3 for the Gulf of Nicoya and the North Coast. A preliminary survey of the south coast, identified approximately 150 fishermen but provides no information on vessels and gear. Of particular interest for the Gulf is the difference between the urban fishermen (those based in the port town of Puntarenas) and the rural fishermen. Relatively greater numbers of fishermen (61%) and vessels (79%) are based in rural communities of the Gulf. The rural fishermen principally use vessels carved from tree trunks (dugouts) powered by oars, and use baited hand lines. In contrast, the urban based fishermen principally use vessels of plank construction (which have a larger carrying capacity) powered by inboard diesel engines and use gill nets. In addition, the ratio fishermen to vessels in the urban communities is more than twice that in the rural communities (6.2 to 2.7). Presumably this relects the larger vessels used by urban fishermen.

Patterns for the North Coast mirror thoce for the rural communities in the Gulf. Hand lines are the most common gear and the ratio of fishermen to vessels is relatively low (3.2). Most of the vessels are engine powered, however, almost two-thirds using outboard motors.

A summary of Pollnac's non-random survey of 125 fishermen is presented in Table 4. Urban fishermen are older, have more education and more fishing experience than their rural counterparts. Higher percentages of the rural fishermen surveyed own boats and had fathers who were fishermen. For more detailed data from the survey the reader is referred to Chapter 16.

The characteristics of a typical fishing trip for each gear type are summarized in Table 5. Gill net fishermen yield the highest catches (and gross revenues). While hand line trips result in less catch per trip, they tand to yield higher valued species (eg. corvina). Two crew members are most common for gill nat and long line trips. Hand line fishermen tend to fish alone.

Evidence from the analysis of sample data from 807 interviews of fishermen conducted in conjunction with the Costa Rican Ministry of Agriculture during the period August, 1976 to July, 1977 suggests that fishermen in the Gulf of

Table 3.

Gulf of Nicoya				North Coast
	Total	Urban	Rural	
Number of fishermen	2106	816	1290	271
Number of vessels	618	131	487	84
of planked construction	233	94	139	
dug outs	385	37	348	
Powered				
with fixed motors	245	96	149	25
with outboards	26	16	10	55
with oars	347	19	328	4
Number of gear	482	155	327	339
gill nets	153	108	45	46
hand lines	288	28	260	282
long lines	41	19	22	2
other				9

Table 3. Numbers of Fishermen, Boats and Gear: Gulf of Nicoya 1976

Table 4.

Survey of Fishermen	Total	Urban	Rural
Age in years	30.7	32.7	27.6
Educa (years)	3.6	3.9	3.2
Years of fishing experience	12.3	12.6	11.8
% boat owners	38%	31%	50%
% fisherman father	53%	43%	68%
Number of fishermen in sample using			
gill net only	63	46(61%)	17(34%)
long line only	18	10(13%)	8(16%)
hand line only	19	7 (9%)	12(24%)
gill net & long line	11	11(15%)	-
gill net & hand line	1	-	1 (1%)
long line & hand line	12	-	12(24%)
other	1	1 (1%)	-
Total in sample	125	75	50

Table 4. Sample Survey of Fishermen Gulf of Nicoya 1977.

Table 5.

	Gill Net	Long Line	Hand Line
Catch per trip (lbs.)[a]	202	140	135
Average weighted price (per lb.)[b]	$1.93	$1.43	$2.07
Days fished per trip[a]	1.78	1.42	2.25
Percent of trips with[b]			
1 crew member	3%	49%	57%
2 crew members	75%	41%	27%
3 or more crew members	22%	10%	16%

a - factena data

b - interview data

Table 5. Gear-type Statistics, Gulf of Nicoya 1976 - 1977.

Nicoya fish near and land their catch in their home village. For example, 98% of all the sampled types of Pantarenas-based fishermen landed their catches in Puntarenas. The exception is the fishermen on the islands where primary buyers do not operate. Most fishermen located on the islands sell their catch at the nearest of the three major landing zones.

Seventy-two percent of the Puntarenas-based trips sampled were conducted in zones 5, 6 or 7 (Figure 1) while 87% of the northeast coast fishermen reported trips in zones 2 and 3 (Figure 2) and 89% of northwestern tip fishermen reported trips in zones 1, 2 or 3 (Figure 3). Nearly all the trips (92.5%) of Chira-based fishermen were centered in zone 2. This clearly illustrates that fishermen were fishing in zones relatively close to home ports. Similarly, 64% of the landings sampled in Puntarenas represented trips in fishing zone 5 and 6 (Figure 4), the closest zones to Puntarenas, while 84% of the trip landings in the northeast coast reported fishing in zones 2 and 3.

These findings are somewhat surprising given the relatively small size of the Gulf and the types of boats and gear used. Although most fishermen stay close to home, those using larger boats (gillnetters), showed the greatest propensity to travel longer distances.

5. Distribution of Catch and Revenues in the Gulf of Nicoya. Generally, Primera Grande and Primera Pequena, two commercial class names for approximately six of the most highly valued species of fish, are concentrated in the innermost sections of the Gulf near the northwestern tip, while other commercial classes tend to be located nearer the mouth of the Gulf. Since fishermen tend to fish close to home, the catch in the two zones nearest the northwest tip of the Gulf is composed largely of Primera Grande and Primera Pequena. During the sample period, over 80% of the revenue from fish sold in these zones was accounted for by these classes alone. The value of the catch landed in Puntarenas, however, was more evenly distributed among the commercial classes. While 63% of the sampled artisanal catch was landed in Puntarenas, it accounted for only 58% of the total revenue generated by the artisanal fleet. In addition, Puntarenas accounted for only 39% of the revenue generated by Primera Grande, the most highly valued class. Finally, Puntarenas based fishermen received only 34% of the total revenue generated by artisanal fishing activity. These results suggest that the fishery in the Gulf of Nicoya is not homogeneous. Rural fishermen are providing large proportions of the type of catch most desired by consumers, a significant proportion of the exchange between fishermen and primary buyers is taking place in rural areas, and a large percent of the income is flowing to rural households.

C. Description of the Wholesale Sector.

The wholesale sector is a large and vital part of an overall marketing system which provides for the flow of fresh fish from small scale fishermen to the consuming public. The movement of fish from producer to consumer involves the marketing services of primary buyers (port wholesalers), truckers, and retailers. The primary buyers buy fish from the fishermen on the docks and beach landing sites and perform the services of assembly and storage. They either sell the fish to transporters or take the fish themselves to the retail outlets in the capital city of San Jose and other population centers in the vicinity of San Jose. The retailers then carry out the final marketing stage of selling the fish to consumers.

1. Primary Buyers. The primary buyers provide the first link in the marketing chain that carries the produce of the artisanal fishermen to the consuming public. They purchase the fish directly from the fishermen at the port or beach sites. Their installations for handling and storing fish are in general rather modest. Their buildings are usually extensions added onto private homes or small lean-tos. Data gathered from interviews in 1976 indicated that the average building size was about 44 square meters and the

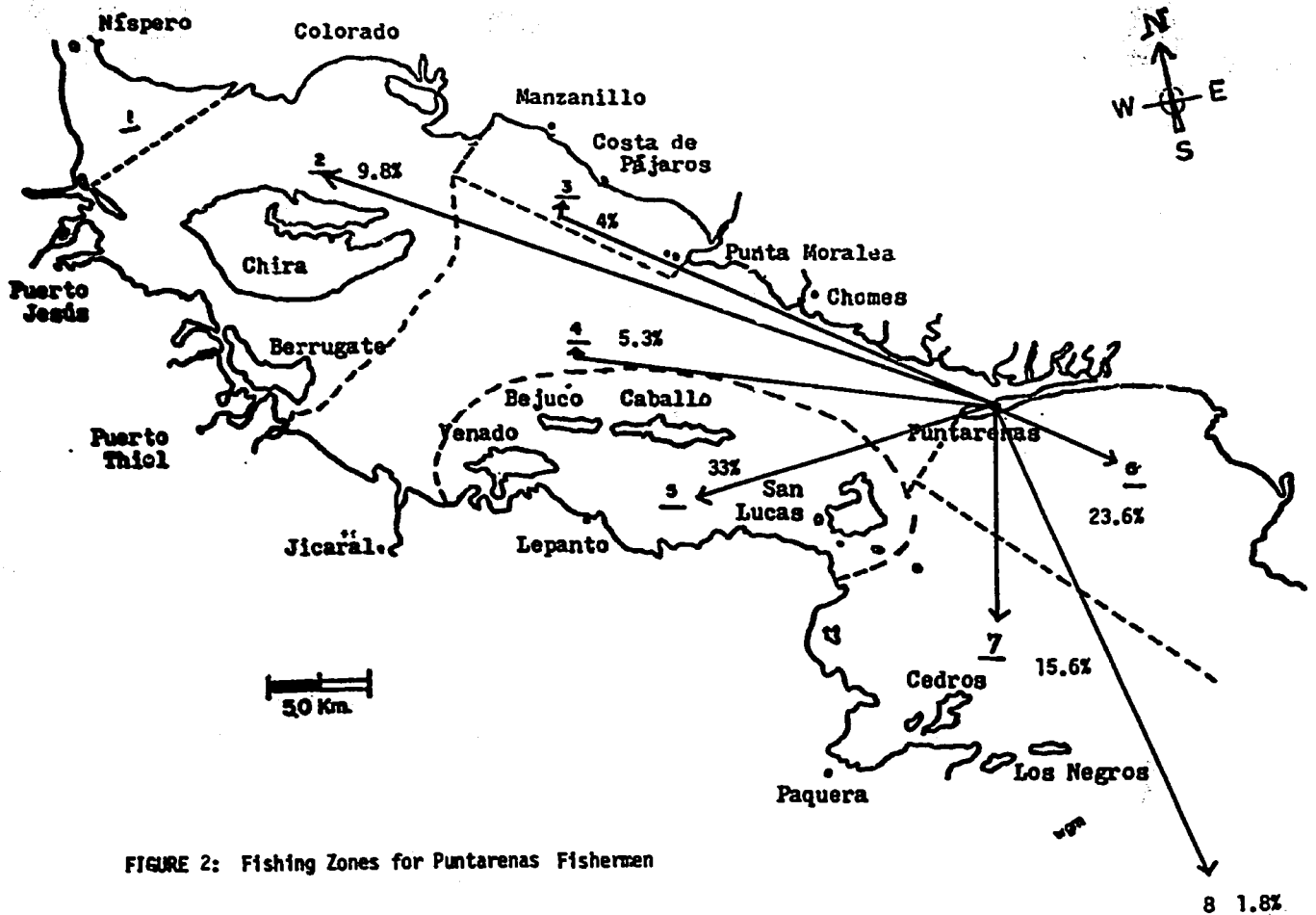

FIGURE 2: Fishing Zones for Puntarenas Fishermen

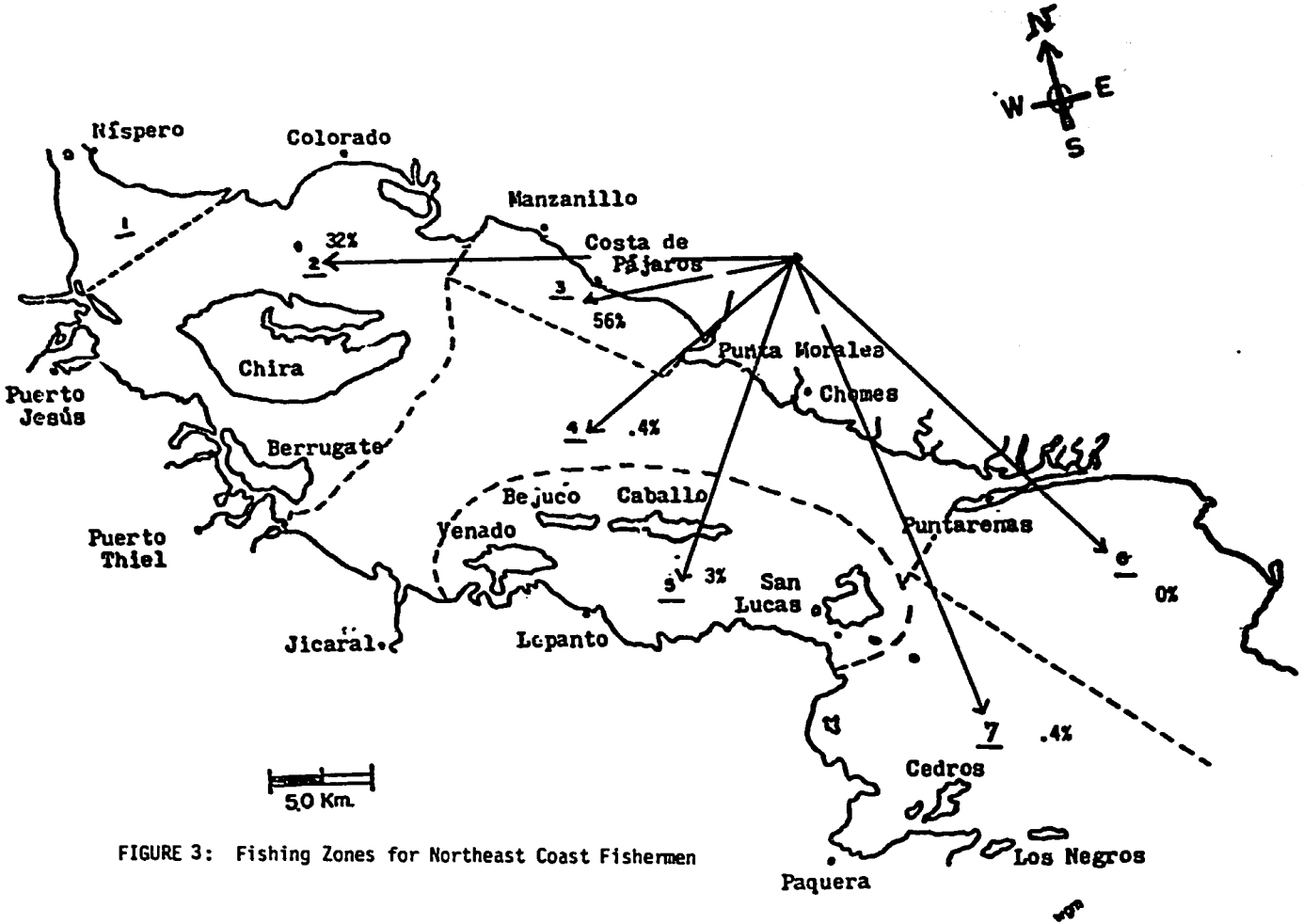

FIGURE 3: Fishing Zones for Northeast Coast Fishermen

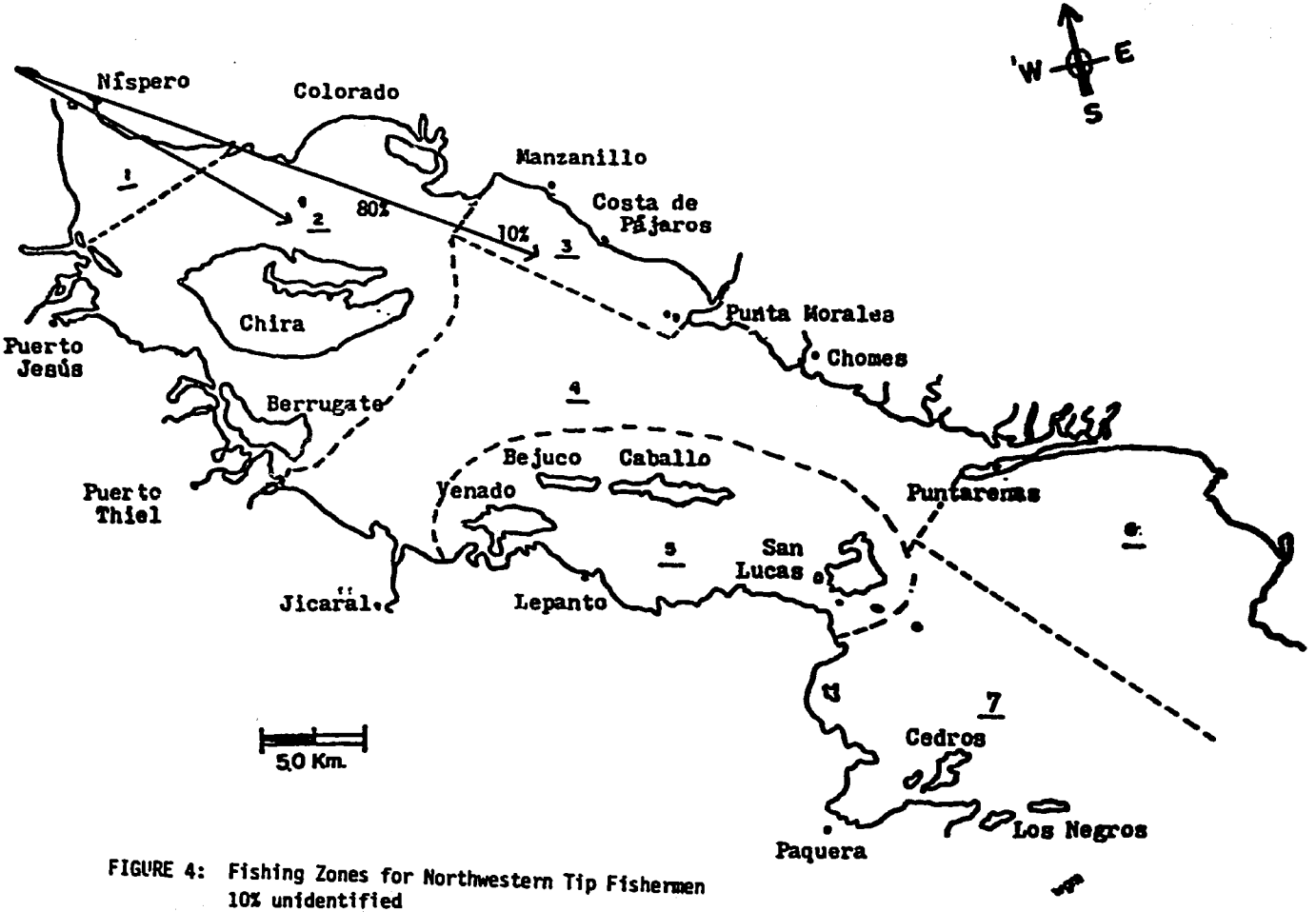

FIGURE 4: Fishing Zones for Northwestern Tip Fishermen
10% unidentified

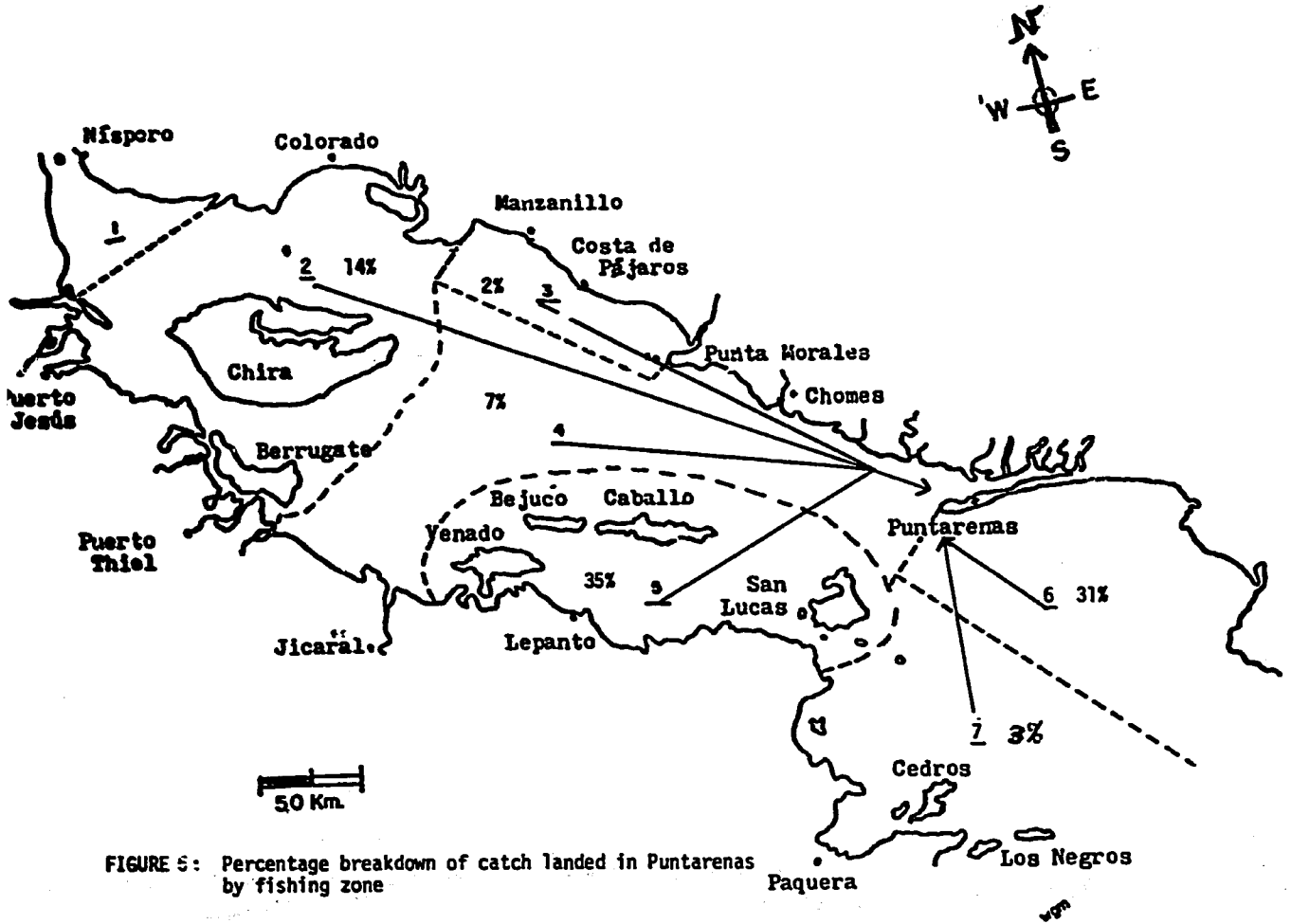

FIGURE 5: Percentage breakdown of catch landed in Puntarenas by fishing zone

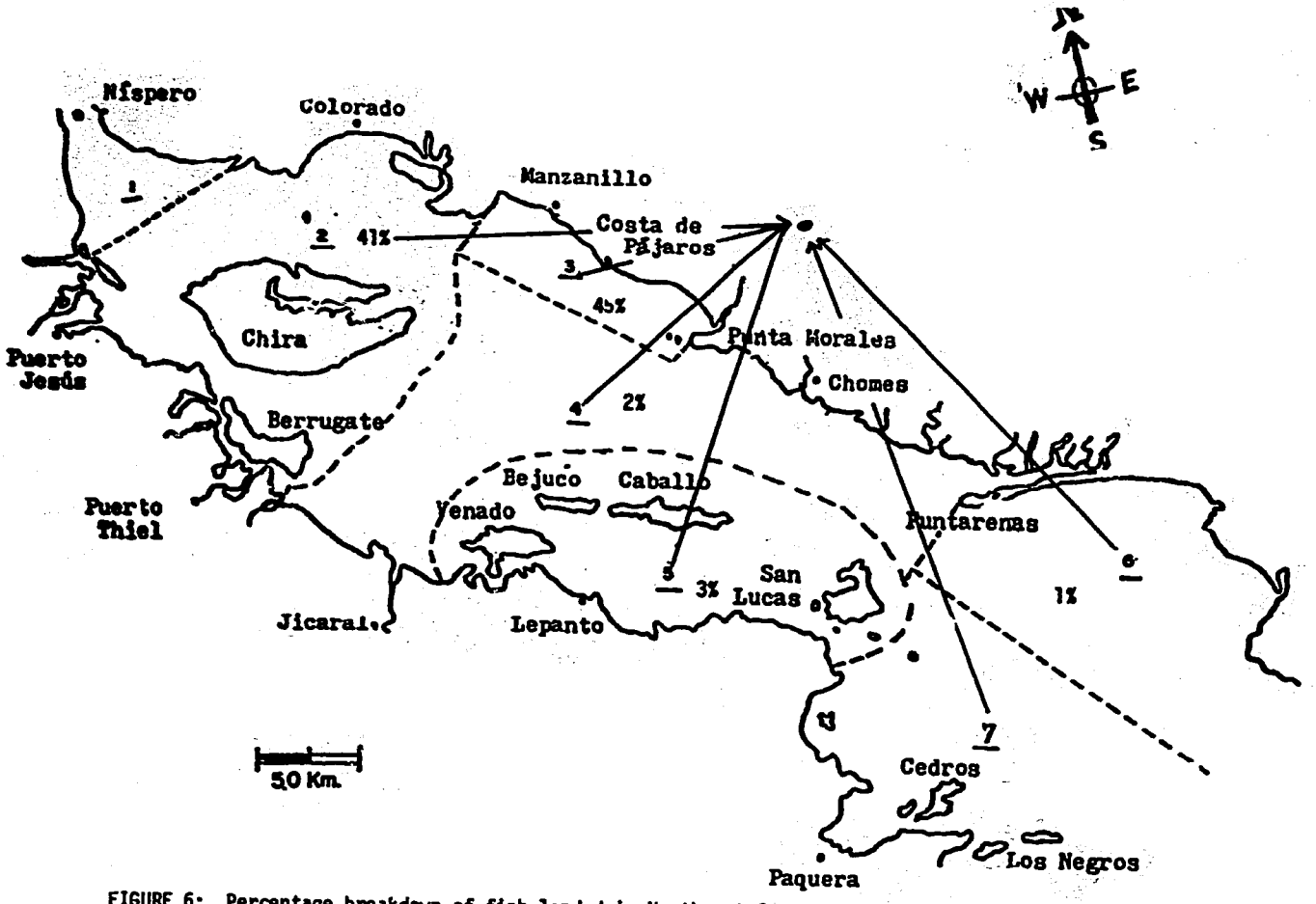

FIGURE 6: Percentage breakdown of fish landed in Northeast Coast by fishing zone.

average ice box and/or freezer capacity was about 5,000 pounds.

The data from daily purchasing receipts collected from the primary buyers between September, 1976, and February, 1978, revealed a total of 34 different primary buyers operating in the port of Puntarenas and in various outlying landing sites around the gulf (see Figure 6). For the most part, these buyers were concentrated near the landing areas of Puntarenas.

Several types of ownership may be distinguished among the primary buyers. Twenty-four firms are owned by individuals and six by partnerships or corporations. There is one fishermen's cooperative (COOPEPES) and one fishermen's union (UNPEPES). The union is different from the cooperative in that it is not regulated by the bylaws and legal safeguards of an officially inscribed cooperative. The union is much smaller and united to a great extent by family relationships.

2. Species and Classification of Fish. A large variety of fish is purchased by the primary buyers. Although not all the buyers use the same categories of classifying the fish they purchase, the majority follow a classification which utilizes both size and species. The major classifications are: large first class fish (primera grande), small first class fish (primera pequena), classified fish (clasificado), small shark (cazon), two large types of shark (posta blanca and posta negra), and low grade "trash fish" (chatarra).

Table 6 presents the eight major (marketing) classifications of finfish which the artisanal fishermen landed in the region of Puntarenas during the period between September, 1976, and February, 1977, when purchasing data were collected. The largest amount of fish purchased by the primary buyers during this period were in the class Cola and Agria. Small first class fish was a distant second in terms of the amount purchased (see Table 6).

The large and small first class fish categories brought the fishermen the highest ex-vessel prices per pound, with a weighted average price of 3.31 colones and 2.60 colones, respectively (8.5 colones = U.S. $1.00). Cazon, Posta Blanca, Clasifacado, and Cola and Agria fell in the middle price range of 1.86 to 1.40 colones per pound. Posta Negra had a weighted average price of .98 colones per pound while the commercially less attractive fish in the "Chatarra" category brought a weighted average price of .61 colones per pound (see Table 7 for the ranking of fin fish according to their weighted average price).

Because of the relatively large amount purchased, the middle-priced fish category, Cola and Agria, generated more revenue for the fishermen than any other species or category of fish landed during the survey period. Posta Negra and the species in the Clasifacado category were the least important fish in terms of revenue paid to the fishermen by the buyers (see Table 7).

D. Transport-Wholesalers (Transportista).

Transportistas are wholesalers who purchase fish from the primary wholesalers or directly from the fishermen and transport them to the retail market. The Transportista travels to various communities along the gulf purchasing fish. Fish are graded, culled and stored in large ice boxes for transport to San Jose. An average Transportista is capable of storing about 2,500 pounds of fish on his truck and makes two or three trips per week. If the supply of fish is low, he may be forced to leave for San Jose with less than a full load rather than face the possibility of losses due to spoilage. Poorly developed transportation systems have hindered artisanal fisheries development in areas away from the gulf, even when sufficient fish stocks appear to exist.

E. The Retail Sector

Forty-five fish retailers operate in Costa Rica's Central Valley (Table

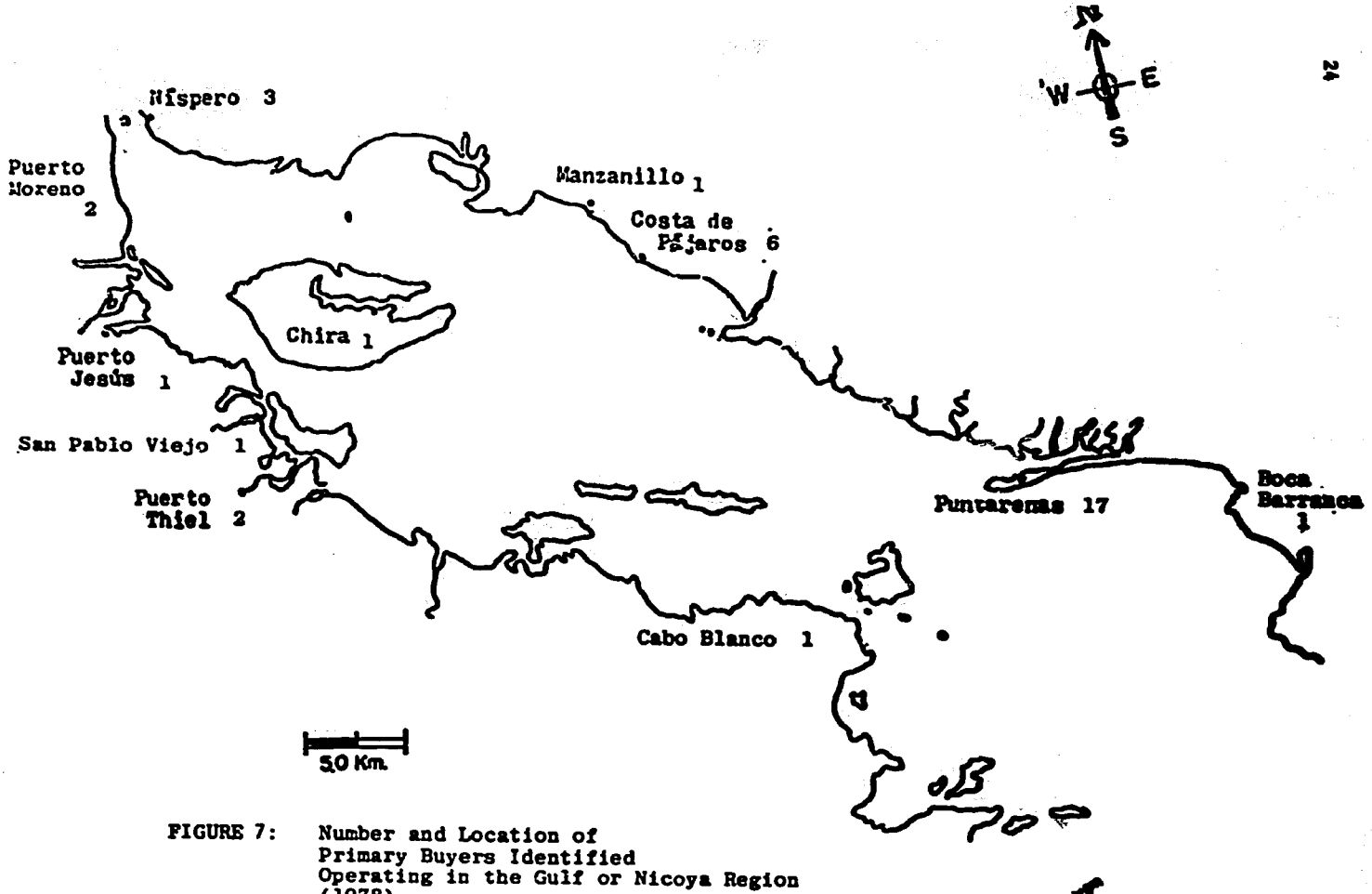

FIGURE 7: Number and Location of Primary Buyers Identified Operating in the Gulf or Nicoya Region (1978)

Table 6.

a) Species and Classifications of Fish Purchased by the Primary Buyers

A. Primera Grande: corvina, robalo

B. Primera Pequena: corvina, robalo, pargo, aguada, cabrillo, mero

C. Clasificado: macarela, berrugate

D. Cazon

E. Cola y Agria: cola, agria, bagre, cuminate, pargo

F. Posta Blanca: posta blanca, posta gata

G. Posta Negra

H. Chatarra: jurel, liza, raya

b) Ranking of Finfish by Amount Purchased (Sept. 1, 1976 to Feb. 15, 1977)

	Species	Weight (lbs.)	Percent of Total Amount Purchased
1.	Cola y Agria	441,340	35.9
2.	Primera Pequena	229,399	14.9
3.	Chatarra	212,130	13.8
4.	Cazon	201,184	13.1
5.	Primera Grande	171,634	11.2
6.	Posta Blanca	113,955	7.4
7.	Clasificado	48,365	3.1
8.	Posta Negra	7,551	.4

Table 7.

a) Ranking of Finfish by Weighted Ex-vessel Average Price (Sept. 1, 1976 to Feb. 15, 1977)

1.	Primera Grande	3.31
2.	Primera Pequena	2.60
3.	Cazon	1.86
4.	Posta Blanca	1.44
5.	Clasificado	1.43
6.	Cola y Agria	1.40
7.	Posta Negra	.98
8.	Chatarra	.61

b) Ranking of Finfish in Terms of Revenue to Fishermen

	Species	Revenue	Percent of Total Revenue
1.	Cola y Agria	773,974	28.7
2.	Primera Pequena	596,445	22.1
3.	Primera Grande	568,240	21.1
4.	Cazon	374,854	13.9
5.	Posta Blanca	164,626	6.1
6.	Chatarra	128,557	4.8
7.	Clasificado	69,013	2.6
8.	Posta Negra	7,406	.3

8)[1]. With the exception of two outlets all of these firms were traditional pescaderias (retail outlets which sell fish only).

Twenty-nine of the firms are located in San Jose, twenty-two within a three-block area in downtown San Jose. Similar concentrations were common in other cities in the Central Valley. Eleven firms operated in the larger suburban cities of Alejuela, Heredia and Cartago. The remaining four firms were located in new markets in smaller towns within 50 kilometers of San Jose.

Thirty-five of the firms identified were located in large central markets which may house over 100 small shops. These markets sell a wide variety of food and non-food items. Most of the markets are municipally owned. Supermarkets are becoming more prevalent but most people still shop in the traditional market areas.

Fish retailers generally work six days a week. Retail outlets located in privately owned markets are open for a half day on Sundays. Public markets are closed on Sundays. Firms may close two or three days per month because of shortages in the supply of fish or for holidays. On the average, fish retailers are open ten hours a day. Fridays and Saturdays are traditionally the busiest days of the week as people travel from rural towns to do their weekly shopping. Wednesday is the least active day of the week. The most active part of the day is in the mornings.

Other retailers include supermarkets and the Consejo National de Produccion. Supermarkets, with the exception of the Mas Por Menos chain and the Super Dan, purchase frozen fish from one of two wholesalers in San Jose. The Mas Por Menos Company is vertically integrated. The company owns a landings-pier in Puntarenas and purchases fish directly from artisanal fishermen.

The Consejo Nacional de Produccion (CNP) has several hundred outlets (expendios) located throughout the country. These outlets sell a wide variety of food products. Fish are stored in and sold from freezers. Prices are listed on the wall. The CNP purchases fish from the cooperative COOPEPES in Puntarenas and transports them to San Ramon, a city halfway to San Jose. The fish are quick frozen and packaged in plastic bags. Fish are then stored and delivered to CNP outlets once a week. The stated purpose of the CNP is to stablize market prices, which it attempts to accomplish by purchasing and storing fish when it is abundant and releasing it when supply is low.

F. Consumption

Very little is known about the consumption patterns and demand for fresh marine fin fish in Costa Rica. According to one set of calculations (Cubrero, Diaz and Gonzales, 1975), per capita consumption of all fish products has varied between 1.5 and 3.0 kilos between 1960 and 1974. To our knowledge, no data exists on fresh fish consumption for years up to 1976.

II. El Salvador

The Republic of El Salvador is the smallest country in Central America with an area of about 21,000 square kilometers (8,260 square miles) roughly about the size of the state of Massachusetts. It is bordered by Guatemala, Honduras and Nicaragua, and faces the Pacific Ocean to the south.

El Salvador is comprised of three distinct regions, formed by two ranges of mountains running from east to west. The coastal belt on the south is

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[1]The Costa Rican Department of Marine Fisheries has continued to collect information on fish retailing and has located ten additional pescaderias. Eight of these lie outside the area covered by this study.

Table 8.

Number of Fresh Fish Retail Outlets in the Central Valley of Costa Rica (July 1976)

LOCATION	NUMBER OF PESCADERIAS	CITY TOTAL
Mercado Central (municipal)	8	
Mercado Del Carnes	7	
Mercado Bourbon and Vicinity	7	
Mercado Coca Cola (municipal)	2	
Vicinity of Mercado de Mayero	2	
Plaza Viques (municipal)	2	
Others	1	
San Jose		29
Guadelupe		2
Mercado Central (municipal)	3	
Other	1	
Cartago		4
Mercado Central (municipal)	2	
Heredia		3
Mercado Central (municipal)	3	
Other	1	
Alejuela		3
Mercados Centrales (municipal)	3	
Grecia and Naranjo		3

Total number of pescaderias in municipal markets = 25

Source: Personal interviews.

relatively hot; the central region, where most of the population lives, is subtropical; and the northern region is mountainous.

The estimated population of El Salvador in 1976 was 4.27 million, composed of Mestizos (89%) Indians (10%) and Caucasians (1%). With over 190 persons per square kilometer, El Salvador is the second most densely populated country in the Western Hemisphere with a population over one million. The average annual rate of growth in the population is a high 3.5%.

The Physical Quality of Life Index for El Salvador was 64 in the mid - 1970s, compared to an average of 70 for all of Latin America and 95 for the United States. The people of El Salvador have serious nutritional deficiencies. The per capita intake of calories has never been greater than 84% of the minimum established by the Food Agricultural Organization of the United Nations (FAO, 1976). According to the Institute for Nutrition of Central America and Panama, the per capita intake of protein is 83% of the recommended level, and only 12.7% of this intake consists of animal protein (Anaya, 1976). Together with the low literacy rate (50% of persons over age 10), these factors are likely causes of the low PQLI.

A. Economy (General)

The Gross Domestic Product for El Salvador in 1976 was $2.46 billion (in constant 1976 dollars), an increase of 3.9% over 1975. Per capita GDP was a low $580, growing only 0.4% over the previous year, and contines to be very unevenly distributed. The economy is largely agricultural, which utilizes 67% of the land and 47% of the labor force. Coffee is the country's principal export (41% of total exports), with sugar, cotton and shrimp as other major export items. Industry, which produces and processes light consumer goods (food and beverages, footwear and clothing), did not progress significantly in the 1970s. The country's economic infrastructure is relatively well developed, with good roads, communications, electric power and banking facilities. Significant economic problems include heavy population pressure on land, a coffee-dependent economy, limited unused arable land and mineral resources, high seasonal unemployment, and a very uneven distribution of income.

B. The Fishing Sub-Sector of the Economy

The fishing industry's contribution to total economic output has been small. During the period 1968-1974, the fishing sub-sector accounted for 2.31% of the agricultural gross national product and 0.72% of total GNP. As indicated above, shrimp is a major export item for EL Salvador.

El Salvador's coastline is 200 miles in length. It includes two estuaries (the Barra de Santiago and Jaltepeque) the Bay of Jiquilisco, and the Gulf of Fonseca, which is shared with Nicaragua and Honduras. The country has a major river (the Lempa) which is 160 miles long, three smaller rivers, six lakes and reservoirs of significant size that are utilized for fresh fish production. As of 1976, 138 ponds comprising a total of 39.28 square hectares of surface area were engaged in aquacultural activity. In terms of volume, however, marine fin-fish dominates the market. In 1967 the Government of El Salvadore limited entry to this fishery to 72 vessels. These 72 trawlers are operated by three firms. Most of the industrial catch (mainly shrimp) is destined for export, prepared and processed by the firms located in either La Union or El Triunfo. Small amounts of shrimp go to restaurants and hotels in San Salvador. However, a substantial part of a vessel's by-catch of fin-fish is distributed through the internal marketing system for domestic consumption. The yearly volume of this fin-fish is presented in Table 9. The remainder of the catch is used for industrial purposes, such as fish-meal.

Another source of industrial by-catch comes from the Nicaraguan shrimp fleet that trawls the shared waters in the Gulf of Fonseca. Because of the

FIGURE 8. EL SALVADOR

Table 9: MARINE PRODUCTION BY ARTISANAL FISHERY AND BYCATCH PRODUCTION OF THE INDUSTRIAL FLEET, EL SALVADOR, 1975-1977. IN METRIC TONS.

HARVEST AREA	1975		1976		1977		Industrial Bycatch		
	Coop	Other	Coop	Other	Coop	Other	1975	1976	1977
Barra de Santiago									
Fin-fish	0	14	0	29	0	13	1433	1345	1071
Non Fin-fish	0	30	0	50	0	42			
Acajutla									
Fin-fish	260	*	188	*	163	*			
La Libertad									
Fin-fish	358	*	302	*	395	*			
Non Fin-fish	-	*	5	*	1	*			
Jiquilisco/El Triunfo									
Fin-fish	50	200	29	129	24	52			
Non Fin-fish	-	264	-	38	-	35			
Jaltepeque/Herradura									
Fin-fish	0	30	0	17	0	14			
Non Fin-fish	0	373	0	76	0	16			
El Tamarindo									
Fin-fish	277	**	129	114	128	114			
Non Fin-fish	-	**	-	213	-	157			
La Union									
Fin-fish	72	**	36	103	99	77			
Non Fin-fish	-	**	-	2	-	-			
Totals	1017	867	779	751	810	520			

Source: Directorate for Natural Renewable Resources, Ministry of Agriculture, Soyapango, El Salvador.

0 = cooperative not established

* = all production assumed to be by cooperative

** = data not collected that year for this sector

- = no production

short distances and protected waters, many people can go out daily in small artisan boats and purchase by-catches from the vessels. This production is brought to shore and channeled through the domestic marketing system in a manner very similar to that of the artisanal catch.

The artisanal sector catches a mix of fin-fish and shell-fish which, along with the fresh water species caught in the lakes, provides the bulk of domestic consumption. Although the fresh-water artisanal sector is active, its present contribution of total volume is small. Most of the gear and technology used in the two capture fisheries is similar.

The marine artisanal sector, consisting of oceanic, coastal, estuarine and inland fishing is made up of approximately 5,000 fishermen. They use boats which are seldom greater than 22 feet in length and are driven by oars, oars and sails, or small motors. The gear used includes poles and hooks, casting nets, trawl lines, or set devices such as gill-nets, tangle nets or shark nets (Fuentes, 1976).

The five principal fishing areas which are the residence of the majority of the fishermen contain cooperatives. These are 1) Acajutla, 2) La Libertad, 3) El Triunfo, 4) El Tamarindo, and 5) La Union. There are secondary harvest areas as well. These are areas where there are enough fishermen to produce more than the local village can consume, but which have not formed cooperatives. These are 1) Barra de Santiago, 2) La Herradura (Jaltepeque estuary), 3) Maculis, and 4) Islands in the Gulf of Fonseca. (See Figure 8).

Individual harvest areas exhibit different characteristics in their fish production and distribution. The description begins with the westernmost area of Barra de Santiago (Figure 8) and proceeds eastward along the coast.

Barra de Santiago. The Barra de Santiago is the outermost land bank at the mouth of the Zapote river, almost at the Guatemalan border. Surrounded by mangrove swamps and the sea, the outer bank is accessible only by boat. Approximately 100 fishermen live in the area, fishing primarily in the protected waters of the estuary. Family members take the fin-fish production to small rural villages within a few hours distance by bus. According to the available statistics, 400-600 pounds of fin-fish at most leave this harvest area daily. The average is likely less. Two buyers arrive daily to purchase 'punche' or fiddler crab which abound in the mangrove swamps. Each of these two buyers own trucks, rent stalls in the San Salvador wholesale market, deal exclusively in 'punche', and for most purposes, are duopolistic wholesale suppliers of this product in that market.

Acajutla. Not far down the coast from the Barra de Santiago lies the major deepwater seaport of Acajutla. The city of Acajutla (pop. 20,000) is connected by good asphalt highways to several large and medium sized cities. Bus service is daily and frequent, and there is a passenger-freight train to Sonsonate and San Salvador. Acajutla is also the location of the largest (in terms of membership) and second most productive artisanal fishing cooperative in El Salvador. The fishing grounds are located off the open coast with no protective bays for boats to take refuge in storms. Shark, mackeral, ocean catfish and several species of first class fish (red snapper, grouper, corvina) make up the principal species caught. Shark dominates the catch. All landings take place on an old steel commercial pier. At the time of landing, the cooperative sets up a weight and check-in station on the pier. Also present are a large number of buyers who typically offer a price greater than or equal to the price the cooperative offers, but less than the sale price of the cooperative. Available statistics do not indicate how much of the total production is purchased outside the cooperative. It is reported that of the 380 total fishermen in Acajutla, approximately 260 are members of the cooperative. The catch not purchased by the private buyers is marketed by the cooperative which takes the better class fish to Guatemala and the less-valued species to Santa Ana.

La Libertad. The port of La Libertad is a town of approximately 7,000 inhabitants. It is centrally located along the coast, connected by good

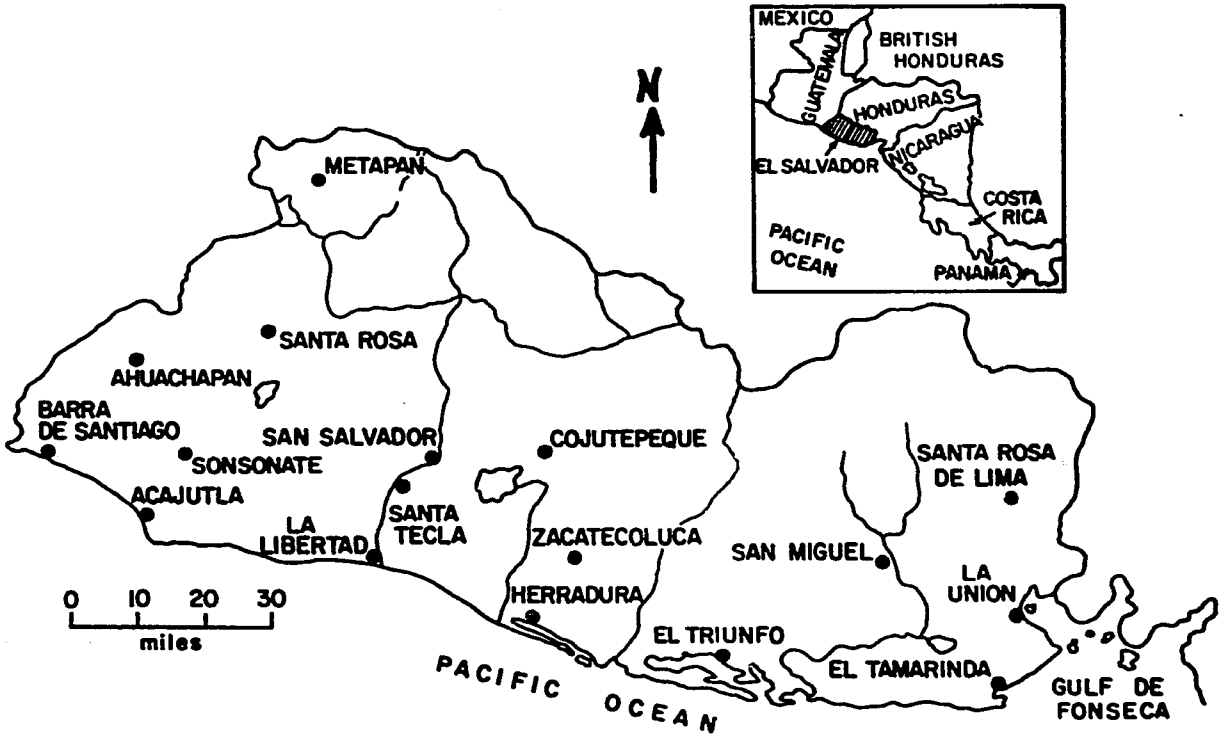

Figure 9. Principle Landing Sites and Marketing Centers: El Salvador

asphalt roads, and is the closest recreation and fishing port to the city of San Salvador. The fishing resource is considered less than ideal off La Libertad. Like Acajutla, the coast is open, with no natural protective barriers within reach of the artisanal fleet, and set gear is often caught and towed away by trawling shrimp vessels working the same grounds. The La Libertad cooperative is consistently the largest producer (by a significant margin) of all the artisanal cooperatives. It enjoys a monopsonistic buying position, and is the only cooperative to successively integrate forward into wholesaling on a large scale. The cooperative rents a stall in the wholesale market. By taking advantage of its large quantity of specialized species (principally ocean catfish) and skillful marketing, the cooperative has captured a large market-share. During the dry season, a period of increased demand, about five small buyers from nearby villages arrive at the port. However, they buy from the cooperative which maintains its monopsonistic position.

La Herradura and the Jaltepeque Estuary. Moving west one comes to the estuary of Jaltepeque, where the main village is known as La Heradura. Larger than the Barra de Santiago, it is still small in absolute terms. At this writing no fishing cooperative exists, but several fishermen produce enough for six buyers to go to San Salvador daily. The principal species is 'jaiba', a type of water crab. Significant amounts of shrimp and limited amounts of fin-fish also are handled by these merchants. Only two of the six buyers own vehicles; they provide transport to three others for a fee. The remaining buyer goes by bus.

El Triunfo and Jiquilisco Bay. Jiquilisco Bay is the country's largest estuary, measuring 121 square kilometers in area. The port of El Triunfo, located on the innermost shore, is a village of approximately 5,000 people. The estuary is surrounded by mangrove swamps and several large inhabited islands. Road access is good, except for the last seven kilometers leading into town. El Triunfo is also the site of operations for three private shrimp companies. Most of the country's 72 trawlers, of approximately 65 feet in length with a 25 ton capacity, are based in this port. The three companies have complete facilities for docking, vessel maintenance and repair, and processing. It is in El Triunfo that the shrimp companies unload the by-catch which is destined for domestic consumption. The three contract buyers who pay for the exclusive right to market this catch maintain assembly and storage facilities in the port. It is estimated that approximately 65 artisanal fishermen from El Triunfo fish daily and the level of fishing is considered to be the least sophisticated. The cooperative located there has the most difficult organizational, membership and financial problems of all the cooperatives. Its production is the lowest and its marketing practices are passive. Fin-fish of lower classes are the principal catch. Also important is the large production of bivalves dug out of the mud by men, women, and children.

Gulf of Fonseca. Separating El Salvador from Nicaragua is the Gulf of Fonseca. Each country has fishing grounds within the Gulf. The inhabitants of the port of La Union, the village of El Tamarindo, and six islands of Salvadorean domain are the principal fishers of these waters. There are several large Nicaraguan shrimp vessels which trawl the nearby Nicaraguan waters. Many villagers go out daily to meet the foreign vessels and purchase their by-catch. While this practice is carried on by more people and total volume is greater in La Union, there is a sizable and important operation of this nature located in El Tamarindo.

El Tamarindo. El Tamarindo is a small village, located at the end of a peninsula projecting into the southern part of the Gulf. The last twelve kilometers of the road into the village are unpaved and rough. It is situated sixty kilometers from San Miguel, the nearest large city, and is 170 kilometers from San Salvador, a little more than three hours diving time.

Besides Tamarindo, there are other smaller coastal villages to the east,

known as Maculis, La Tunas and Playas Negras. The site is quite advantageous for its proximity to good quality fishing grounds. There is an active cooperative which produces a substantial quantity of first class fin-fish and shark. There are also oyster and lobster fisheries.

The cooperative located in El Tamarindo has an erratic marketing system. During the wet season, the cooperative can be counted upon to purchase a fisherman's catch at a fair price and it regularly takes produce to Guatemala. However, during the dry season the cooperative fails to obtain a good share of the available supply because of a lack of aggressive marketing practices. At this time of year competition for purchase of the production increases greatly; both in the number of buyers and the quantities they are willing to purchase. The buyers seek out the fishermen at the landing site, while the cooperative waits for the fishermen to arrive at the cooperative's facilities. Apparently there is insufficient allegiance or other motive for the fishermen to sell all their catch to the cooperative. In addition, the cooperative must purchase at a fixed price, whereas the private buyer can offer a price higher than the cooperatives' purchase price, but less than the cooperatives' selling price. The result is that the cooperative markets much less during the dry season.

La Union. La Union is a medium-sized city and a secondary commercial port with a bay not as deep as Acajutla's. Good asphalt highways connect it to San Miguel, about 40 kilometers away, and San Salvador, a distance of approximately 220 kilometers. Bus service is frequent. The majority of the artisanal fishermen in La Union fish in the Salvadorean waters of the Gulf, but at times many risk losing their equipment, gear and perhaps life to fish the remaining rich areas in Nicaraguan waters. Of the dozen fresh-fish buyers which operate out of La Union, only about one-half purchase from artisanal landings. The rest are involved in the buying and transporting of the commercial Nicaraguan by-catch.

One of the youngest cooperatives is located in La Union. The cooperative is the largest single purchaser of artisanal landings. It sells large amounts to two Guatemalan transporters, as well as many of the local merchants for the municipal market and several who come each day from San Miguel by bus. Of the remaining buyers for artisanal fish, two control fishing operations and are considered large buyers in the area. No official record of the quantity of by-catch coming from Nicaragua is kept. Estimations made during this study indicate that the annual amount is around 800 metric tons annually. This is about 25 to 30% less than that brought in by the Salvadorean fleet which averages around 1100-1200 metric tons. This supply source provides employment for many in marketing and boating activities. Most who market the catch do so in quantities of 400 pounds or less. However, there is one large operation consisting of boats and motors, cleaning and assembling facilities, and a truck which handles only commercial by-catch. This firm has horizontally extended its operations by selling some of its catch to other marketers and transporting others to market for a fee.

The Islands. Four Salvadorean islands (Zacatillo, Martin Perez, Conchaguita and Meanguera) are inhabited by fishermen. The number that fish year round is small compared to those which fish part-time. For example, Ulloa and Drew (1978) found that on the island of Zacatillo, ten men fish all year, while as many as 300 fish only during February-March, when consumption of dried fish is at its height. Most of the islands lack basic services such as potable water, electricity, waste disposal and schools. Due to the lack of ice on the islands, fish must either be dried or sold shortly after being caught. One primary buyer who brings fish from the islands was located during the course of this investigation. The buyer was found to be integrated into fishing operations and makes daily trips by boat to the islands to purchase fresh fish. The buyer is located on an isolated shore between La Union and El Tamarindo, but holds a strategic location for access to the islands. The buyer maintains storage facilities. A transporter from San Salvador makes

trips every two or three days to purchase from this buyer.

C. Distribution and Consumption

Fresh-fish for domestic consumption is distributed through decentralized marketing channels comprised of primary buyers, transporters, wholesalers, and retailers. Distances from the coastal harvest areas to San Salvador are relatively short. The time required to travel from the farthest port in a loaded vehicle is less than five hours. In general, roads are good. Two other large cities and most of the intermediate-sized urban areas are even closer to fish producing areas.

Because of its location and large population, San Salvador is the country's distribution and consumption center. The nation's one wholesale market is located in the basement of the city's largest marketplace. Retailers from eleven other markets, street vendors who walk suburban neighborhoods, and restaurants and hotels purchase fish at this market daily. Secondary transporters who carry the product to more distant locations also purchase at the market.

Tilic and McCleary (1971) reported that the three large cities account for 60% of total consumption, and Parkman and Salgado (1974) found most of the fish destined for medium sized and small towns passes through San Salvador first. Tilic and McCleary also report that only 3% of the domestic fresh and frozen supply is sold through sources other than public markets. Supermarkets prefer to sell the frozen form because of convenience, but the frozen food market is limited. Incomes are such that very few of the population have freezers or refrigerators with freezers.

Fish are grouped commercially into classes reflecting consumer preferences. First class fish contains the highest valued species and consists of red snapper, snook, corvina and grouper. Second class refers to fin-fish of middle value. This class includes shark, grunts and mullet. Third class is made up of the lowest valued species, consisting of ocean catfish, jack mackeral, eel and mojarra. Non fin-fish products, such as mollusks and crustaceans are not included in these classifications.

Since 1970 the annual per-capita fish consumption (PCC) has been decreasing, where PCC is defined as total population divided by the total quantity consumed. Tilic and McCleary (1971) report PCC as high as 2.58 kilograms (KG) in 1966, down to 2.19 KG in 1969. The planning office for the Directorate of Natural Resources reports PCC rates for 1971, 1972, and 1973 as 1.72, 1.58 and 1.67 KG, respectively (Anaya, 1976). This decline since 1966 probably can be explained by a combination of a steadily increasing population with no increase in production.

The Guatemalan export market for Salvadorean artisanally produced fresh-fish is very important for both fishermen and marketers. A substantial quantity of the first-class fish, sharks and crustaceans are exported to the wholesale market, supermarkets, hotels and restaurants in Guatemala. It is estimated that approximately 26% of the total artisanal fin-fish catch is taken to Guatemala. The percentage of lobsters and oysters is much higher. Additionally, large quantities of dried fish, especially shark, are taken to Guatemala. This export market is a consistent outlet for a country that at times has a surplus for certain species within its domestic distribution system.

III. Guatemala

The Republic of Guatemala is the northernmost and most populous of the five countries in Central America. it is bordered by Mexico, Bazil, Honduras and El Salvador, with Pacific coastline to the south and the caribbean to the east. The Pacific coastline is approximately 320 kilometers (200 miles) long,

and the Carribean spans about 80 kilometers (50 miles). Approximately the size of Tennessee, Guatemala has an area of 108,780 square kilometers (42,000 square miles).

The central highlands, where Guatemala City is located, is the most heavily populated region of the country. Other regions include the narrow plain along the Pacific coast, the fertile river valley in the Caribbean lowlands, and the sparsely populated Department of Peten in the north. The climate in the central highlands is temperate, with temperatures ranging from 50°-70°F and rainfall from 70-200 inches.

The estimated population of Guatemala in 1976 was 6.44 million, composed mainly of Mestizos and Indians. The average annual growth rate of the population is 2.8%. Population density is low (56.3 persons per km^2) relative to El Salvador.

The Physical Quality of Life Index for Guatemala was a low 54 in the mid-1970s, compared to an average of 70 for all of Latin America and 95 for the United States. This low value reflects the relatively low literacy rate (38%), life expectancy (52 years) and high infant mortality rate (79 per 1000).

A. Economy (General)

The Gross Domestic Product for Guatemala in 1976 was 5.12 billion (in 1976 dollars), an increase of 7.4% over the previous year. Per capita GDP was a modest $795 and growing at 4.6% per annum. Like other Central American countries, Guatemala's economy is dominated by agriculture. Coffee is the country's most important export and contributed about 8% to real GNP in 1977. Other important export crops include cotton, sugar, meat and bananas. Agriculture employs most of the country's work force and comprises more than a quarter of its GDP.

B. The Guatemalan Fishing Industry.

The fishing industry in Guatemala is composed of three fisheries the industrial, cooperative, and artisanal. Two shrimp companies, Pesca S.A., and El Ganadero S. A., operating on the Pacific Coast, comprise what is known as the "industrial" fishery, termed industrial because the two companies package and process shrimp and fish on a large scale. In 1973, the latest year for which data were available, Pesca was operating 21 vessels and El Ganadero 7. Both owned packing plants as well. The total pounds of shrimp landed by these companies each year has varied from 693,914 pounds in 1960 to a high of 3,804,241 pounds in 1973 (Ministerio de Agricultura, Department de Pesca Maritima 1973). The two companies also report a large by-catch of fin fish, although they keep only 20% of the fish because of its small size and low market value in comparison to shrimp.

The cooperative fishery consists of five government sponsored cooperatives operating on the Pacific Coast. The oldest cooperative, El Hawaii, has been in existence since 1973. The cooperative owns a 35-foot steel hull vessel, a 20-foot fiberglass skiff, as well as two buildings; one for processing and storage of fish, the other for storage and repair of fishing equipment. It is estimated by the cooperative that combined landings of the two vessels averages 1,000 pounds per day. Because the remaining four cooperatives have been more recently established, no information on their operation is available.

The artisanal, or small-scale fishery, is the largest in terms of number of fishermen, vessels, and pounds of fish landed. In 1967 FAO estimated a total of 2,200 full time artisanal fishermen on the Pacific and Atlantic coasts and freshwater lakes (Lopez, 1967). Seventy percent of these fishermen were on the Pacific coast. Lesser (1974) estimates an average annual catch of the artisanal sector in excess of 2 million pounds, although he notes poor

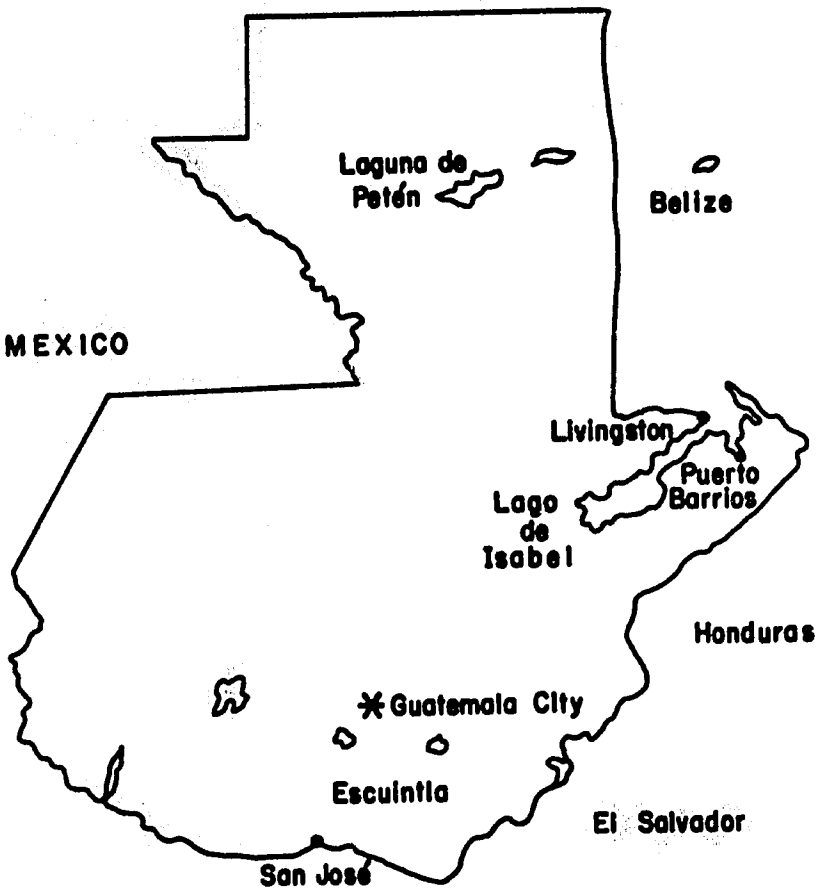

FIGURE 10. GUATAMALA

data collection methods were used to arrive at this figure.

Fishing Methods in the Artisanal Sector. The FAO study also estimates a total of 1,900 artisanal vessels in use. Most of these vessels are small, wooden skiffs or dugouts, 9-17 feet in length. Approximately 45% have motors, the remaining 55% are propelled with oars or poles. The fishing methods used by this sector are elementary, mostly hand line or cast net fishing. In San Jose, the largest port on the Pacific, nearly all fishing is done with baited hand lines. In Iztapa, another Pacific port, cast net fishing is the most common, although gill nets are also used.

Because there are no good harbors on the Pacific Coast, the fishing methods used and the species caught depend on launching vessels beyond the surf. In several towns, including San Jose, long piers are available to the fishermen to lower their boats into the ocean. In Iztapa where there are no such facilities, most fishing is tidal (canal and river) water fishing. Lesser estimates an average catch per person of 30-60 pounds per day in San Jose, from the ocean fishery, as compared to an average of 10 pounds per day for all canal and river locations. The Fisheries Department notes a decrease in the importance of river and canal fishing during the past few years due to pollution from cotton pesticides in the water.

Because of the small size of vessels utilized by the artisanal fishermen, as well as the lack of sophisticated technology, fishermen are influenced to a great extent by the weather. During the rainy season, spear fishermen who fish for snook are not able to operate due to a loss of visibility from muddied waters. During the dry season, many vessels apparently make two fishing trips daily, but during the rainy season effort is restricted by large waves and uncertain weather. The result is that less fish is supplied during the rainy season, and that supply is sporadic.

FAO estimates an average daily catch per fisherman of 23 pounds. For the period during which their study was conducted, FAO data suggest fishermen earn approximately $20 (U.S.) per week; 80% of which is from the sale of fish. Although most of the fisherman's catch is sold fresh (estimated by Lesser (1974) at 90%), a portion is dried and salted and part is retained for consumption by the fisherman.

Fish preservation methods at sea are poor. The larger, more expensive fish, such as robalo and boca colorado are eviscerated immediately after catching. Shark is headed, gutted and skinned quickly because it deteriorates rapidly. No effort is made to preserve the rest of the catch at sea even though temperatures range from 80-100 degrees along the coast.

Fish Preparation and Transport. Once on shore, each fisherman sells his catch to one of many dealers present. Individuals or families hired by the dealer see that the fish is washed and the second class fish is eviscerated. The fish is packed in large woven bamboo baskets lined with plastic and palm leaves, and an equal weight of ice, for shipment to Guatemala City or other urban areas. Most fish is transported by bus from San Jose to Guatemala City. From Iztapa, one dealer uses the bus, while the other two, who own small trucking companies, are able to transport fish as well as other goods to market in Guatemala City. When fish from San Jose and Iztapa reaches Guatemala City, it is taken directly to the Terminal market. The Terminal is the largest of the 21 public markets in the city, and serves as the center for secondary wholesaling of all food items. Most fish, including that from the Atlantic and freshwater lakes, as well as the fish imported from Honduras, Nicaragua, and El Salvador, is brought to the Terminal.

Wholesale Marketing. At 6:00 a.m. on any given morning, seven or eight wholesalers from the Atlantic and Pacific Coasts can be found at the rear of the Terminal selling fish to secondary wholesalers from the Terminal, as well as wholesalers from other markets, hotels, and restaurants. Some primary wholesalers have fixed stalls in the terminal where they sell wholesale and retail, thus eliminating the secondary wholesaler. Fish (mojarra, julin, and

liseta) from the lakes is brought to the market early in the morning and then sporadically during the day. Imported fish, particularly that from El Salvador arrives later in the day, although there appeared to be no fixed schedule for these deliveries. The city government levies a tax on each basket of fish entering the Terminal. A city employee stands at the market entrance to record the number of baskets entering the market and to collect the 10¢ tax per basket.

Supply into the market varies greatly. The daily quantity of fin fish entering the Terminal ranged from an estimated low of 1,000 lbs. to an estimated high of 4,300 lbs. during June to October, 1976. The supply of fish was generally greater Monday, Friday, and Saturday. Consumers were found to shop more frequently on those days as well.

On Mondays and Fridays, approximately 20 ambulantes, or door-to-door fish salesmen, are found at the Terminal buying their daily supplies. These men carry the fish in metal pans or woven bags for sale throughout the city. Some ambulantes vary their selling areas, while others return to the same areas regularly. The daily quantity of fish bought by each ambulante averages ten pounds. The ambulantes have no storage facilities or other investment in equipment. City buses are used for transportation to the selling areas.

Retail Marketing. There are 21 public markets in Guatemala including the Terminal market. Retailers from these markets buy fish at the Terminal early in the morning and are ready to sell by 9:00 a.m. Fish vendors reported that the fish is carried from the Terminal to the surrounding markets by city bus or "caminonetts," station wagons that transport goods for a set fee. Figure 11 indicates the location of the markets within the city. It is clear that some areas may be served by a few markets, while consumers in other areas must go some distance to shop. The lower numbered zones represent the older areas of the city, in which are located most of the public markets. Informal markets have sprung up in the streets around the city to serve the areas without markets; however, little is known about these operations due to their impermanence.

Markets vary in distance from the Terminal (2 to 20 miles), in size, and in quantity of fish handled. Some markets have two or three vendors who report selling 10-20 pounds on an average day. In the Terminal, the fish area is clearly defined and has 27 vendors. The retailers surveyed reported average sales of 20-30 pounds per day, although some report 5-10 pounds of sales on a bad day. Two of the larger retailers averaged 50 pounds of sales daily.

All other markets resemble the terminal in that most goods for the home can be purchased in each. Fish vending varies little by market. Each market is characterized by similar stalls, weighing, and displaying facilities. Retail sales of fish in general are usually small, averaging 2 pounds. The range of retail prices for fish was 40¢ to $1.20 per pound. Liseta, morarra, juilin, and tiburon (shark) are among the lower priced fish; robalo, boca colorado, and large corvina are the more expensive species. With the exception of tiburon, the less expensive fish are sold whole; the more expensive are sold in steaks. Tiburon is fileted at sea because of its rapid deterioration rate. Fish heads are also sold for use in soup. The most common fish head sold is robalo (red snapper).

Collectively, the public markets account for a high percentage of the fresh fish available in Guatemala. However, it is possible to buy frozen fish in the supermarket or corner grocery. Much of the frozen fish is poorly preserved and marketed, particularly the fish frozen whole without packaging.

The two shrimp companies sell neatly packaged fish fillets and small whole fish, generally in one pound bags. Packaged fish is also imported from Honduras and Nicaragua. Some of this fish is sold frozen, some refrigerated, although it is not uncommon to see the packaged fish displayed without ice.

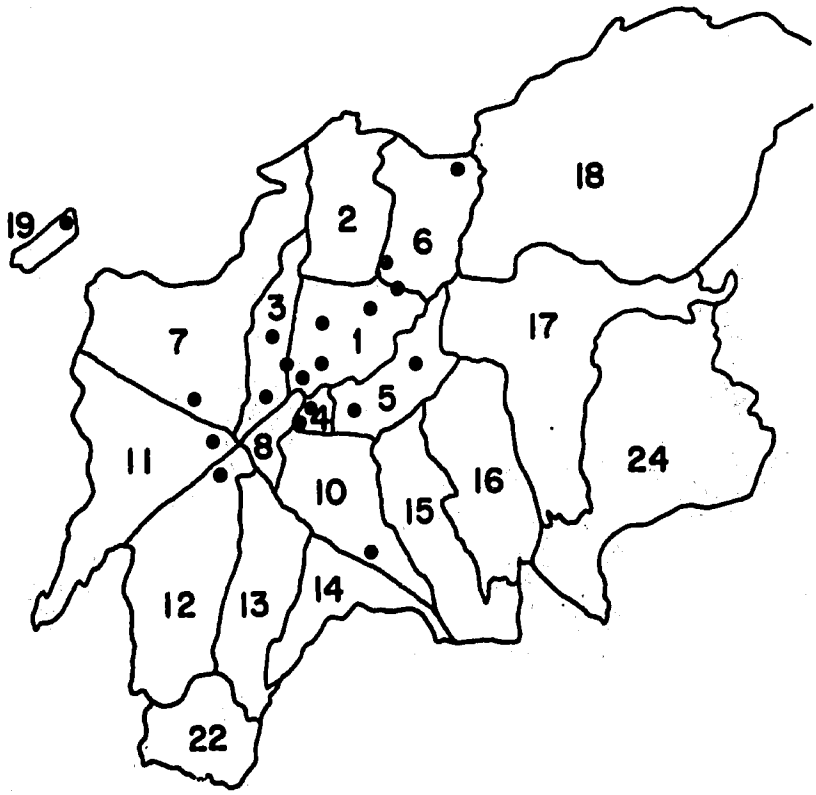

FIGURE 11. LOCATION OF MARKETS IN GUATAMALA CITY BY ZONE.

III. Concluding Remarks

This completes our overview of the three countries studied in this volume. While the countries exhibit several differences, they also exhibit similarities important for our research results. The small-scale fisheries in the three Central American countries are fairly similar with respect to the species caught, the harvesting methods and marketing system. The economics of the three countries are also fairly similar. These similarities, we believe, suggest that the research results presented herein are valid for most Central American locales, if not for much of Latin America. Whether the results are valid for other parts of the third world is an open question, however.

FOOTNOTES

[1]Unless otherwise noted, the data used in this chapter are taken from two sources: Wilkie and Reich, Statistical Abstract of Latin America (1980), and U.S. Department of State, Background Notes, various issues.

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CHAPTER 3. ASSESSMENT SURVEYS - COSTA RICA
BY D.K. Stevenson

The objective of this study was to test systems of data collection and analysis useful for the assessment of individual stocks harvested by tropical artisanal fisheries. The assessment objective was the determination of maximum sustainable yield by means of a mathematical yield model (Beverton-Holt model, 1956) modified for use with tropical fish populations. Methodologies which were tested were aimed at estimating vital statistics (growth and mortality rates) required by the model.

A major emphasis was to test low-technology parameter estimation procedures which would be uniquely applicable to the evaluation of stocks harvested by tropical artisanal fisheries in the LDCs and which could be implemented by fishery agencies in these countries. Toward this end, assessment procedures tested in Costa Rica were evaluated in terms of their general usefulness in other LDCs.

I. Selection of an Assessment Model

Although the Beverton-Holt model requires more data than other models, it was selected for several reasons. First, the parameters required by this model can be estimated under ideal conditions after one year of data collection. Thus, this model could be effectively used in situations where adequate historical data (e.g., catch and effort statistics) do not exist. Second, this model has been modified (Holt, 1962; Kutty, 1970) for use with tropical fish populations by the substitution of size-dependent terms for age-dependent terms and the use of exploitation rates and mortality/growth ratios rather than individual estimates of growth, natural mortality and fishing mortality. Third, once the required parameters have been estimated, this model is more versatile than other models since it permits yield to be maximized by means of gear regulations as well as limitations on fishing effort.

The Beverton-Holt model, of course, still is limited in its application by assumptions such as constant growth and mortality, the fact that it applies to single species populations (and thus ignores species interactions) and the fact that recruitment, a natural variable which has a profound effect on the biomass of exploited populations, is usually unknown.

II. Selection of Parameter Estimation Procedures

Two methods for estimating growth and mortality rates were tested in Costa Rica. They were: 1) the analysis of length-frequency data, and 2) a tag and recapture study. Both of these methods frequently have been used for estimating the vital statistics of temperate zone fish populations exploited by large-scale fisheries. Length data have been analyzed for assessment purposes in tropical artisanal fisheries (Ommanney, 1949; Jhingran and Natarajan, 1969; Munro, 1974; Chapman and Van Well, 1978; Marten, 1978), but recently developed mathematical techniques for analyzing polymodal frequency distributions have not been widely applied to species exploited in these fisheries. There have been a few attempts to apply tag and recapture techniques on a modest scale to tropical fish populations (Randall, 1962; Moe, 1966, 1972), but researchers have generally avoided relying on local technology for tagging purposes and on artisanal fishermen for recoveries.

Length frequency data are readily available in the LDCs and can be collected directly from commercial landings without large investments in sea-time or equipment. For this reason, the development of survey methods and analyti-

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cal techniques which facilitated the use of this source of information was a high priority during the first year of the study. The tag and recapture study was initiated at a later date as an alternative method which required a more technological approach to parameter estimation.

A number of methods were tested for estimating growth and mortality rates from length data and from tag and recapture data. Growth was estimated from the increments in the mean monthly lengths of component size groups in length data obtained by a given fishing gear in a given fishing zone, and by direct measurement of individual tagged fish at release and recapture.

Total mortality rates were estimated from data on the decline in the relative abundance of fish sampled in successive length classes (when growth estimates were available), from data on the relative abundance of fish in two different year classes (in individual monthly length-frequency distributions) and by using the proportion of tagged fish which are returned over time (with known estimates of fishing effort). Natural and fishing mortality rates also can be estimated from tag and recapture data by the same procedure. An additional method for estimating natural and fishing mortality which was tested required data on the relative abundance of three successive year classes. These data are usually obtained by sampling the catch of two different fishing gears where one gear harvests these year classes in direct proportion to their actual abundance and the other harvests selectively.

An important analytical technique which was tested for the estimation of mean lengths, variances and percent compositions of individual size groups in a polymodal length-frequency distribution was a computerized maximum likelihood estimation technique (Tomlinson, 1971; Yong and Skillman, 1975) originally formulated by Hasselblad (1966) and now available for use by computer. This technique is essentially a more objective formulation of graphical techniques developed thirty years ago (Harding, 1949; Cassie, 1950) which based the separation of individual, normally-distributed size groups on the points of inflexion in a cumulative size frequency curve. This technique permits, under certain conditions, the estimation of mean length and percent composition of individual size groups from polymodal length frequency distributions which cannot be reliaby interpreted visually. This procedure was judged to be particularly applicable for tropical fish populations which, because of high growth rates, short life spans, and multiple spawning seasons, may be characterized by length-frequency distributions which do not show clearly defined size groups.

III. Design and Implementation of Data Collection Procedures

Sample Survey of Commercial Landings. Commercial landings were sampled in Puntarenas, the principal landing port in the Gulf of Nicoya, on a continual basis from July 1976 through June 1977, by University of Rhode Island (URI) and Ministry of Agriculture (MAG) biologists, Over 40,000 individual length measurements were made on 1,412 occasions. Eighty-five percent of those measurements were collected from six species (Table 1). Length data were collected and processed as monthly length frequencies for three different fishing zones (Figure 1) and different gear types for approximately fifteen species. Secondary information collected from the same landings survey included catch and effort data by species from different zones and for different gears.

Since the primary objective of the biological sampling program was to estimate vital statistics from length-frequency data, landings samples were not distributed at random to reflect actual fishing activity (gears used and zones fished) in the Gulf. In fact, sampling was directed at those landing sites which provided greater numbers of the more valuable commercial species (corvina, snapper and mackerel). Many of the less valuable species were not measured; these included sea catfish (commercial class "cola") and sharks

TABLE 1. Number of Length Measurements Collected for Six Principal Species Landed by the Artisanal Fleet in Puntarenas, Costa Rica, During the Period July 1976 to June 1977

Species		Sample Size
Micropogon altipinnis	Corvina agria	9,331
Cynoscion squamipinnis	Corvina aguda	13,833
Cynoscion albus	Corvina reina	2,783
Cynoscion phoxocephalus	Corvina picuda	2,079
Cynoscion stolzmanni	Corvina collamarilla	1,432
Scomberomorus sierra	Macarela	4,695
	Total	34,153

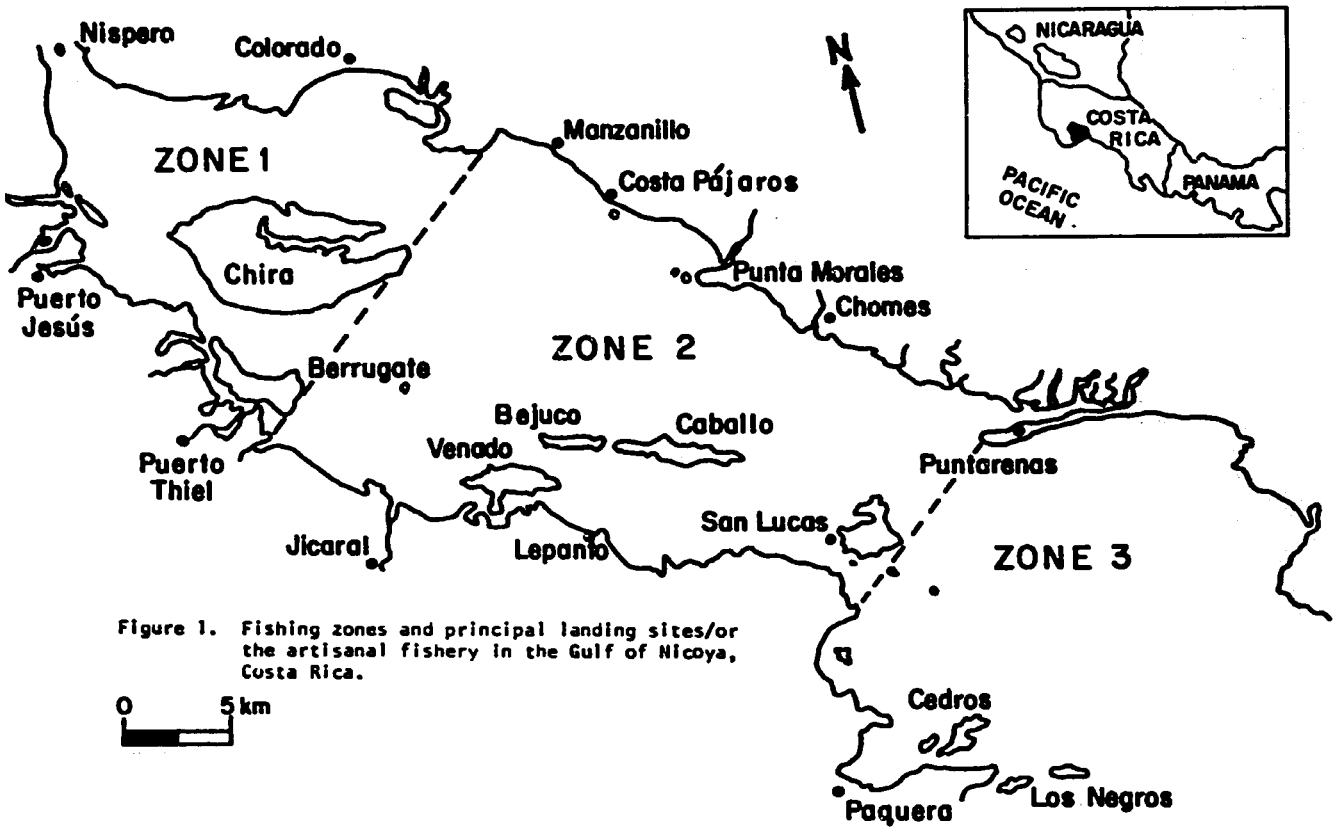

Figure 1. Fishing zones and principal landing sites/or the artisanal fishery in the Gulf of Nicoya, Costa Rica.

(classes "cazon" and "posta") which were landed with their heads removed. Only two species of the diverse commercial category "chatarra" were selected for measurement.

All fish landed by artisanal fishermen in Puntarenas are eviscerated and thus it was impossible to collect ancillary biological information such as sex, weight and reproductive condition useful for assessment purposes. Attempts were made to collect these data by means of on-board sampling, but trips were not made on a regular basis and very little information was compiled.

Tag and Recapture Study. A total of 2,264 fish were tagged by URI and MAG biologists during two six-week periods in 1978 (Feb.-March and June-July). Two species accounted for 60 percent of the total number of tagged fish (Table 2). Approximately twenty species were tagged; nearly all of them currently are exploited by the artisanal fleet in the Gulf of Nicoya.

Tagging was conducted with a 250-meter lampara net and a small five-meter trawl, both operated by hand from a 25-foot commercial gill-netting vessel in shallow areas adjacent to several estuaries which empty into the west side of the Gulf (Figure 2). Tagged fish were recovered from local fishermen and consisted of 59 returns, representing 2.6 percent of the total number of tagged fish. One species accounted for 42 percent of all returns (Table 2) and was the only species which provided sufficient data for parameter estimation.

IV. Evaluation of Parameter Estimation Techniques: Length-Frequency Data

Growth Estimates. Reliable growth estimates depend on the determination of the mean length for each individual size group in a given length frequency distribution and a calculation of the increment of each size group over time. The absolute age of individual size groups does not have to be known. Efforts to mathematically estimate mean lengths were hindered by several problems.

First, the length frequencies for many species varied depending on the fishing zone (Figures 3,4) and/or the gear used (Figures 5,6,7). For these species, data from different zones or gears could not be combined and monthly sample sizes often were too low to permit reliable mean length estimation. Second, the degree of overlap between adjacent size groups often was considerable, a factor which further reduced the precision of mean length estimation, even for species which were sampled in abundance (Figure 8). Third, for some species, length frequency distributions did not change in any significant way from one month to the next (Figure 9). The continual dominance of a single size group suggested continual recruitment, a pheonomenon which made growth estimation by this procedure impossible in many cases.

The problem of growth estimation was exacerbated by the selective performance of gear such as gill nets which only captured fish in a certain defined size range. For Micropogon altipinnis, for example, fish were captured in a narrow 25 cm length range which was very close to the maximum limiting length (L_∞) attained by the species and were repeatedly represented by a single predominant size group (Figure 10). Estimates of growth which rely on only a limited size range are risky, especially if the sampled size range is close to L_∞ and L_∞ is not known with any certainty.

Length-frequencies obtained from hook and line fishing were often equally restricted in range. Samples of the larger species captured with hooks, however, displayed more complex size compositions (Figures 11,12). For species such as Ctnoscion albus, individual size groups could be expected to remain in the exploitable size range for a longer period, thus permitting the estimation of growth from a longer time series of size increments.

Mortality Estimates. A direct method for estimating total mortality which does not require a priori growth rate estimates requires estimates of the

TABLE 2. Numbers of Fish Tagged and Recovered, by Species, During 1977-78 by URI and MAG Biologists in the Gulf of Nicoya, Costa Rica

Family, species	Tagged	Recovered	Percent Recovered
Sciaenidae (croakers)			
Micropogon altipinnis	41	1	.025
Cynoscion stolzmanni	72	4	.056
Cynoscion albus	22	2	.091
Ophioscion sp.	678	5	.007
Paralonchurus dumerilii	85	0	-
Cynoscion phoxocephalus	32	1	.030
Cynoscion squamipinnis	184	1	.005
Others	16	0	-
Lutjanidae (snapper)			
Lutjanus argentiventris	96	8	.083
Lutjanus colorado	27	1	.037
Others	14	0	-
Centropomidae (snooks)			
Centropomus undecimalis	3	2	.670
Centropomus unionensis	84	1	.011
Centropomus pectinatus	13	0	-
Centropomus robalito	12	1	.083
Centropomus spp.	30	4	.130
Ariidae (catfish)			
Sciades troschelii	691	25	.036
Felichthys jordani	78	2	.025
Others	86	1	.012
Total	2264	59	.026

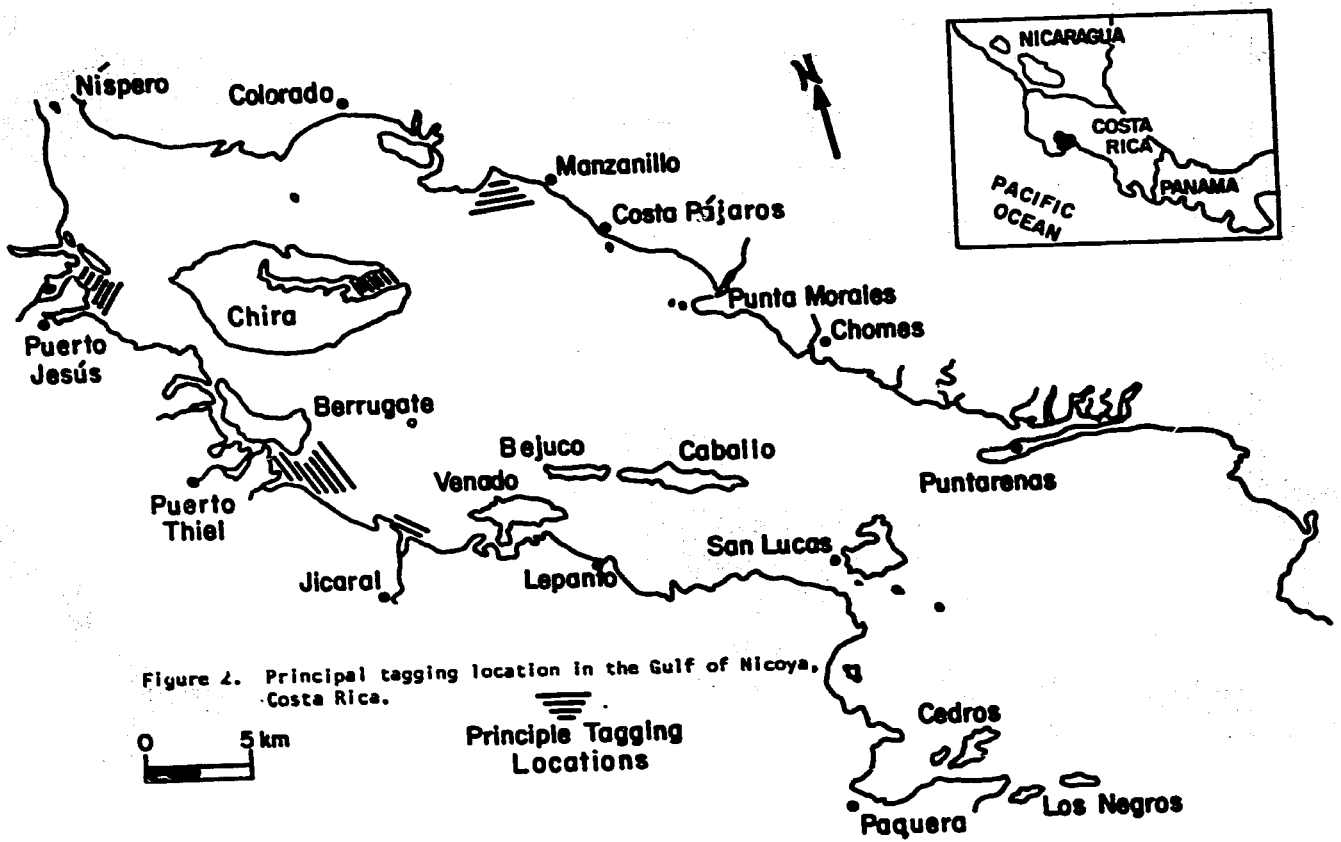

Figure 2. Principal tagging location in the Gulf of Nicoya, Costa Rica.

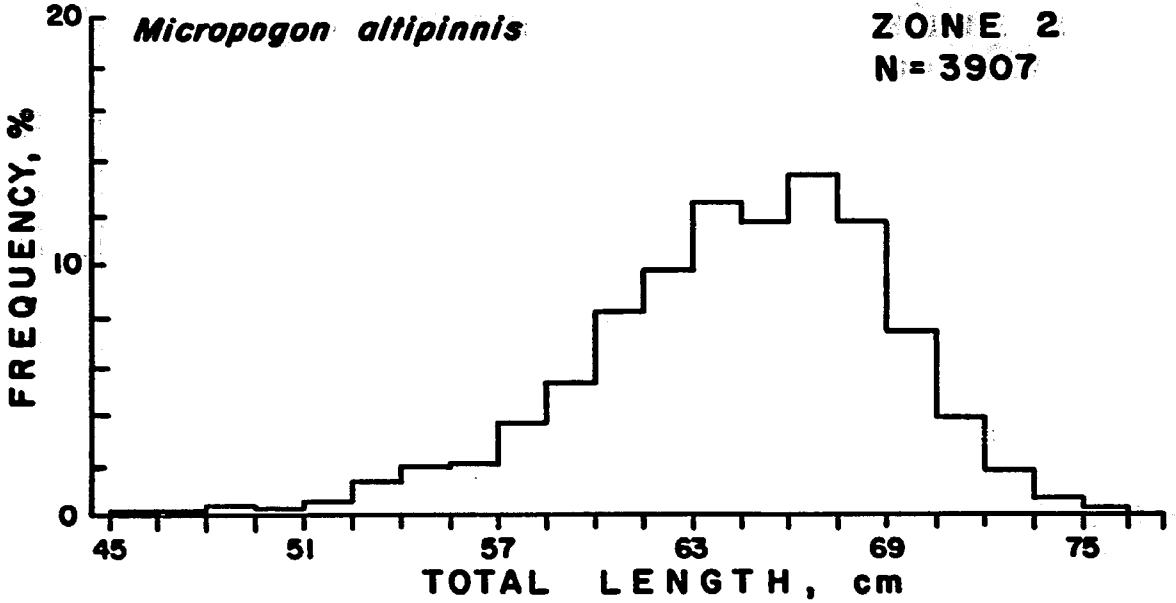

Figure 3. Average annual 1976 - 1977 length frequency distributions for corvina agria (Micropogon altipinnis) caught in 12.5 - 15.0 cm mesh gill nets in Zone 2, Gulf of Nicoya, Costa Rica.

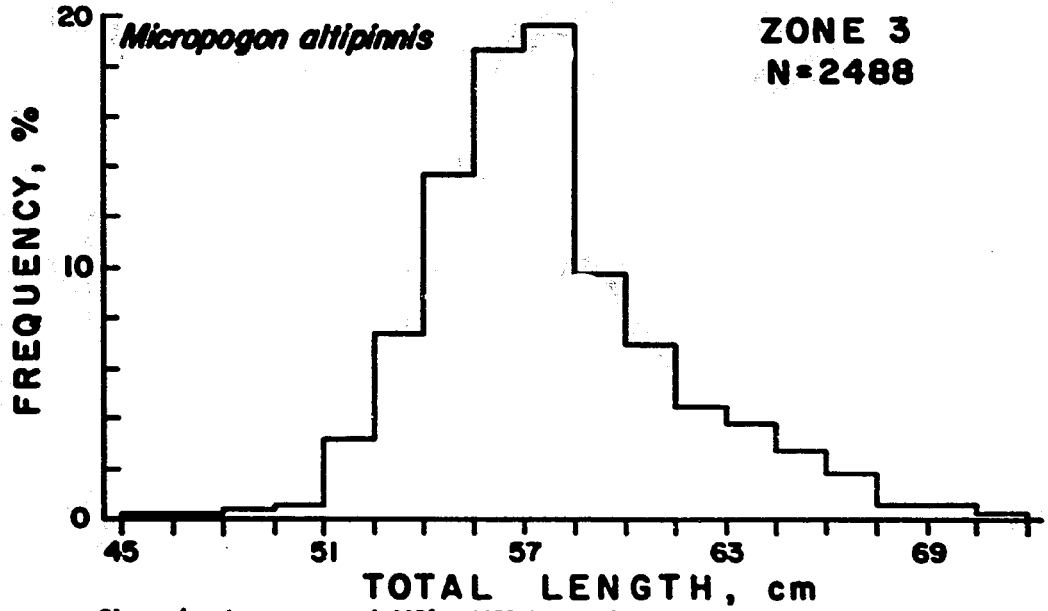

Figure 4. Average annual 1976 - 1977 length frequency distributions for corvina agria (Micropogon altipinnis) caught in 12.5 - 15.0 cm mesh gill nets in Zone 3, Gulf of Nicoya, Costa Rica.

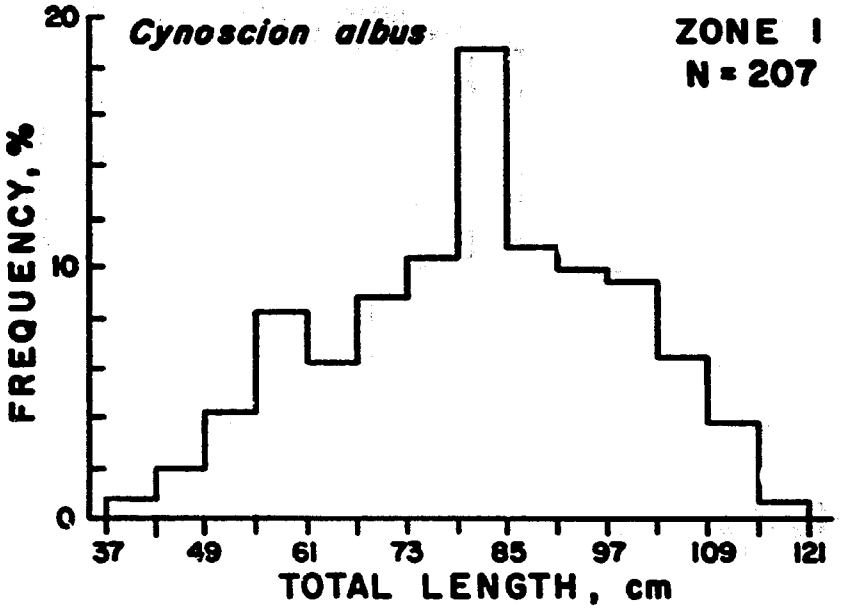

Figure 5. Average annual 1976 - 1977 length frequency distributions for corvina reina (Cynoscion albus) caught in 12.5 - 15.0 cm mesh gill nets in Zone I, Gulf of Nicoya, Costa Rica.

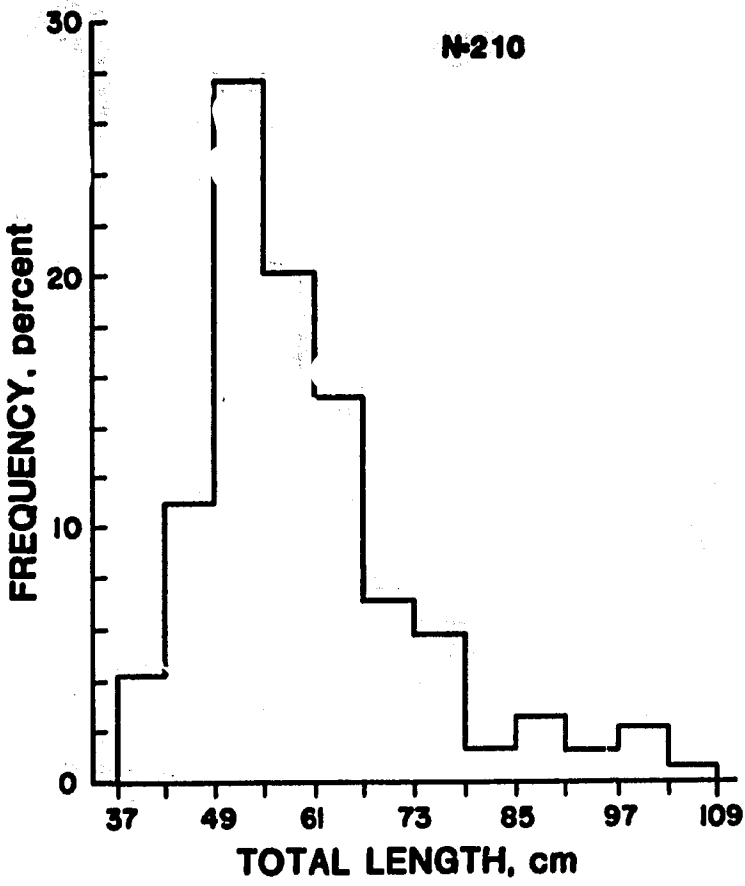

Figure 6. Average annual 1976 - 1977 length frequency distributions for corvina reina (Cynoscion albus) caught in 10.0 - 11.25 cm mesh gill nets in Zone I, Gulf of Nicoya, Costa Rica.

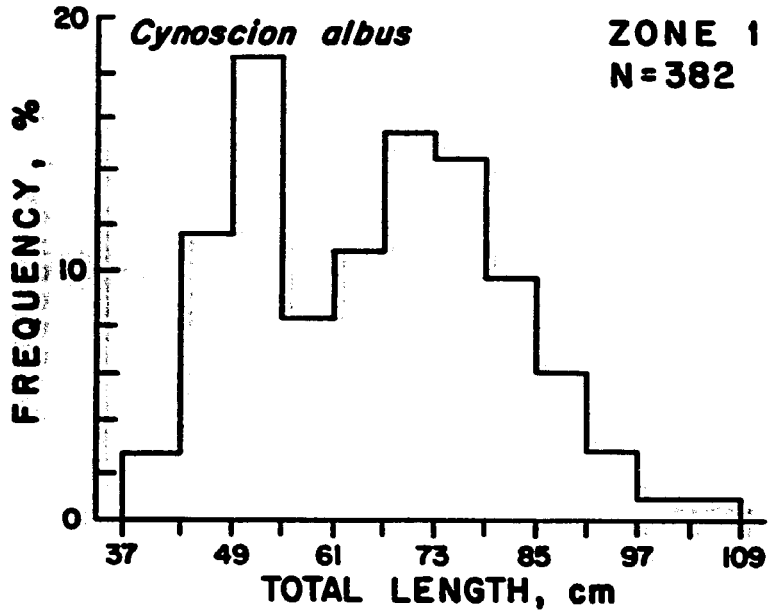

Figure 7. Average annual 1976 - 1977 length frequency distribtuions for corvina reina (Cynoscion albus) caught with hooks in Zone 1, Gulf of Nicoya, Costa Rica.

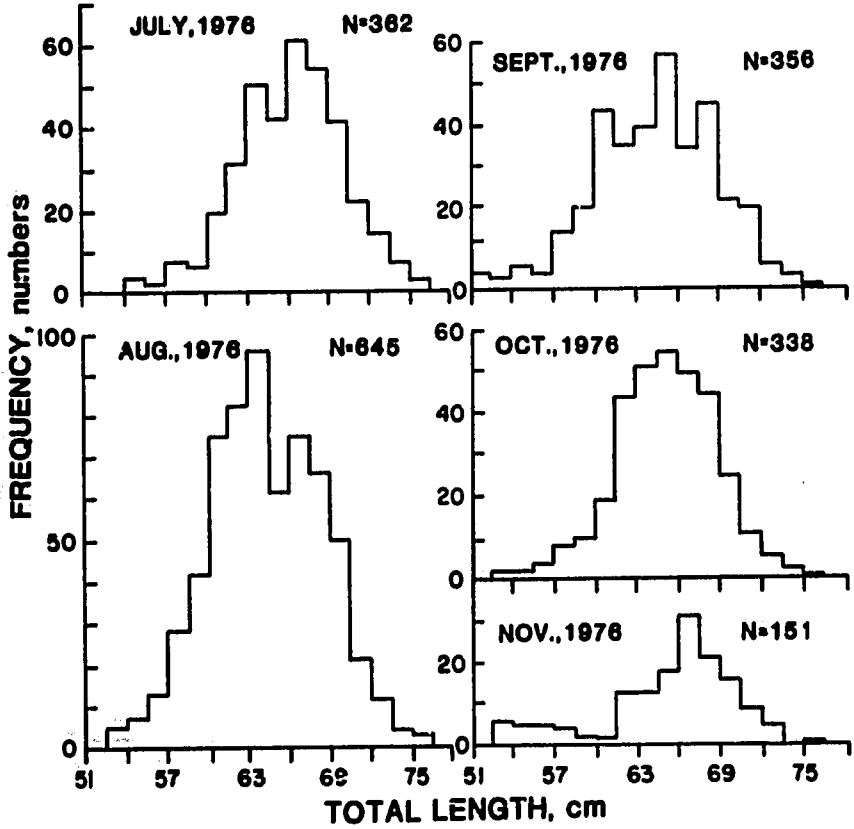

Figure 6. Monthly length frequency distributions for corvina aqria (*Micropogon altipinnis*) caught with 12.5 - 15.0 cm mesh gill nets in Zone 2, Gulf of Nicoya, Costa Rica, during 1976.

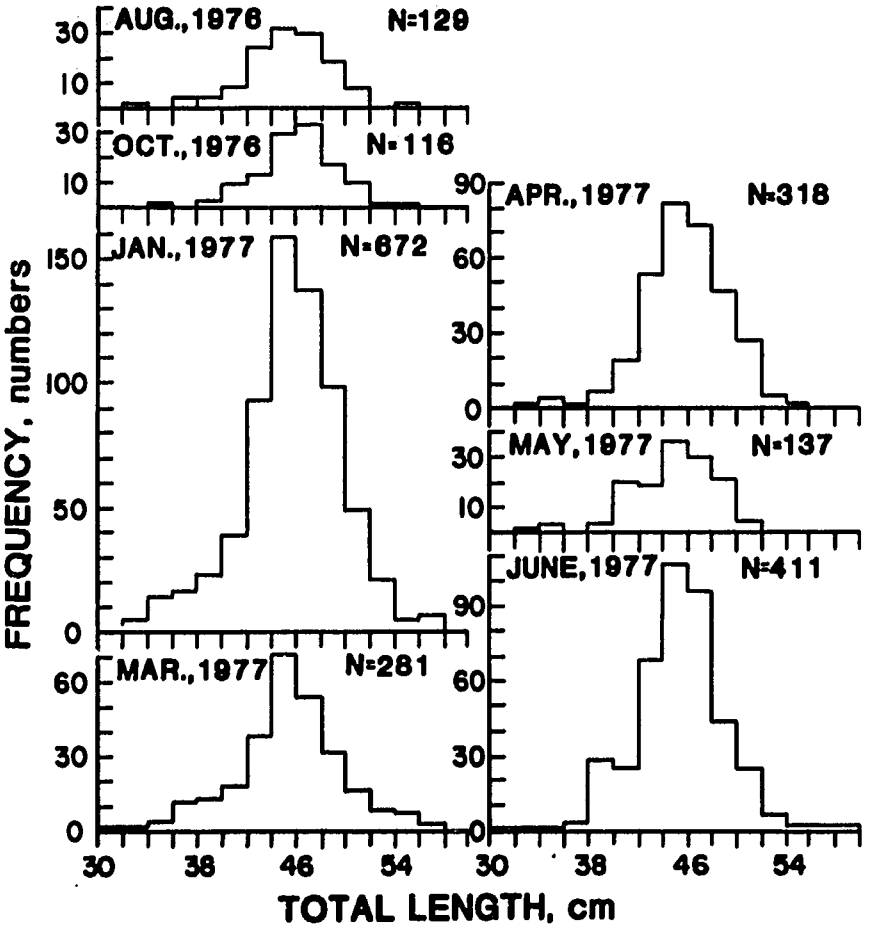

Figure 9. Monthly length frequency distributions for corvina aguada (Cynoscion squamipinnis) caught with 7.5 - 8.5 cm mesh gill nets in Zone 2, Gulf of Nicoya, Costa Rica, during 1976 - 1977.

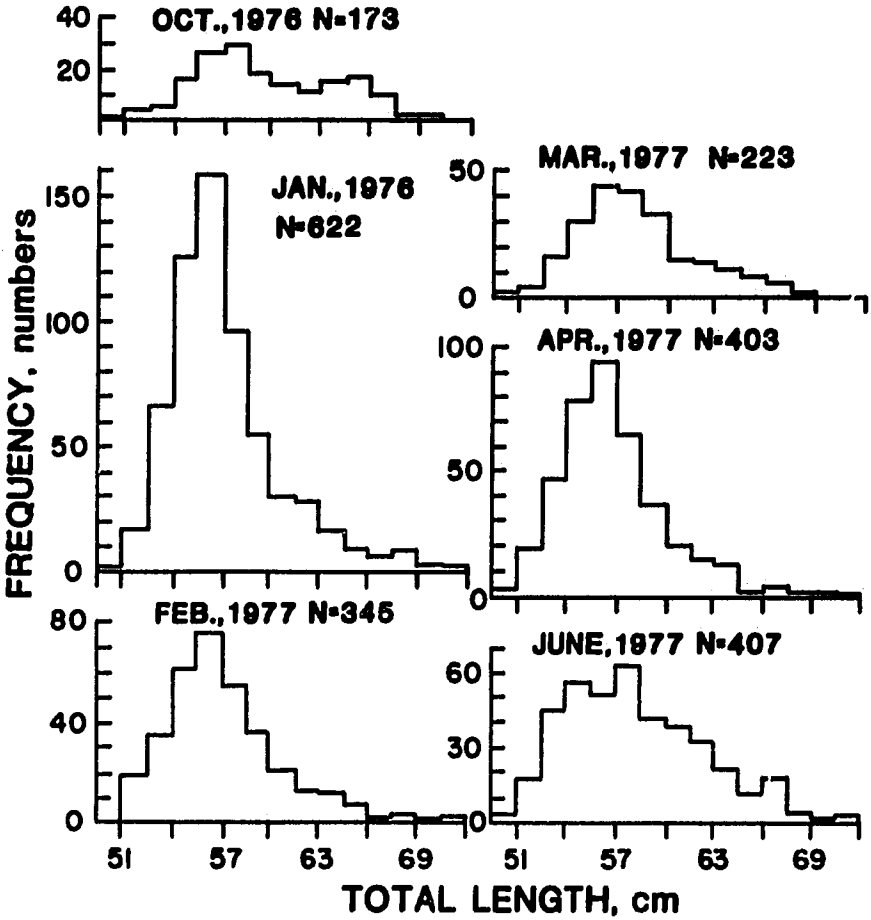

Figure 10. Monthly length frequency distributions for corvina agria (Micropogon altipinnis) caught with 12.5 - 15.0 cm mesh gill nets in Zone 3, Gulf of Nicoya, Costa Rica, during 1976 - 1977.

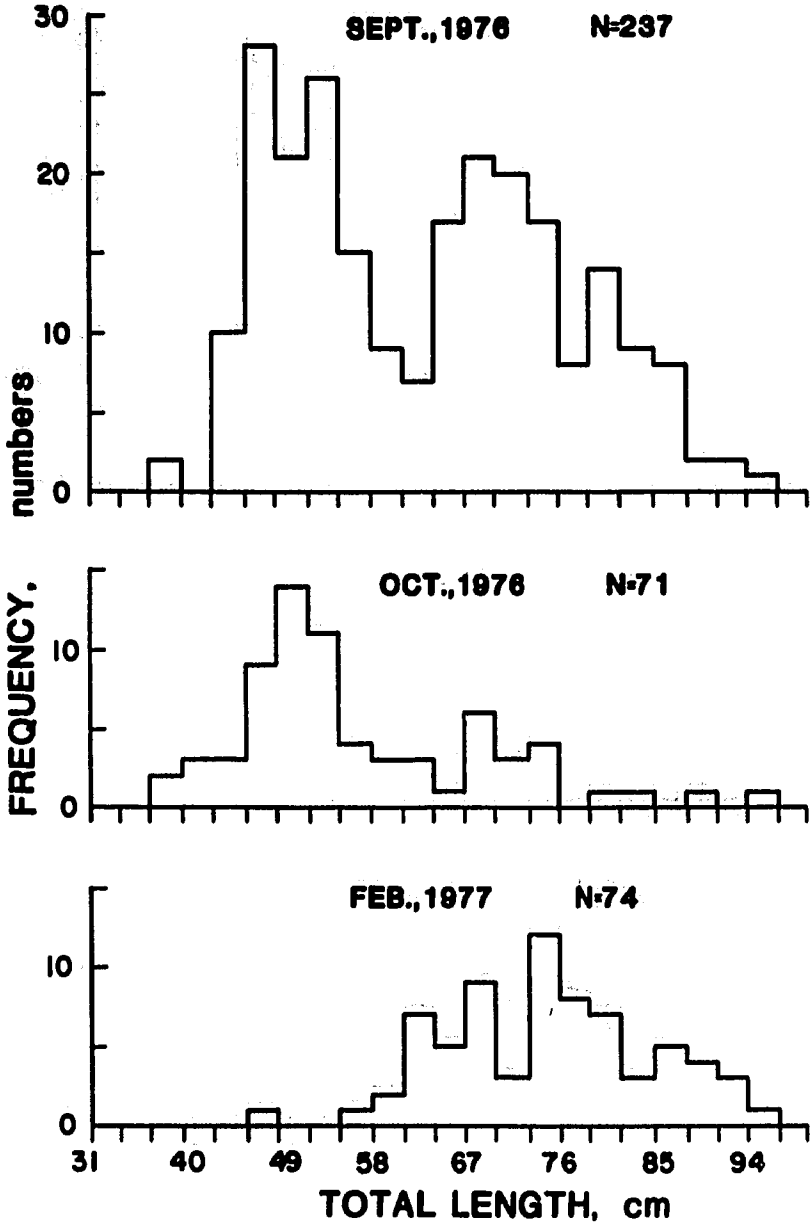

Figure 11. Monthly length frequency distributions for corvina reina (*Cynoscion albus*) caught with hooks in Zone 1, Gulf of Nicoya, Costa Rica, during 1976 - 1977.

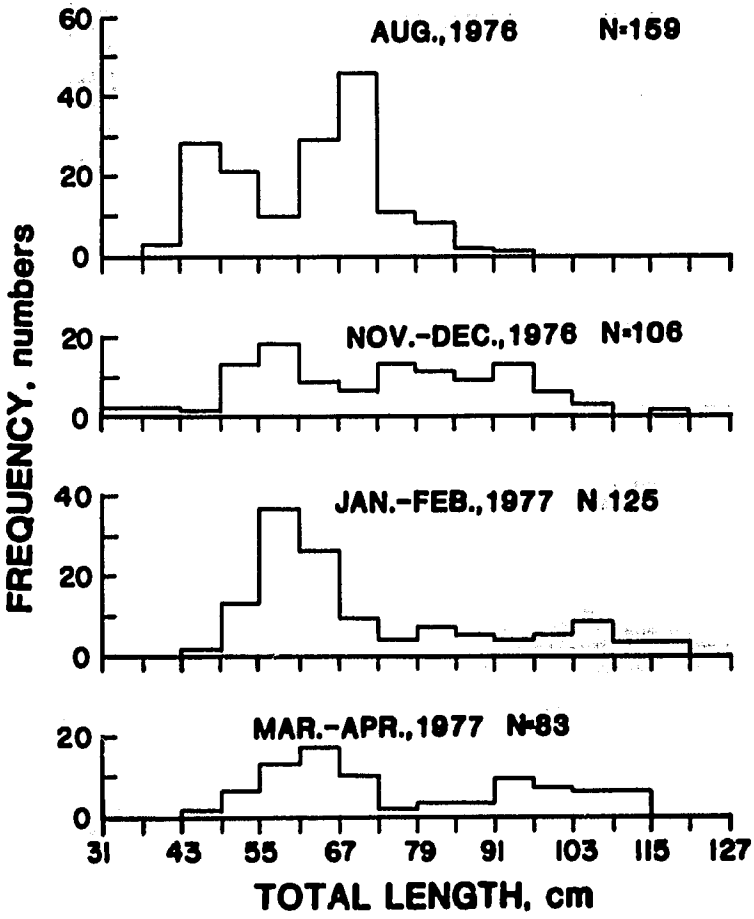

Figure 12. Monthly and bi-monthly length frequency distributions for corvina reina (Cynoscion albus) caught with hooks in Zone 2, Gulf of Nicoya, Costa Rica, during 1976 - 1977.

relative abundance of at least two size groups in a length-frequency distribution. Although the absolute age of these size groups need not be known, the time which is required for fish in group A to attain the size of fish in group B must be known. Furthermore, both size groups must be captured beyond the selection range of the gear being used.

This estimation method required the application of the same computerized mathematical analysis (ENORMSEP) which was used to estimate mean lengths of individual size groups in a polymodal length-frequency distribution and was hindered by the same problems. Moreover, McNew and Summerfelt (1978) have reported that the probability of error in the estimation of the relative abundance of individual size groups is greater than the error associated with mean length ($\bar{l}$) estimation. Also, since the "transition time" between l_a and l_b must be known, this method is severely limited by the fact that male and female fish may grow at different rates and that some species may spawn more than once a year. Length samples obtained from whole fish of known sex were insufficient for total mortality rate estimation by this method.

An indirect method for estimating total mortality (Z) from length data requires a priori knowledge of growth (K). Estimates are derived according to the following formula (Beverton-Holt, 1956):

$$Z = K \frac{(L_\infty - \bar{l})}{(\bar{l} - l_c)}$$

where l_c = the smallest length of fish that are fully represented in the catch

$\bar{l}$ = mean length of fish greater than l_c.

This method was applied to the estimation of total mortality rates for the two species for which at least rough approximations of K and L_∞ were known.

No estimates of natural mortality and fishing mortality could be obtained from length-frequency distributions compiled in Costa Rica. The method which was tested required that fishing effort vary according to the age of fish captured by two different gears (e.g., as a result of gear selectivity). For a gill net fishery, for example, the method requires that: (1) two size groups be exploited selectively by one mesh size while a third is exploited with 100 percent efficiency by the same mesh; (2) the same three size groups be exploited concurrently in a smaller-meshed net or by some reference gear (e.g., a trawl) with 100 percent efficiency; (3) two of three groups remain in the exploitable size range for three months or more.

Due to the extremely simple size compositions of the sampled species, these requirements clearly could not be met by species harvested with gill nets or hooks in the Gulf of Nicoya. This method would have a much greater probability of success when applied to long-lived species which grow slowly and in fishing areas which are amenable to bottom trawling or purse-seining.

General Conclusions. For most species, either restricted size ranges, the extreme overlap of adjacent size groups or low sample size prevented the use of mathematical length-frequency resolution techniques. Growth rates were estimated for two species (Cynoscion albus and Cynoscion squamipinnis) from modal length progressions over brief time intervals. Modal lengths were determined from a visual inspection of length-frequency data. However, even for these two species, only a small sub-set of the total available length data was used. The results obtained did not justify the effort invested in collecting, compiling and analyzing 40,000 individual length measurements.

Direct methods for estimating total mortality from length data require samples with at least two clearly-defined size groups captured non-selectively, adequate sample sizes and complementary biological information.

An alternative was to estimate Z from length data with no age information, but with a priori estimates of growth. These calculations were performed for Cynoscion albus and Cynoscion squamipinnis.

V. Evaluation of Parameter Estimation Techniques: Tag and Recapture

In order to estimate valid growth and mortality rates for any given species from a tag and recapture study, reliable data are required from approximately 50 recoveries. Assuming a 5 percent return rate, therefore, at least 1,000 fish must be tagged per species. Only two species were tagged in sufficient quantities to permit parameter estimation and only one of these was of any significant commercial importance (Table 2).

Use of a more efficient capture gear (e.g., a larger trawl and a larger vessel) would probably have increased the numbers of tagged fish for some species, but probably not for species such as the corvinas, snappers and snooks which apparently abound in shallow waters near the mouths of estuaries and are inaccessible to most large-scale fishing operations.

Growth Estimates. In addition to the low number of returns, another significant problem which prevented the estimate of reliable growth rates was the accuracy of individual length measurements, both at the moment of tagging and upon recovery. Some fish, for instance, were reported to be smaller at recapture than at tagging. Great care was taken to standardize measurement procedures aboard the vessel. Nevertheless, a probable measurement error of $\pm$ 5 mm significantly affected growth estimates for fish which remained at liberty for short periods of time.

A more significant source of measurement error resulted from the dependence on fish buyers in remote areas of the Gulf to measure recovered fish. Anticipating that some fish would be recaptured by fishermen who do not bring their catch to Puntarenas, meter sticks were distributed to buyers in outlying areas and they were instructed to measure fish which could not be held until a MAG biologist arrived from Puntarenas. Buyers who co-operated were paid a reward nearly equal to what the fishermen received. Since fish were tagged in the more remote areas of the Gulf and did not move large distances during the interval between tagging and recapture, many of the recovered fish were turned in to these buyers and measured by them. Many of these measurements were clearly erroneous.

An additional source of error in length measurements presumably resulted from the shrinkage of fish which were frozen or held on ice before measurement. A 5 mm correction was applied to length-at-capture measurements for fish known to have been previously iced or frozen.

Growth was estimated from a linear regression of the average length increment per day versus initial length for eight records of "cuminate colorado" (Selades troschell). These eight records were selected from an original total of 21 after rejecting all measurements made by non-biologists and correcting for fish which were iced or frozen before measurement. The regression was significant at 90 percent confidence, but only after arbitrarily eliminating two points from an original group of ten.

This exercise demonstrated the importance of 1) marking a sufficient number of fish so that growth and mortality can still be reliably estimated after "bad" data are eliminated, and 2) collecting reliable information when the number of tagged fish, or the expected recovery rate, is low.

Mortality Estimates. Mortality estimation from tagging studies requires 1) that all recaptured fish are reported, 2) that some correction be made for fish which die as a result of tagging and 3) that tagged fish distribute themselves randomly within the entire population upon release.

Some marked fish which were recaptured were never reported. Future efforts to monitor tag returns from artisanal fishermen must account for

fishermen's suspiscious of research projects which they feel will result in some curtailment of their livelihood. Given a large enough population of tagged fish which are distributed uniformly over the fishing grounds, methods should be developed for selecting a sub-set of fishermen who can be assumed to cooperate fully and monitoring their fishing activity separately aa a means of evaluating the degree of non-reporting. The number of fish tagged during this study was not sufficient to justify such an effort.

Attempts were made to assess the mortality of fish after tagging. Floating cages were deployed, one containing tagged fish and one containing untagged fish, but the experiment had to be abandoned after the cages were damaged and apparently vadalized.

An important result of the tagging study was the observation that tagged fish did not move significantly during the interval between tagging and recapture. In most cases, recoveries were reported from the same general area where they were tagged. If fish populations exploited in tropical estuaries such as the Gulf of Nicoya are locally distributed, it cannot be assumed that marked fish will disperse and mix uniformly with unmarked fish. Thus, a fundamental assumption of mortality estimation is violated and other methods must be pursued.

General Conclusions. Tag and recapture studies can be expected to be of marginal value for tropical small-scale fishery stock assessment unless several technological problems are solved. Chief among these is the need to tag large numbers of the commercially important species and release them with minimal damage. Effort must be made to obtain the cooperation of fishermen in remote areas and to recover tagged fish intact and in good condition in order to improve length measurements. This method is not appropriate for mortality rate estimation if marked fish do not mix uniformly with unmarked fish over the entire study area.

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CHAPTER 4. ECONOMIC SURVEYS OF THE CAPTURE SECTOR--COSTA RICA

By J.G. Sutinen and W.C. Kolberg

This chapter describes and evaluates two surveys of the capture sector in the Gulf of Nicoya, Costa Rica.[1] The two surveys were conducted simultaneously using different sampling and collection procedures, one an interview of randomly selected respondents and the other requiring self enumeration by non-randomly selected respondents. Both surveys generated data for a year but were effectively monitored for only a five-month period (September, 1976 through January, 1977).

1. Description of the Surveys

Planning. The first step in planning a survey is to define its objectives. While our immediate objective was to test and refine alternative methods for collecting and processing data, the ultimate aim is to design and implement an information system to serve the process of fisheries development and management. The questions raised in this process are expected to be very general on one hand, relating to a broad range of subjects, and to be very specific to a particular region, country and/or fishery on the other hand. While these questions have not been rigorously formulated, they are expected to be addressed using a bioeconomic analytical framework.

The population chosen for each survey was the small-scale fishermen of the Nicoya Gulf. The unit of analysis selected was the fishing firm (in most cases synonymous with a single vessel) and its production activities during (i) a fishing trip and (ii) a given period of time, such as a month. Two frame surveys were available to us. One was a census of gear in the fishery, taken the previous year by the Ministry of Agriculture. The other was a census of all sales by fishermen of their catch, covering the same period as the two surveys. Receipts of these sales were collected and processed to determine the weight and value of catch by gear type and days fished over the five month period.

Resources for the survey field work included six personnel of the Ministry of Agriculture (MAG) and two from the University of Rhode Island (URI), plus access to vehicles for site visits and various support personnel and supplies (e.g., paper). Other temporary labor was employed to work on data processing during the later stages of the survey.

The interview and self enumeration methods were selected for testing because they appeared feasible and to have the potential for providing a large quantity of high quality data. The observation methods, where a data collector records his observations of transactions and the fishing operation, appeared feasible but too costly for the quantity and quality of data likely to be generated. The specific interview method chosen involved a personal interview of the highest ranking crew member (e.g., captain) at the time the catch was sold. Usually, this corresponded to the end of a fishing trip for one vessel. In a few cases, however, multiple trips resulted in the catch sold in a single transaction.[2] The self-enumeration method involved individual boat owners keeping bookkeeping records on all fishing related activities. These records were copied at least once a month by survey personnel.

The variables for which data were collected focused on, but were not limited to, the costs and earnings of the fishing operation. The specific data collected differed by method. That is, the self-enumeration method generated data on total revenue and catch, days fished, costs (e.g., fuel, ice, and including maintenance and repairs), and returns to the crew and to the boat. These data were recorded for every fishing trip over the six month

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period. In addition, for a subset of the fishermen participating in the self-enumeration method, an inventory was taken of all gear and equipment, estimated market values, and a description of his indebtedness and the remuneration system used in his operation.

The data generated by the interview method were more detailed in the three categories of catch, effort and costs. Catch was broken down by commercial class and species, with a price for each. Effort was specified by gear measurements and the number of hours and where it was in the water. Costs were broken down by each input (e.g., fuel) and included the quantity used and price paid for each input. The costs of repairs and maintenance since the last trip were also requested. The self-enumeration method recorded data on a maximum of 26 variables per fishing trip; however, only 10 to 15 were commonly used. The interview method recorded data on up to 362 variables, with about 100 to 125 commonly recorded.

The sampling procedures available for this study fall into two categories: random and non-random. Random sampling was attempted for both methods but failed for the self-enumeration method. A large fraction of the fishermen who participated in the self-enumeration method volunteered, and several who were selected randomly chose not to participate. A simple random sampling procedure was chosen for the interview method. Stratified sampling was not feasible given the setting (though the data were later stratified). Systematic sampling was ruled out because of possible bias commonly associated with populations having periodic trends (Cochran, 1977). Since the geographic area of the fishery is quite small and relatively easily covered, cluster sampling was deemed not necessary.

All firms were not given the same chance to be selected by the random sample. Instead, firms were weighted by the number of days fished. That is, a firm that fished twice as many days was twice as likely to enter the sample. The actual mechanics of this procedure are described below. Other weighting schemes were possible (e.g., weighted by pounds or value of catch), but days fished was chosen in order to more accurately reflect the productive activity of capital and labor. Since the goals of development and management programs generally are to improve the returns to fishermen, we require representative data on their activity. Alternatively, if the goal of subsequent data analysis is to explain production then the appropriate weight would be pounds or value of the catch.

The time period for the survey was determined largely by exogenous factors. URI personnel visited the Gulf of Nicoya in February, 1976, to make preliminary arrangements for the survey. URI field staff could not locate in Costa Rica until June, and originally planned to leave at the end of August to return to Rhode Island, providing three months for testing the two survey methods. Effective data collection did not begin until August, however, due to several unexpected delays in the field. Some URI field staff extended their stay in Costa Rica in order to supervise and monitor the surveys through November. Ministry of Agriculture personnel continued the surveys through the following August.

Design. The major step in the design phase of a survey is the development and testing of the data collection instruments. The self-enumeration method involved constructing simple bookkeeping forms for the fishermen to use. The forms were adapted from a set developed for the Food and Agriculture Organization (Laxenaire, 1973). The interview form was developed in the field by URI and MAG personnel. Both instruments were tested and revised until an optimal instrument design emerged. The interviewers/collectors were trained in conjunction with this testing process.

Also included in the design phase is determination of the sample size, collection frequency, and the respondents. The sample size for the self-enumeration method was limited by the number of fishermen that could be recruited over a six week period. While we sought as many as possible, we ended with 58 individuals regularly filling out the bookkeeping forms. The

sample size for the interview method was limited by the available resources. In this case, three MAC personnel were available for interviewing. We orginally scheduled approximately 150 interviews per month, which would have fully accupied the three interviewers. For reasons noted below, our actual sample size was considerably smaller, numbering less than 400 for the five month period.

For the self-enumeration method the data were recorded continuously for each trip over the six month period, and collected at least once a month. The interview method was a simple random sample of the fishing trips made each month of the study.

As noted above, participants in the self-enumeration system were selected non-randomly. The participating, boat-owning fishermen were initially recruited in a series of meetings, then taught how to use the bookkeeping forms to record their costs and earnings. The respondent selected for the interview was the highest ranking crew member present during the sales transaction. In the majority of cases, he was the owner or captain of the boat.

Implementation. Only the interview method required repeated drawing of a sample, conducted once a month. From the previous month's sales receipts the days fished associated with each sale were recorded by site and hour of the day the catch was sold. This process yielded a distribution of days fished for all sites (Table 1), and a distribution of days fished by day of the week and hour of the day for each site (Table 2). Using a random number generator, the sample was drawn in two steps. First, the number of interviews was determined for each site. For example based on the previous month's landings, Punta was assigned an interview every time the two digit random number was between 1 and 49, inclusive, Enramada A assigned an interview every time a random number between 50 and 58 appeared, etc. This procedure generated the number of interviews for the current month as shown in the rightmost column of Table 1.

The second step involved allocating the assigned number of interviews for each site across days of the week and hours of each day. From the previous month's receipts a percent distribution of days fished by day and hour was calculated. Numbers between 1 and 100 were assigned to each day-hour combination, followed by a draw of two digit random numbers. The size of the sample for each site, of course, is given by the first step. For example, 53 interviews were assigned the Punta site and distributed as shown by the numbers in parentheses in Table 2. This two-step process provided a set of times and locations for the interviews.

At the time, the magnitude and distribution of landings appeared to vary little across weeks in a month; however, days of the week and hours of the day exhibited considerable differences in landings. Therefore, we treated all weeks the same for a given month, and sampled by week, day and hour as described above.

Three weeks of each month were set aside for interviewing in the city of Puntarenas, where the majority of large landing sites are located. The fourth week was devoted to interviewing at sites around the Gulf, which required transportation and lodging for the two interviewers used on this segment of the survey. For Puntarenas a sample of 100 interviews was drawn, each specifying a landing site, day of the week and hour of the day. The first week of each month was filled with as many interviews as could be scheduled. Frequently, no transaction would occur at the assigned time and place. When this happened, the same time and place were scheduled on the same day of the following week. The low ratio of successful interviews to the target number (400/750) was due almost entirely to imperfect timing in which no one was available for the interview; only one respondent refused an interview. For outside Puntarenas, the goal was 50 interviews, but the interviewers were encouraged to conduct as many as possible. The interviewers were assigned a specific location to interview for each day of their week long trip around the

TABLE 1

Site	Days Fished for Previous Month		Number of Interviews for Current Month
	Number	Percent	
Punta	794	49	53
Enramada A	139	9	6
Enramada B	160	10	10
Enramada C	284	17	11
Mercado	121	7	13
Pescarnes	136	8	7
Totals	1,634	100	100

Table 1. Distribution of Days Fished by Landing Site Puntarenas Costa Rica 1976.

TABLE 2

SITE: Punta

Hour of Day	Day of Week							Totals
	Mon.	Tue.	Wed.	Thur.	Fri.	Sat.	Sun.	
6	1	1 (3)	1	3 (2)	4 (1)	1 (1)	0	11 (7)
7	2 (2)	2 (1)	1 (1)	2	4 (2)	2 (1)	1 (2)	13 (9)
8	3 (1)	1 (1)	3 (3)	2 (1)	2	3 (1)	2 (2)	17 (10)
9	3 (2)	6 (3)	2 (1)	1	3 (2)	1	1 (1)	17 (9)
10	2 (2)	3 (2)	1 (2)	1	2 (1)	1	1 (1)	11 (8)
11	2 (1)	2 (1)	5 (2)	0	1	1	1	12 (4)
12	1	0	0	2 (2)	0	3	0	6 (2)
13	0	0	0	1	1	1 (2)	0	3 (2)
14	1	0	0	0	0	1	1	3
15	1	0	1	1 (2)	1	2	0	6 (2)
16	0	0	0	0	0	0	0	0
17	0	0	0	0	0	1	0	1
18	0	0	0	0	0	0	0	0
Totals	16 (8)	15 (11)	14 (9)	13 (7)	18 (6)	17 (6)	7 (6)	100 (53)

Table 2. Distribution of Landings by Day of Week and Hour of Day Puntarenas 1976.

Gulf, a schedule also based on information from previous months' sales receipts.

Interviewers had a rigid schedule to follow each week, traveling each day by bus or motorcycle to the selected landing sites in Puntarenas. For example, an interviewer's schedule might have him at site number one between 7 and 8 a.m., site number three between 9 and 10 a.m., back in the office until noon at which time he begins a schedule of site visits for the afternoon. He was instructed to interview the first boat landing at this assigned site within the assigned hour. The interviewers reviewed their data sheets for errors before turning the sheets over for processing.

Collecting the data for the self-enumeration method required visiting the participating fishermen once or twice a month, and transferring data to an indentical set of records kept by the survey staff. Once back at the office, the records were checked for consistency.

Processing. For both methods the data sheets were received and edited by a survey supervisor who checked for errors in the data. Where necessary, numerical codes were assigned before the data were transcribed to computer coding sheets. The coding sheets were then checked and errors eliminated by a team of faculty and students, a process that consumed considerable manpower and resulted in lengthy delays (see below). Once cleaned satisfactorily, the data were punched on cards at the URI academic computer center.

II. Evaluation of the Surveys

The evaluation focuses on the measurement reliability of the survey data, sampling problems causing imprecise measurement, and the costs of the two survey methods.

Measurement Reliability. Since every attempt was made to draw a random sample for the interview method, we expect estimates of population behavior based on sample data to have a reasonable degree of statistical precision. The purpose of this section is to characterize the extent to which the random survey method generated reliable measurements of population activity.

Actual population activity is assumed to be given by the landings receipts collected over the same period as the sample survey. The landings receipts contain the following data for each trip:

date and hour of sale;
names of buyer, seller and boat;
gear used;
days fished;
weight and value of landings by commercial class.

We compare actual population data with the sample survey data for days fished and catch (landings weight) broken down by landing zone, gear type and commercial class.

The average days fished per trip for the population, broken down by landing zone and gear type, are given in Table 3 (standard deviations are given in parentheses and the number of landings or trips, in brackets). Average days fished per trip for the survey are given in Table 4, where 90% confidence intervals follow the sample means. For five of the 16 sample estimates (i.e., 31%) the population means lie within the corresponding 90% confidence interval. This suggests the survey data on days fished do not yield precise estimates for the population as a whole.

Table 5 presents the results of a single four percent simple random sample of all landing receipts. In this case, for 15 of the 16 estimates the population means lie within the corresponding confidence interval. For days fished per trip, a simple random sample out-performs our field survey. This is one indication that, despite all of our efforts, our survey sampling

program was not effectively random. Some reasons for this failure are discussed below.

The results of the sample survey data on catch per trip are not quite as dismal. Tables 6 and 7 present the catch per trip for the population and the sample survey broken down by commercial class, gear type and landing zone. Here, 33 out of 56 (or 59%) of the population means lie within a 90% confidence interval for the sample estimate. Again, however, a four percent simple random sample of the landings receipts provides a higher proportion of "good" estimates (see Table 8).

The survey sample also provides acceptable estimates of catch composition for the five month period. Table 9 lists the percent composition by selected commercial classes for both the population and the survey sample. Using the Chi-square test, there is no statistical difference (at = 0.1) between the two sources for the entire period. The survey sample provides good estimates of composition for only two individual months (September and November), however.

Sampling Problems. Why did our sample survey yield such poor estimates, particularly for days fished, the variable upon which we based our sampling program? The answer is that our sample is not representative of the population. Table 10 presents the percent frequencies of days fished for both the survey sample and the population. Using the chi-square test, we must reject the hypothesis that the frequency distribution for the sample survey is the same as that for the population (at = .01). In other words, if our survey sample were truly random there is only a remote probability that this frequency distribution would occur. Our survey was most carefully conducted in Puntarenas (Zone A). Therefore, we might expect the sample for Puntarenas to be representative of the population in that zone. A similar test for Puntarenas sites, however, rejects the hypothesis of representativeness. This leaves us to conclude that while we went through the motions of drawing a random sample, we did not succeed.

We did not succeed in drawing a random sample because of some inherent flaws in the design of the sampling procedure. As described above, the sample was drawn from an expected population of landings, or trips, weighted by the number of days fished. The expected distribution of the landings and days fished was taken as the previous month's actual distribution (given by the landings receipts). However, there was considerable change in the distribution of landings and days fished from one month to the next. Table 11 shows how the distribution of days fished changed from month to month. The distribution of landings changed in a similar manner, which often led us to not encounter a boat at the time and place scheduled for an interview. In fact, we completed only 43 percent of the number of interviews planned, and the realized distribution of interviews was quite different from the planned distribution (e.g., see Figures 1 and 2).

The survey also resulted in large numbers of interviews conducted during short intervals, instead of being spread out over time. Table 12 presents the realized number of interviews for each week of the survey. One-third of the weeks account for over two-thirds (217) of the interviews realized. Therefore, the timing of the interviews was another cause of the unrepresentativeness of our sample.

Costs. The total cost for both surveys (self enumeration and interview) and the census (sales receipts) is estimated to be approximately $29,000. This figure includes the salaries of all URI and MAG personnel involved plus all supplies and travel expenses. To compare the cost of the two survey methods in their actual form would not be meaningful because they differ in number of variables and observations obtained.[3]

To compare the two survey methods we estimate the cost of each system for the same number of variable (v) and observations (n). That is, we seek to construct a general cost function for each method that is of the form c = c(v,n). This general form will be broken into four functions, each

TABLE 3. Average Days Fished per Trip, Population

Gear Type	Landing Site Zones			
	All Zones	A	C	D
All gear	1.87	1.95	1.37	2.03
	(1.45) [7389]	(1.57) [5133]	(0.77) [1265]	(0.90) [369]
Gill net	1.78	1.89	1.38	2.12
	(1.33) [3713]	(1.48) [2390]	(0.77) [861]	(0.93) [266]
Long line	1.42	1.45	1.25	-----
	(1.08) [1660]	(1.15) [1322]	(0.65) [285]	
Hand line	2.25	2.25	1.56	1.96
	(1.62) [1544]	(1.70) [1092]	(0.91) [63]	(0.74) [79]

Source: Landings receipts.

TABLE 4. Average Days Fished per Trip, Sample Survey

Gear Type	Landing Site Zones			
	All Zones	A	C	D
All gear	1.58 ± .13	2.03*± .26	1.12 ± .07	1.39 ± .19
	(1.43) [322]	(1.91) [148]	(0.49) [125]	(0.79) [49]
Gill net	1.40 ± .11	1.47 ± .18	1.30*± .14	1.41 ± .22
	(0.89) [177]	(1.05) [887]	(0.65) [57]	(0.76) [32]
Long line	1.39*± .40	1.89*± .57	1.00 ± 0.00	1.00 ± 0.00
	(1.25) [59]	(1.77) [26]	(0.00) [32]	(0.00) [1]
Hand line	1.71 ± .40	3.44*± 1.21	1.00 ± 0.00	1.33 ± .39
	(1.86) [59]	(2.94) [16]	(0.00) [34]	(0.71) [9]

Source: Survey interviews.

*Corresponding population mean lies within the confidence level.

TABLE 5. Average Days Fished per Trip, Simple Random Sample

Gear Type	Landing Site Zones			
	All Zones	A	C	D
All Gear	1.95* ± .14 (1.48) [308]	1.99* ± .61 (1.65) [20]	1.49* ± .17 (0.79) [59]	2.18* ± .28 (0.79) [22]
Gill net	1.86* ± .18 (1.36) [152]	1.93* ± .28 (1.61) [917]	1.45* ± .21 (0.74) [357]	2.30* ± .27 (0.73) [207]
Long line	1.52* ± .22 (1.13) [68]	1.55* ± .29 (1.24) [49]	1.47* ± .35 (0.87) [17	* ---
Hand line	2.13* ± .30 (1.50) [68]	2.04* ± .35 (1.48) [48]	1.69* ± .65 (0.89) [57]	1.00 ± 0.00 0.00) [17]

Source: Four percent random sample of landings receipts.

*Corresponding population mean lies within the confidence interval.

TABLE 6. Average Catch per Trip, Population

	Commercial Class							
	All	PG	PP	CL	ByC	PT	CyA	CH
All trips	194.5	22.4	29.9	6.7	25.3	14.5	68.7	26.8
n= 8197	(340.5)	(60.1)	(71.5)	(31.6)	(130.0)	(160.3)	(142.8)	(71.6)
	By Gear Type							
Gill net	202.1	28.0	35.5	10.1	24.6	6.3	68.7	28.8
n = 3980	(222.6)	(62.9)	(64.5)	(36.6)	(70.7)	(46.2)	(127.2)	(76.5)
Long line	140.1	1.6	5.4	1.8	18.6	9.5	80.4	22.8
n = 1876	(262.1)	(11.0)	(38.7)	(15.7)	(41.6)	(117.9)	(180.3)	(57.9)
Hand line	135.0	32.1	42.1	1.1	4.7	0.9	37.9	16.2
n = 1646	(197.4)	(76.5)	(93.0)	(9.4)	(15.6)	(19.3)	(85.1)	(42.6)
	By Zone							
A	209.2	20.5	31.3	7.2	32.0	17.5	71.1	29.6
n = 5699	(355.4)	(62.3)	(76.3)	(33.5)	(105.9)	(180.9)	(145.0)	(79.3)
C	141.6	21.9	22.9	4.8	1.8	0.2	70.2	19.6
n = 1413	(193.7)	(38.7)	(41.6)	(18.1)	(12.2)	(4.2)	(157.2)	(47.4)
D	203.1	58.4	33.6	0.1	1.2	7.4	88.0	14.4
n = 395	(195.3)	(91.7)	(82.3)	(1.3)	(6.2)	(39.9)	(115.5)	(24.4)

Source: Landings receipts.

TABLE 7. Average Catch per Trip, Sample Survey

	Commercial Class							
	All	PG	PP	CL	ByC	PT	CyA	CH
All trips	171.0 ± 19.79	*19.6 ± 4.07	*31.6 ± 5.96	*8.5 ± 4.09	*20.8 ± 6.26	8.0 ± 5.68	*60.3 ± 9.36	19.6 ± 4.73
n = 318	(215.2)	(44.3)	(64.8)	(44.5)	(68.1)	(61.8)	(101.8)	(51.4)
	By Gear Type							
Gill net	*191.3 ± 26.6	*23.6 ± 5.23	45.5 ± 9.49	*9.8 ± 3.52	*22.2 ± 7.81	*8.8 ± 7.69	*59.2 ± 14.28	18.5 ± 4.23
n = 176	(215.2)	(42.3)	(76.8)	(28.5)	(63.4)	(62.2)	(115.5)	(34.2)
Long line	*114.8 ± 31.39	0.1 ± 0.06	1.9 ± 1.86	*4.5 ± 6.41	*24.4 ± 16.0	*6.5 ± 10.5	67.3 ± 11.9	10.0 ± 3.84
	(174.0)	(0.3)	(8.7)	(30.0)	(75.0)	(49.4)	(55.7)	(18.1)
Hand line	*118.9 ± 43.6	*21.7 ± 12.9	23.7 ± 11.8	*12.4 ± 19.0	*3.8 ± 4.08	0.0 ± 0.0	*40.3 ± 17.0	*16.0 ± 14.9
n = 57	(201.0)	(59.6)	(54.5)	(87.5)	(18.8)		(78.6)	(68.7)
	By Zone							
A	249.2 ± 37.4	*19.4 ± 6.7	*35.6 ± 10.7	17.0 ± 8.7	*41.8 ± 12.8	*14.5 ± 11.6	*84.5 ± 18.3	*30.8 ± 9.8
n = 147	(276.9)	(49.8)	(79.2)	(64.2)	(94.9)	(86.0)	(135.2)	(72.9)
C	96.4 ± 13.8	15.4 ± 4.4	*29.7 ± 8.0	1.3 ± .89	*3.4 ± 2.4	0.0 ± 0.0	36.8 ± 5.4	9.4 ± 1.82
n = 125	(94.1)	(30.3)	(54.6)	(6.1)	(16.6)		(43.5)	(12.4)
D	125.6 ± 30.9	31.2 ± 13.3	24.2 ± 7.38	*1.2 ± 1.28	*0.6 ± 0.58	*9.5 ± 12.5	47.1 ± 16.9	*11.5 ± 3.4
n = 46	(127.8)	(55.1)	(30.5)	(5.3)	(2.4)	(51.9)	(69.8)	(13.4)

Source: Survey interviews.

*Corresponding population mean lies within the confidence.

TABLE 8. Average Catch per Trip, Simple Random Sample

	Commercial Class							
	All	PG	PP	CL	ByC	PT	CyA	CH
All trips	*176.2 ± 21.3	*19.14 ± 4.29	*32.9 ± 7.70	4.9 ± 1.72	*21.4 ± 6.12	2.4 ± 1.4	*62.0 ± 9.9	*33.3 ± 8.37
n = 298	(224.1)	(45.2)	(81.0)	(18.1)	(64.4)	(14.7)	(104.0)	(88.1)
	By Gear Type							
Gill net	*208.2 ± 27.4	*24.7 ± 6.25	*40.3 ± 10.0	7.1 ± 2.7	*28.7 ± 10.9	2.8 ± 2.1	*69.4 ± 16.0	*35.0 ± 7.18
n = 156	(205.9)	(47.6)	(83.6)	(20.5)	(83.2)	(16.1)	(122.4)	(54.7)
Long line	111.5 ± 25.0	0.37 ± 0.62	2.6 ± 2.67	0.33 ± .30	*16.9 ± 6.33	0.38 ± .62	*69.0 ± 19.12	*21.8 ± 7.62
n = 58	(116.4)	(2.9)	(12.4)	(1.4)	(29.4)	(2.9)	(88.8)	(35.4)
Hand line	*125.5 ± 32.7	21.4 ± 10.4	*35.0 ± 13.1	*1.4 ± 1.3	*7.4 ± 5.7	*1.73 ± 1.8	*41.0 ± 13.6	*17.5 ± 8.06
n = 70	(166.7)	(51.2)	(66.8)	(6.6)	(29.1)	(9.2)	(69.4)	(41.1)
	By Zone							
A	*187.2 ± 27.6	*18.0 ± 5.5	*36.2 ± 9.5	*5.4 ± 2.14	*28.4 ± 8.6	2.8 ± 1.9	58.9 ± 11.0	*37.3 ± 11.7
n = 203	(240.0)	(47.7)	(82.8)	(18.6)	(75.1)	(16.8)	(95.6)	(102.0)
C	*143.9 ± 33.8	*24.8 ± 9.9	*22.3 ± 9.6	*2.8 ± 2.0	*3.7 ± 5.4	*1.3 ± 1.24	*64.9 ± 22.2	*24.0 ± 9.4
n = 57	(155.6)	(45.5)	(44.5)	(9.5)	(24.4)	(5.7)	(102.0)	(43.5)
D	*254.5 ± 96.8	36.1 ± 16.2	11.7 ± 6.0	0.0 ± 0.0	*6.0 ± 9.8	*5.1 ± 8.4	*169.7 ± 89.7	*25.8 ± 15.7
n = 14	(220.9)	(37.0)	(13.8)	(0.0)	(22.4)	(19.2)	(204.6)	(35.9)

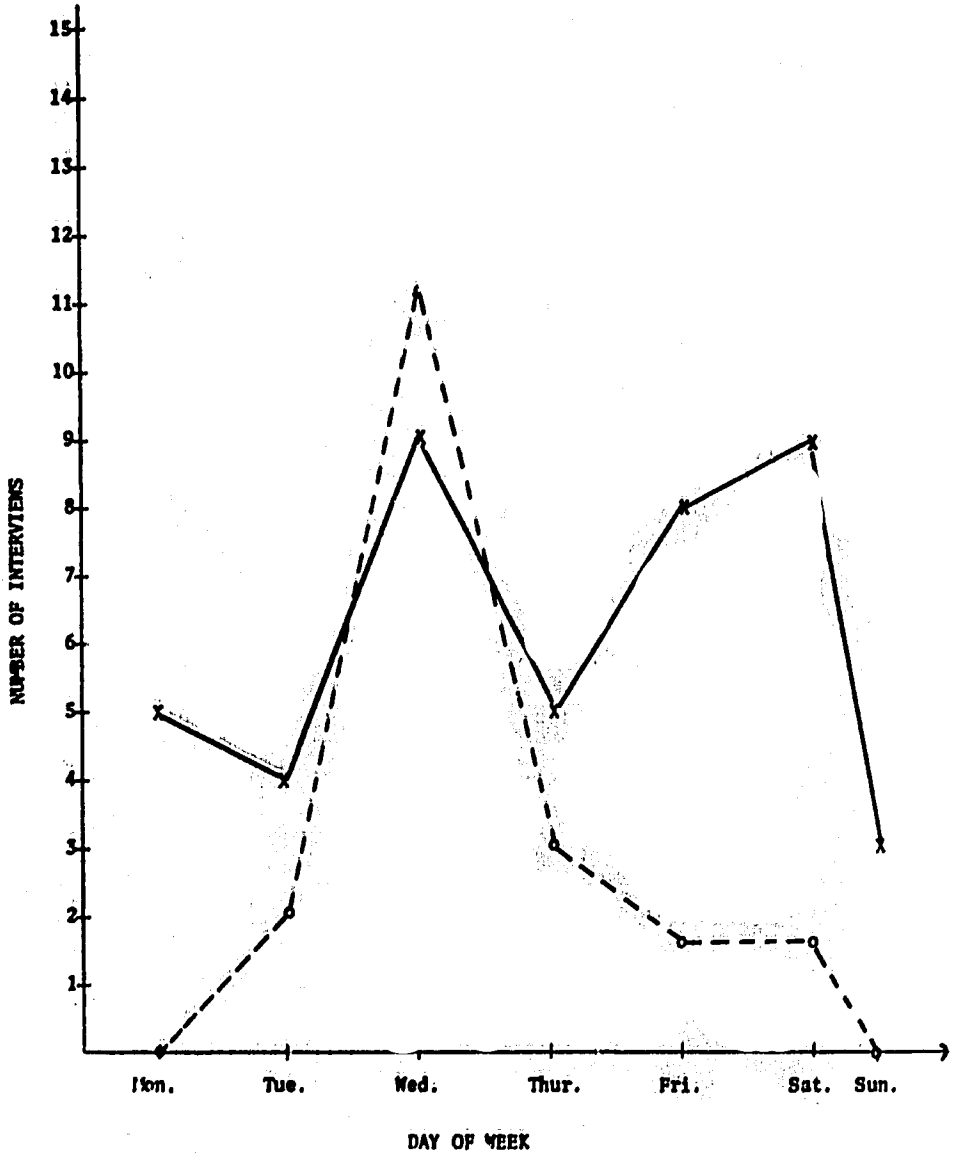
Source: Four percent random sample of landings receipts.

*Corresponding population mean lies within the confidence interval.

TABLE 9. Monthly Percentage Breakdown by Commercial Class

Commercial Classes	September	October	November	December	January	Entire Period
Primera Grande, population	.17	.12	.11	.08	.09	.11
(sample)	(.13)	(.04)	(.13)	(.09)	(.18)	(.11)
Primera Pequena, population	.17	.16	.13	.16	.14	.15
(sample)	(.26)	(.08)	(.13)	(.28)	(.26)	(.18)
Clasificado, population	.02	.03	.04	.05	.03	.03
(sample)	(.01)	(.04)	(.04)	(.13)	(.04)	(.05)
Bolillo-Cazon, population	.11	.15	.12	.12	.16	.13
(sample)	(.10)	(.23)	(.08)	(.08)	(.08)	(.12)
Posta Tiburon, population	.06	.07	.08	.09	.07	.07
(sample)	(.06)	(.12)	(.03)	(.0)	(.0)	(.05)
Cola-Agria, population	.37	.36	.37	.34	.33	.35
(sample)	(.34)	(.36)	(.49)	(.31)	(.22)	(.36)
Chatarra, population	.10	.12	.14	.16	.16	.14
(sample)	(.[illegible])	(.13)	(.09)	(.10)	(.15)	(.11)

FIGURE 1. Distribution of Actual and Planned Interviews by Day of Week (Punta, November, 1976).



X = planned sample size

o = realized sample size.

FIGURE 2. Distribution of Actual and Planned Interviews by Hour of Day (Punta, November, 1976).

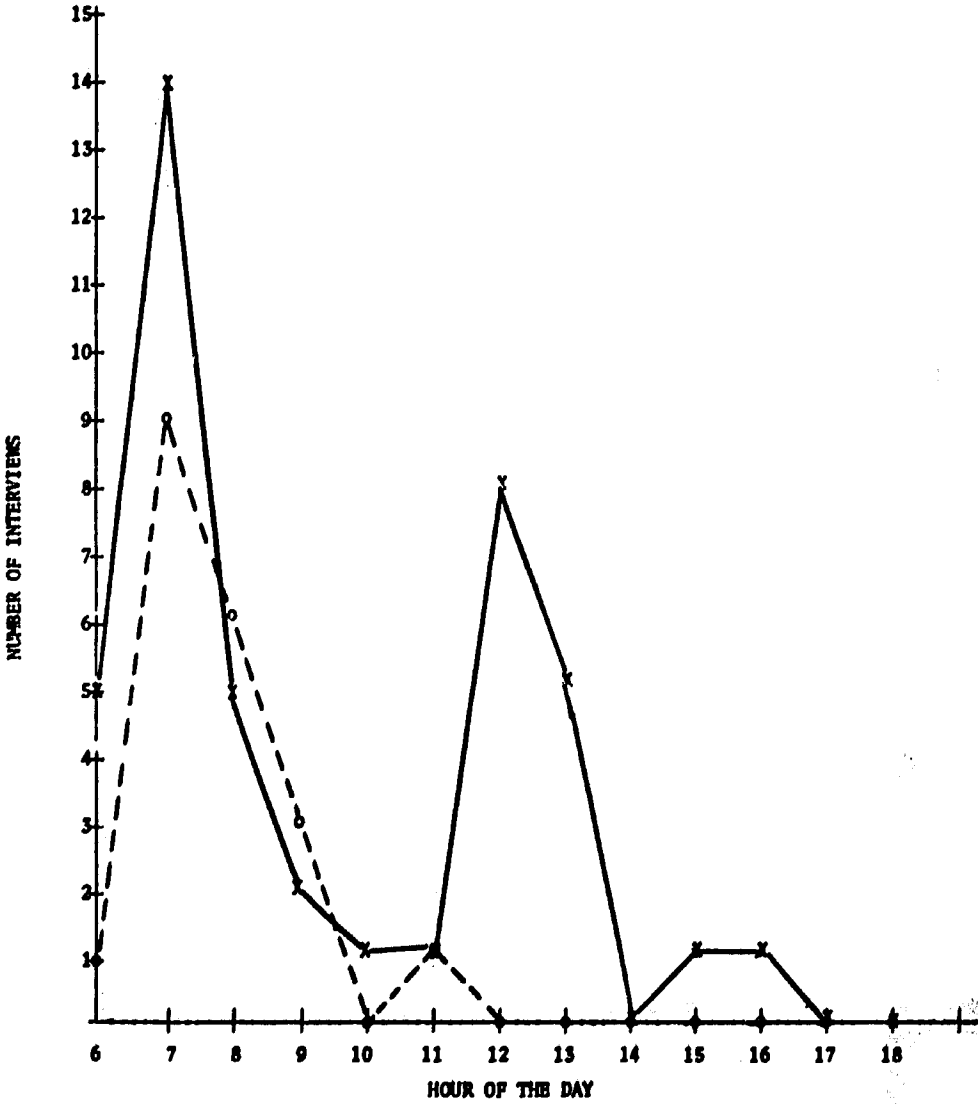


TABLE 10. Percent Frequencies of Days Fished for Survey Sample and Population

	Survey Sample				Population			
	Gill Net	Long Line	Hand Line	Other	Gill Net	Long Line	Hand Line	Other
Puntarenas Sites								
Punta	.120	.049	.063	.053	.148	.030	.060	.021
Enramada A	.008	.022	.00	.000	.005	.054	.000	.002
Enramada B	.045	.003	.006	.012	.058	.026	.009	.001
Enramada C	.028	.002	.012	.026	.017	.001	.032	.004
Marcado	.078	.002	.026	.018	.045	.022	.062	.018
Pescarnes	.035	.012	.002	.004	.051	.005	.017	.022
Other Sites in Puntarenas	.000	.002	.000	.020	.008	.003	.000	.004
Costa de Pajaros & Manzanillo	.146	.063	.067	.000	.087	.026	.007	.004
Nispero	.089	.000	.024	.020	.041	.00	.011	.002
Other Sites	.000	.000	.000	.000	.025	.005	.055	.010

TABLE 11. % Distribution of Days Fished, Landings Receipts

Landing Site Punta	Days of the Week							T.D.F.*	# Trips
	M	T	W	TH	F	S	S		
Month 9	13	8	10	18	12	20	10	753	364
10	13	12	16	11	16	24	6	1,004	419
11	17	15	20	6	20	13	10	647	205
12	21	8	19	24	13	14	7	460	180
1	19	10	14	6	14	14	19	377	157
Averages	16.6	10.6	15.8	13.0	15.0	17.0	10.4	648.2	265

Landing Site Punta	Hours of the Day													A.M.	P.M.
	6	7	8	9	10	11	12	13	14	15	16	17	18		
Month 9	4	14	20	9	11	3	5	2	6	6	2	2	2	61	25
10	5	18	16	7	6	6	12	7	5	1	2	-	1	58	28
11	5	9	14	7	11	3	5	1	4	3	1	1	3	49	18
12	7	13	15	13	11	11	12	2	4	6	6	-	1	70	31
1	8	8	19	15	12	4	5	4	8	3	2	2	-	66	24
Averages	6.8	12.4	16.8	10.2	10.2	5.4	7.8	3.2	5.4	3.8	2.6	1.4	1.4	60.8	25.2

*T.D.F. = total days fished.

TABLE 12. Number of Interviews per Week, Survey of Artisanal Fishermen, Gulf of Nicoya, September, 1976 - January, 1977

Date	Week	Zone A	Zones C,D	Totals
Sept. 8-14	1	12		12
15-21	2	7	9	16
22-29	3	10	17	27
Sept. 30-Oct. 6	4	3		3
Oct. 7-13	5	23		23
14-20	6	10	2	12
21-27	7	13	20	39
Oct. 28-Nov. 3	8	3		3
Nov. 4-10	9	13		13
11-17	10	19		19
18-24	11	3	16	19
Nov. 25-Dec. 1	12	4	18	22
Dec. 2-8	13			
9-15	14	8		8
16-22	15	5		5
23-29	16	1	40	41
Dec. 30-Jan. 5	17		1	1
Jan. 6-12	18			
13-19	19	11		11
20-27	10	1	45	46
28-30	21		2	2
				322

representing the cost of a phase of the survey:

$$c = c(v,n) = \sum_{j=1}^{4} f_j(v,n)$$

where j denotes a separate phase. The specific function form of the f_j is

$$f_j = \alpha_0 + \alpha_1 + \alpha_2 n + \alpha_3 nv + \alpha_4 mv^{\beta} \qquad (1)$$

Justification for this functional form will become evident as we proceed.

Table 13 indicates which steps or activities of each phase imply costs that are fixed or that vary with either the number of variables or observations or both. Table 14 presents the costs of each method in terms of the functional relationship specified in (1). The procedure for determining the coefficients for the variable costs is less than perfect but straightforward. The cost of an activity that is assumed to vary with the number of variables is divided by the number of variables to obtain the coeficient value.

The value of β in the last term (1) plays a significant role in determining the ralative efficiency of the two methods. This exponent, where we assume $\beta > 1$, is meant to reflect the cost of greater complexity. The more variables a fisherman has to record, the more training and monitoring required by survey personnel to ensure a given quality of data. For the interview more variables imply more questions and, hence, more time to conduct the interview. Also, more variables typically deal with more complex issues, requiring more time to obtain the information. In each method, costs are assumed to increase at an increasing rate as complexity, as measured by the number of variables, increases. The values of β are chosen arbitrarily. While there is no statistical evidence to suggest what the β values might be, we reason that the β for self enumeration should be greater than the β for the interview system. This is based on the assumption that it is easier, i.e. less costly, to train a few interviewers to collect data on more variables than it is to train several individual fishermen to record data on the same large set of variables.

The equations for TC_1 and TC_2 provide rough estimates of the cost of duplicating each of these two methods in another setting similar to Costa Rica. However, the present problem facing the Fisheries Department in Costa Rica is which of these two systems should be continued. Therefore, we require estimates of the costs for each system that will continue over time. The costs that we expect to continue over time are those enclosed in parentheses in Table 14. Summed, these costs yield equations SE and I in Table 14, which are meant to provide estimates of the periodic costs of the two survey methods.

We are now ready to compare the relative efficiency of the two systems. For this we require appropriate ranges for v and n. The smallest number of variables we consider is 10, the minimum that would yield any useful data beyond what the sales receipts provide. Ten variables are intended to represent the minimum acceptable set of information to be collected (and would likely include the date and place of sale, weight and the catch, total revenue, days fished, crew size, gear type, trip operating expenses, payment to crew and to the boat). The next largest size chosen is 40 variables which would imply an expanded bookkeeping system (self enumeration) and a shortened interview. One hundred variables would allow a breakdown by species and some detail on fishing locations and time with gear in the water. The last size, 300 variables, would represent a slightly shortened version of the original questionaire.

Increases in the size of the sample (i.e., number of observations, n) improves the statistical precision of the estimates calculated from the sample

TABLE 13. Relation of Costs to Number of Variables and Observations

Costs of:	Self-Enumeration			Interview		
	F	v	n	F	v	n
1. Planning						
a. selecting population and unit of analysis	X			X		
b. frame survey	X			X		
c. personnel and resource identification	X			X		
d. selecting collection method, specific variables, sampling procedure	X			X		
2. Design						
a. instrument development	X	+	+	X	+	+
b. sample size	X			X		
c. collection frequency	X			X		
d. respondent selections			+	X		
e. sample drawing	X			X		
3. Collection						
a. site visits			+			+
b. recording data		+	+		+	+
c. reviewing data		+	+		+	+
4. Processing						
a. editing	X	+	+	X	+	+
b. coding	X	+	+	X	+	+
c. transcribing		+	+		+	+
d. cleaning		+	+		+	+

Note: F = fixed costs; v = costs that vary with the number of variables; n = costs that vary with the number of observations; an X indicates fixed costs occur and a + indicates the costs vary directly with the number of variables or observations.

TABLE 14. Survey Cost Functions*

Self Enumeration Method	X_0	X_1V	X_2n	X_3nv	$X_4nv\beta$
j = 1	2,278				
2	1,632	20.9v	1.46n		
3			(.167n)		(.002nv^2)
4	(544)			(.006nv)	
$TC_1(0)$ =	4,364	20.9v	1.627n	.006nv	.002nv^2
SE = $TC_1(t)$ =	544	.167n	.006nv	.002nv^2	

Interview Method	X_0	X_1V	X_2n	X_3nv	$X_4nv\beta$
j = 1	1,150				
2	3,061	6.8v		.002nv	
3	(206)		(7.26n)		.002nv$^{1.2}$
4	(83)			(.005nv)	
$TC_2(0)$	4,500	6.8v	7.26n	.0052nv	.002nv$^{1.2}$
I = $TC_2(t)$	800	7.26n	.005nv	.002nv$^{1.2}$	

*All figures are in 1976-1977 U.S. dollars.

data. For a probability of .95, we have estimated the sample sizes necessary to yield sample estimates for each gear type that lies within r% of the true mean for each gear type (see Table 15). For example, simple random sampling, with a sample size of about 2,000 distributed across gear types as shown in the top part of Table 15, will yield a sample mean that lies within 10 percent of the true mean for each gear type. Using stratified sampling, a sample of 2,000 allocated as shown in the bottom part of Table 15, will yield a sample mean that lies within 5 percent of the true mean for all gear types and with much less precise estimates of each gear type mean. In Table 16, sample sizes for a simple random sampling program are given, together with the associated precision level.

Substituting the values for v and n in the equations for SE and 1, given in Table 14, yields estimates of the cost per period for each of the two systems. It is immediately obvious that the self enumeration system is less costly for small sets of variables (above the dashed line in Table 16), while the interview method is superior for large sets of variables. This result is illustrated further in Figure 3, where four combinations of v and n are considered. The points are connected by straight lines (an approximation since the true relationship is curvilinear). It appears that the interview method becomes superior at around 50 to 55 variables.

Equation SE and 1 likely give over-estimates of the costs that would actually be experienced over time. There is good reason to expect a substantial drop in costs--perhaps as great at 50 percent--as experience leads to better organization, less travel and more effective use of manpower.

While the self enumeration method is less costly for small sets of variables, it has at least two significant disadvantages. First, the participants are not chosen randomly, and it is likely that randomly chosen participants would have a high attrition rate. An alternative to random selection is judicious selection of a few representative firms in each strata. For example, in the Gulf of Nicoya six strata appear most useful for explaining variations in production--i.e., where each of the three gear types is subdivided between urban (Puntarenas) and rural home bases.

The other major disadvantage of the self enumeration method is that the sample of fishermen is static over time. If the fishery is growing with new fishermen entering the fishery, the new entrants would not have an equal chance of being included in the sample. To avoid this potential problem, the system could be modified such that a proportion of the sample is replaced periodically (e.g., 25% every year). But recruiting and training new fishermen to keep accurate records is expensive, requiring additional time of survey personnel and transport costs. Assuming 25 percent of the sample is replaced every period, the bookkeeping cost function changes from

$$\beta = 5544 + .167n + .006nv + .002nv^2$$

to:

$$\beta = 870 + .532n + .006nv + .002nv^2$$

(These calculations further assume it will be as costly to recruit new fishermen into the system as it was initially.) This modified self enumeration system still is less costly than the interview system for small sets of variables.

The principal advantage of the interview method is that it potentially allows the random selection of the observations, yielding reliable estimation of statistical precision. Also, for detailed information (i.e., large sets of variables) it is less costly than the self enumeration system. Besides its high cost, the principal disadvantages of the interview method are that it does not provide good information on periodic production activities (e.g., montly income) nor on the costs of repairs and maintenance and the value of capital equipment. These disadvantages could be overcome by regular (e.g., montly) interviews of the same set of randomly selected fishermen. However,

TABLE 15. Sample Size Requirements

Simple Random Sampling				
	Gear Type			
Precision	Gill Net	Long Line	Hand Line	Total
r = .05	1,270	1,390	1,096	3,756
.10	417	1,037	548	2,002
.15	197	453	299	949
.20	113	285	182	580

Stratified Random Sampling				
	Gear Type			
Precision	Gill Net	Long Line	Hand Line	Total
r = .05	1,035	577	378	1,990
.10	328	183	120	631

TABLE 16. Cost Estimates for Self-Enumeration and Interview Method ($1,000)

relative error, r%:		.25	.20	.15	.10	.05
sample size, n:		400	600	1,000	1,000	4,000
Number of Variables:						
V = 10	SE	.7	.8	1	1.4	2.3
	I	3.7	5.2	8.1	15.0	30.0
V = 40	SE	2.0	3.0	4.0	8.0	15.0
	I	4.0	5.0	8.0	16.0	31.0
V = 100	SE	9.0	13.0	21.0	42.0	84.0
	I	4.0	6.0	9.0	17.0	34.0
V = 300	SE	73.0	110.0	183.0	364.0	718.0
	I	5.0	7.0	11.0	22.0	43.0

to interview a pre-selected fisherman at the time of sale would be difficult (costly) and probably require an interview at his home between fishing trips. Without self enumeration of the information required, the accuracy of the data obtained would probably drop significantly--unless, of course, a visit was made immediately after each trip. Visiting each fisherman at his home would incur substantial travel costs, especially for fishermen living outside Puntarenas, as it is not uncommon for a full-time fisherman to make 15 to 20 trips per month.

III. Conclusions and Recommendations

From the evidence we have, it appears that a self-enumeration method would be superior for the Nicoya artisanal fishery. This conclusion must be treated with caution, however, and a number of qualifications must be noted.

Some of the more important qualifications are as follows. The bookkeeping system as orginally implemented is not wholly acceptable (the necessary modifications are listed below). The cost estimates are rough and should not be used to determine the added funding necessary to continue the system over time. The conclusions herein are the results of a single experiment; clearly more experimentation is required before we can attach great confidence in our results. The -values assigned in the analysis are questionable. The data generated by both systems, while useful, are less than perfect.

A chief concern at this point is what to recommend tot he Ministry of Agriculture in the way of an on-going data collection system for the small scale fishery in the Gulf of Nicoya.

1. We recommend continuation of the existing system of collecting and processing sales receipts of data. If not already being done, the catch, revenue and effort data should be sorted and compiled by the major gear types.

2. Maintain a flexible and experimental attitude towards any system adopted. Conditions in the fishery and the needs of MAG will likely change, and greater experience will be gained over time. Therefore, successful generation of data may require major adaptation to new conditions in the future.

3. As soon as possible re-institute the bookkeeping system with the following modifications. The number of fishermen in the sample should be between 55 and 60; 50 percent should be gill netters, 30 percent long liners and 20 percent hand liners. Each gear type group should be comprised of urban and rural fishermen in proportion to their presence in the population. These fishermen need not be selected randomly, but there should be some assurance that they are not too unrepresentative of their sub-group (e.g., rural handliners). Twenty to twenty-five percent of the sample should be replaced every year with other fishermen, taking special care to include new entrants to the fishery, new gear types, new fishing strategies and other changes that will occur through time. The forms currently in use should be expanded to include a column for crew size and gear used on each trip. The fishermen also should be encouraged to record the location they fished each trip and to save copies of their sales receipts. The inventory form should be completed at the time a fisherman is recruited to the system, and the form should be revised at least once a year or whenever he acquires a new boat, motor, or gear. Survey personnel should assist each participant to compute monthly totals of his costs and earnings, and record these monthly totals for the government's information system. Of course, a code should be assigned each participant in order that this information remain confidential.

4. To increase the chance of success with the system, the participants should be provided regular feedback and given special attention when appropriate. Useful feedback can be in the form of quarterly reports on the status of costs and earnings by major gear type in the fishery. For example, each participant can compare his quarterly earnings to the average earnings of

his gear type group. The participants can be given special attention by inviting them first to meetings with government officials and other important people, or by notifying them first of new opportunities for government assistance.

Two other problems remain that will have to be faced eventually. One concerns reliable estimates of catch by species and the other involves other income to the less-than-full-time fishermen. At the present time, no reliable information is being obtained on the quantities caught of the important species. When it comes time to face the management problem, and avoid over-exploitation, a good time series of catch and effort data broken down by species will be required. The present commercial class breakdown will not support the analyses required for devising appropriate management policy.. Therefore, some attempt should be made soon to begin collecting catch data by species. This could be accomplished by training the primary buyers to record sales by species, but this likely would take considerable time and effort to implement successfully. An approach we suggest for consideration is to regularly sample landings in order to make estimates of catch for the important species.

A primary goal of fisheries development often is to raise the incomes of the fishermen. However, many fishermen are part-time or occasional fishermen who have other sources of income (e.g., livestock and crops). To obtain an accurate picture of fishermen's income levels we require estimates of their other non-fishing income. Therefore, we recommend adaptation of the data collection instruments to include data on costs and earnings of the other economic activities of the survey participants. This last modification probably would be best instituted later, after the fisheries bookkeeping system is working smoothly.

FOOTNOTES

[1]Several individuals were involved in each of these surveys. Of particular mention are the personnel of the Ministry of Agriculture, Costa Rica, who made these surveys possible: in San Jose, Ings. Eduardo Bravo and Milton Lopez; and in Puntarenas, Srs. Eloy Arrieta, Jorge Barrantes, Giovanni Carranza, Luis Castro, Hernan Ortega and Justo Perez. URI field staff included Jan Johnson and Phil Logan.

[2]For example, in a few rural areas an icebox was used to store the catch of a few small boats. After a few days, the total catch was sold in one transaction.

[3]The bookkeeping system collected data for a maximum of 26 trip variables plus 99 inventory variables from 58 fishermen for over 2,000 fishing trips at an approximate total cost of $12,000. The interview system collected data for a maximum of 362 variables for less than 400 fishing trips at an approximate total cost of $12,000. The sales receipt census collected data on a maximum of 33 variables for less than 8,000 fishing trips at an approximate total cost of $5,000.

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CHAPTER 5. SOCIAL AND CULTURAL ASPECTS OF SURVEYS OF SMALL-SCALE FISHERMEN

BY R.B. Pollnac

Beyond the biological and economic characteristics of the fishery, there are social and cultural variables which impinge upon and can affect the relative effectiveness of data acquisition efforts in LDCs. For example, resource assessment techniques often rely on catch and effort statistics or return of tagged fish. Both of these types of data are practically impossible to obtain without cooperation of the fishermen. Further, our knowledge concerning even the types of fish caught and utilized is so minimal in some regions that research preliminary to actual resource assessment could be rather costly. We would like to stress that the biologist could use the rather considerable knowledge of local fishermen to provide guidelines to facilitate acquisition of data concerning identification of fish stocks, number of species involved and aspects of their distribution and numbers. The remainder of this chapter will focus on aspects of obtaining data from local fishermen and the usefulness of the types of data they can provide.

1. Obtaining Data from Fishermen

The importance of using the proper approach for obtaining data from fishermen can be illustrated by the experience of the author. During this fisheries research project, as well as in many other fisheries projects, the fisherman himself was a crucial link in obtaining data about the small-scale fishery. He is often the only person who can supply certain information since much of his work is conducted away from shore and not easily observed. This separation from land-based society has given the fisherman a world-wide reputation for secrecy and deception. The fisherman's cooperation in providing data is therefore essential. It was thus necessary to determine the attitudes, beliefs, and values that fishermen held concerning some of the questions that our project was asking them. Attention was focused on the economic questionnaire which included catch and effort questions since data concerning income is often the most difficult to elicit.

Experience indicated that the most effective situation for obtaining attitudes of fishermen toward the research we were conducting was in small, natural interacting groups--small groups of fishermen who had gathered to discuss football games, women, etc. In such small groups fishermen feel they have support of companions and are more likely to speak their minds. When spoken to individually, fishermen are likely to acquiesce to what they think the interviewer wants to hear.

The anthropologist and his research assistant were rather familiar faces among the fishermen, and they could enter such groups and gradually turn the conversation around to the economic and biological research which was being conducted. They asked the fishermen what they thought about the catch and effort questions, and invariably they said that they didn't like them. They said they were afraid that the information was going to be used for (1) taxes; (2) to close the gulf or areas of the gulf to fishing; and (3) to prohibit the use of nets in the gulf. When asked if anyone told them why the data was being gathered, they said no. After being told the potential benefits of the research program, the attitude of the entire group changed. The fishermen said that since they were afraid the data was to be used against them, they did not always tell the truth when responding to questions. Their admitting the fact that they had lied indicated that our interviewing technique along with a full explanation of the purpose of the data gathering was an important element in gaining their cooperation. The fishermen themselves even went on to suggest that we should find some way of informing all the fishermen of the potential benefits of the research. They said they had simply been questioned with little or no explanation, and that they were reluctant to cooperate in

research they didn't understand.

The inspectors who had been interviewing the fishermen were also interviewed, and it was discovered that they had a limited understanding of the potential uses of the data. After being read a list of potential uses of the data they said they wished that they had known them beforehand. They went on to say that when fishermen would press them for an explanation they would fabricate some sort of reason, not knowing if it were true or false.

With regard to both fishermen and inspectors, it was determined that they had no problems underatanding various goals of the research. This indicates that full explanations of programs should be provided to fishermen and all inspectors.

This example indicates the important role that proper communication of purpose can play in obtaining data from small-scale fishermen. As the example indicates, several aspects of the communication process have an effect on the evaluation and acceptance of a data-gathering effort.

The communication event entails several important components (cf. Hymes 1964a): (1) the participants--senders, receivers, interpreters, etc; (2) the channels--speaking, newspapers, pamphlets, wall posters, etc.; (3) the codes-the language (national, local dialects, etc.), or a combination of language and illustrations; (4) the setting--formal meeting, on the beach, etc; (5) the message form--salesman's pitch, sermon, informal chat, etc.; and finally (6) the topic--here information concerning the need for data collection from small-scale fishermen. It is important to note that the above components of a communication event form an interrelated whole--a system. For example, relative social status and familiarity of the sender and receiver dictate message form and code in many societies. Familiar message forms or codes may be taken as insulting when used by strangers. Characteristics of the receiver may also dictate the channel and code. It is obvious that written messages or the national language cannot be used with people who have only a rudimentary grasp of reading or the national tongue. The intricacies of these interrelationships suggest that one must be sensitive to the structure of communication events within the local groups of fishermen, either through extensive exposure or with the use of a good local-level assistant.

Turning to the participants in the communication of reasons for catch effort statistics, returning of tagged fish, or obtaining information from fishermen, we will first focus on the sender of the message. Rogers and Shoemaker's (1971) extensive review of the literature concerning communication and the transfer of innovations suggests that individuals most likely to communicate effectively with small-scale fishermen will be those who have empathy with, can identify with the fishermen, and who are credible in the fishermen's eyes. This suggests that reasons for data gathering should be transferred to the fishermen with the assistance of local opinion leaders.

Barnett (1953), however, cautions that prestige is not a good means of identifying opinion leaders who will be effective within specific domains because the prestige rating of the same person may vary from context to context. For example, an opinion leader with regard to net fishing may not be an opinion leader for trap fishing.

Rogers and Shoemaker (1971) present a number of attributes associated with opinion leaders. Nevertheless, even within a specific domain, it is difficult to identify an opinion leader with only the use of identifying characteristics such as social status, degree of social participation, mass media exposure, etc. It is often necessary to rely on sociometric techniques (cf. Menzel and Katz 1956, Lionberger and Copus 1972). If for some reason (i.e., presence of opinion leaders with a vested interest in the status quo) it is not advisable to work through opinion leaders, the change agent should try to inform as many concerned individuals as possible.

Turning to communication channels, those most likely to result in effective, credible message delivery to the small-scale fishermen should be used. Knowledgeable individuals within the society can be consulted (e.g.,

marketing specialists) or opinion surveys of attitudes, beliefs, and values concerning the various channels can be conducted to determine the most effective. Sometimes this must be done on a trial and error basis. Nevertheless, even when an effective medium has been isolated, its success often depends on other factors. For example, Sinha and Mehta (1972) note that success of instructional television in India often depends on the farmer's motivation to change. Rogers and Shoemaker (1971) cite numerous studies which indicate that although mass media (e.g., radio, newspapers, television) are important at the knowledge function (bringing to awareness) interpersonal channels are important at the persuasion function. Most important for international development programs, they indicate that the mass media channels are more effective among peasants in lesser developed countries when used in combination with interpersonal channels in organized small groups of individuals who regularly meet to attend and discuss mass media programs.

Although it is obvious, it must be noted that degree of functional literacy must be determined before written mass media channels can be considered a viable alternative. Additionally, and less obvious, if pictures form an important part of the communicative event, target group familiarity with the interpretation of two-dimensional pictorial material should be taken into consideration (cf. Hudson, 1967).

Use of proper code is also an important consideration, and it is not as simple as merely selecting a language with which the target group is familiar. In bilingual contexts, one language may have more prestige than another (Lambert et al 1958, Rubin 1968) or may be situationally dependent with respect to its usage. For example, Rubin (1968) reports that variance in use of either Guarani or Spanish in Paraguary depends on location, degree of formality, intimacy, seriousness of situation, and sex of participants. Even when only one language is spoken, there may be different codes which signify degree of respect, social class, and other variables. Brown and Ford (1961) clarified the extent to which degree of intimacy and status effect direct address usage in American English. Further, Geertz (1960) indicates that Javanese has three levels of speech, including honorifies which are related to the participant's age, sex, kinship relation, occupation, wealth, education, religious commitment, family background, social setting, content of conversation, the background of social interaction between the speakers, and the presence of a third person. The foregoing are not isolated examples. Such variance in language usage occurs in many societies around the world (cf. Burling 1970, Hymes 1964b) and failure to adhere to these usually unwritten rules may lessen the credibility of a message.

It should be noted that strict adherence to the foregoing precautions will not necessarily guarantee adequate communication. As one sensitive change agent noted, "we spoke the same language, but we didn't communicate" (Weller 1965: 1) Recent psycholinguistic research (Pollnac 1975a, 1975b, Szalay, Lysne, and Bryson 1972) has indicated a significant degree of variability in semantic structure which could impede effective communication. Wallman (1965) indicates that in Basutoland, the failure of a number of development schemes can be attributed to semantic problems in the communication of measurement. Catch and effort statistics rely heavily on communication of measurement (amounts caught, time spent, etc.); hence, efforts must be made to understand the meaning of measurement and the different systems of quantification used by the local fishermen. Pollnac (1974) demonstrates a fair amount of semantic variability with respect to food plants among the Baganda and argues that agriculture change agents must become sensitive to variability in the semantics of agriculture if they are to effectively communicate with various sectors of the population. With respect to fisheries research, names for fish sometimes vary from one area of the coast to another. Additionally, some fish have different names at various stages of the growth cycle in some regions (Pollnac this volume); therefore, attempts to question a fisherman concerning species "X" may result in responses to different types in different regions.

Data gathered without an understanding of this linguistic phenomena would surely result in unusual size distributions for the fisheries biologist to analyze.

The setting of the communication, like the channel, depends upon determining the most effective technique among the small-scale fishermen. As was noted above, however, the setting may effect the code used as well as message form. For example, in our society, a sermon is not the proper message form to be used between friends at a party. Situational constraints such as these operate in other societies in contexts which the investigator may not be aware of without previous research. For example, in much of the world, schooling is associated with children. If communication of reasons for data collection is held in a schoolroom setting with a student-teacher message form, adults in such societies may be reluctant to attend (Foster 1973).

Our examination of aspects of obtaining information from fishermen have identified three areas where prior planning could be of great aid in increasing the reliability of data collected directly from small-scale fishermen. First, communications must be developed to obtain the cooperation of the fishermen. Second, since systems of quantification may vary greatly from society to society (cf. Reed and Lave 1979; Zaslavsky 1973; Gay and Cole 1967), local systems must be determined and understood to insure proper question form and interpretation of responses concerning quantities. Finally, naming systems for fish vary not only between languages, but within languages. Sometimes a given name will refer only to a specific species during a certain stage of the growth cycle, or will be only applicable along certain regions of the coast; hence, great care must be taken to determine the exact referent for all fish names used in data collection schemes.

II. Useful Data Provided by Fishermen

Turning next to the role that small-scale fishermen can play in providing data of use to fishery biologists, it is important to note that local fishermen have usually been interacting with the sea for a long time. In their attempts to wrest a living from the sea, they have made inferences from their observations and constructed taxonomies and theories concerning the marine environment and its flora and fauna. Although some of the conclusions they have drawn regarding explanations for observed phenomena may not be adequate, their observations of correlations and variability within the sea are usually accurate since their livelihood depends on the ability to locate fish of specific types. Anthropologists have been investigating this type of "folk science" for a number of years (cf. Tyler 1969) and their findings indicate that taxonomies and beliefs concerning flora and fauna in the immediate environment of primitive and peasant farmers and fishermen are exceptionally complex and detailed. It is argued here that this "folk science," or ethnoicthyology (ethno-local people, icthyology - science of fish) can save the fishery biologist a great deal of preliminary work in his attempts to understand the fish populations in various parts of the world.

All fishermen have names for the types of organisms they capture. What is surprising is the quantity of marine organisms which are recognized and named by local fishermen. For example, Anderson (1967) reports over 400 marine organisms which are named and recognized by Hong Kong boat people. Cordell (1972) lists over 140 fish named by estuarine canoe fishermen in northeastern Brazil; Morrill (1967) discussed 51 named varieties among small-scale fishermen of the Virgin Islands; and Pollnac (this volume) reports the existence of 122 different categories of fish named by the small-scale fishermen of the Gulf of Nicoya, Costa Rica. All of these taxonomies are relatively complex and hierarchically organized. The elicitation of adequate taxonomies is not a simple matter (cf. Tyler 1969), but once obtained, they can be used in further research to: (1) structure questions to determine the number of types

harvested and utilized; (2) obtain specimens for scientific investigation; and (3) structure questions to obtain further data concerning distribution and behavior.

Since a fisherman's livelihood depends on his ability to find fish, fishing communities, through time, have observed fish behavior and developed locally appropriate systems for locating fish according to physical features in the marine environment, moon position and phase, tides, time of day and year, and various meteorological phenomena. Once again, anthropologists have illustrations of these folk scientific systems (e.g., Cordell 1972, 1974; Forman 1967). This type of information can be of use to fishery biologists in the structuring of sampling techniques for maximum efficiency. For example, information regarding location, behavior, and temporal variability of stocks will permit the use of sampling techniques (e.g., stratified cluster sampling) which will conserve both time and effort and will result in more reliable data. Additionally, the scientist's knowledge of at least what the fishermen know and believe will enhance their credibility in the fishermen's eyes and probably result in the fishermen being more likely to cooperate in the future.

Finally, in many societies, longitudinal data is not available on various fish stocks. Here, we would like to suggest that oral histories concerning catch and effort be obtained from local fishermen. A sample of such histories should be obtained and compared to assess their reliability (Young 1966). The general trends which can be derived from such data, although not as detailed as we would like it, are better than no historical data at all, and if care is taken, can be quite reliable.

Overall, we argue that the fishermen possess a system of knowledge concerning local species of fish that can be of considerable use to fisheries biologists in indentifying stocks, framing questions concerning the stocks, deriving general historical trends of catch and effort, and designing sampling frames for stock assessment. The intelligent use of this information can therefore conserve a great deal of time and effort on the part of the fishery biologists and, in the process, result in enhancing their credibility in the eyes of the local fishermen.

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CHAPTER 6. ANTHROPOLOGICAL SURVEYS OF THE CAPTURE SECTOR —COSTA RICA

BY R.B. Pollnac

Two basic interviewing techniques were used: sample survey interviews and key informant interviewing. The sample surveys were composed of some relatively straight-forward questions concerning the respondent's age, education, fishing equipment, material possessions, etc. (see attached anthropology data list). Other questions were of the open-ended variety where the respondent was requested to reply to a question such as "What do you like about fishing?". The sometimes lengthy responses to open-ended questions such as these were recorded in full and later content analyzed for analysis. Some of the open ended questions were of a projective nature. For example, a fisherman would be asked "What are the qualities of a good fisherman?". It is assumed that in response to this question about some ideal "good fisherman" the respondent "projects" his own ideas of what it would take to make him a good fishermsn onto the hypothetical "good fisherman" referred to in the question.

The sample surveys also included several other forms of questions. The semantic differential was used to compare fishermen's perceptions of fishermen with farmers and administrators. The semantic differential is based on the assumption that an individual's life experiences affect the connotative meaning of concepts (Osgood, Suci, and Tannenbaum, 1957). Respondents are requested to rank concepts on sets of bipolar attributes (e.g., good-bad, fast-slow, etc.) and the results are analyzed to determine the connotative meaning of the concepts ranked. Additionally, a self-anchoring scale, the ladder of life (cf. Cantril, 1963), was used to determine the fishermen's self perceptions of where they stand in relation to their perceptions of the worst and best possible modes of living. Each fisherman interviewed was shown a ten-step ladder diagram wherein the first step symbolized the worst possible life and the tenth, the best. He was asked indicate where he stood on the ladder at the present time as well as five years in the past and future.

Finally, concerning question types in the sample survey, the triad sort technique was used to investigate the structure of meaning of a subset of an economically important variety of fish (corvina). Basically, the triad sort is a technique used to determine the relative similarity in meaning among the members of a set of terms. All possible triadic combinations of the set of terms are formed and the respondent is requested to select from each triad the term most different in meaning along with a reason why it is most different. The two remaining terms are the most similar in the triad. The total number of times each possible pair of terms is classified as most alike is calculated, resulting in a measure of the relative similarity of the terms. The reasons for the various sorts are then content analyzed to determine the attributes used to structure the domain (Pollnac, 1975).

Four surveys were conducted using the types of questions discussed above; two in 1976, one in 1978, and one in 1979. The two 1976 were composed of quota samples of 125 and 80 small-scale fishermen. The first included 75 from Puntarenas and 50 from Costa de Pajaros. The second included 50 from Puntarenas and 30 from Costa de Pajaros. The 1976 survey was divided into two separate surveys as a means of limiting the length of the interview to less than one-half hour. Experience has shown that fishermen are not receptive to interviews lasting much longer than 20 to 30 minutes, and that if the interviews are too long, fatigue sets in and reliability of responses is reduced. A quota sample of 50 small-scale fishermen was interviewed in Puntarenas in 1978 and 70 between Playa el Coco and the Nicaraguan border in 1979.

In obtaining the sample, all landing sites in the areas selected were

visited, and all small-scale fishermen (captains and crew) who were landing fish, working on their boats, or simply visiting the landing site were interviewed. The interviewer travelled from point to point starting at a different landing site each morning; thus, the times of interviewing at the various sites were distributed throughout the day. This system of visiting landing sites at various times throughout the day eliminates possible systematic bias due to landing time. This technique of quota sampling was used because reliable lists of small-scale fishermen were not available. For purposes of analysis, each sample is conceptualized as a sample from the universe of all hypothetically possible data sets collected under the same conditions (Chein, 1976; Thomas, 1976; Freund, 1960). Almost any current journal in the social sciences will contain articles using statistical analyses based on these assumptions. These assumptions have, of course, been questioned (Hogben, 1968; Selvin, 1957) as well as supported (Chein, 1976; Thomas, 1976); thus while some readers may accept the findings based on such samples, others will find them merely suggestive with need for testing using a truly random sample. Further, since we did not sample all fishing communities our sampling procedures do not allow us to claim that our data are representative of all fishermen, or even all small-scale fishermen in the Gulf of Nicoya and north along the Pacific coast of Costa Rica. No matter what the convictions one has concerning the rationale behind the use of statistical tests of significance, carefully collected data from subgroups containing a quota sample drawn from all available fishermen clearly contain information of value to planners, and the interrelationships between the variables in this data can be used to stimulate further research and theory building.

Intensive interviews with key informants within the subject population (here small-scale fishermen) were also used throughout the research. Key informants are individuals having considerable knowledge concerning the domain of interest. Key informants were used to obtain historical data, folk taxonomies, beliefs about fish behavior, and crew structure. A summary of the types of data collected and the methods used can be found in the attached list of anthropological data.

Anthropology Data List

Data Type	Method*
Sociocultural	
age	s
education	s
years fishing	s
full/part time fisherman	s
other, prior, alternative occupation	s
number of dependents	s
father's occupation	s
kinship involvement in fishing	s
material culture (household goods, house ownership)	s
mass media exposure (radio, TV, newspaper, magazine, etc.)	s
crew structure (captain's role, how select crew, etc.)	k
Attitudes, Beliefs, and Values	
most like/dislike about fishing	s
qualities of a good fisherman	s
semantic differential on farmers vs. fishermen	s
semantic differential on fishermen vs. administrators	s
attitude towards son becoming a fisherman	s
future perspective (best & worst things that could happen)	s
self-anchoring scale (ladder of life) for measuring expectations of goal attainment	s
procedures for securing good luck	c
Cooperatives	
membership	s
why/why not join	s
why quit	s
perceived benefits of a cooperative	s
perceptions of cooperative function	s
characteristics of good and bad cooperative members	s
problems of existing cooperative	s
what respondent would do if he were the head of the existing cooperative as a means of improving it	s

*s = survey; k = key informants

Data Type	Method*
Resource and its Exploitation	
history of exploitation and equipment used	k
taxonomy of fish	k
beliefs about behavior of corvina & shark	k
dyadic comparison (shark & corvina)	k
triadic comparison (corvina)	s
use of tides, moons, currents and fishing spots	k,s
changes in production over the past 5 years and perceived causes	s
Economic	
Equipment	
vessel type	s
vessel ownership	s
gear used	s
Effort, Income, Personnel	
days, hours, trips per day/week	s
income per year (fishing and other)	s
income from fishing in past month	s
income maximum and minimum months	s
crew size	s
reasons for selection of specific middleman	s
success at fishing (rank)	k
Investment	
gratification orientations	s
conditions leading to investment in gear	s
type of gear most likely to invest in	s
Other	
Use of book perceived benefits and disadvantages	s
perceived alternatives if no more fishing in the gulf	s

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CHAPTER 7 FOOD SCIENCE AND TECHNOLOGY SURVEYS OF QUALITY ASSESSMENT AND PRESERVATION METHODS OF FISH

By D. Kazantzis, C.O. Chichester, S.M. Constantinides, and Tung-Ching Lee

The artisanal fishermen of Central America, as well as in other areas of the world, still hunt for many fish in the same fashion as their forefathers did. The methods by which they market their fish and preserve their catch have only changed slightly in the last several decades. Although they tend to use ice at least in the market places, this is not universal.

It is estimated that these fishermen supply a significant percentage of the animal protein to the populations immediately adjacent to the sea in the form of fin fish and shellfish. A great deal of evidence has accumulated over the past several years that the handling, processing and marketing and distribution systems for this animal protein are poor. Substantial losses are incurred, thus depriving the dependent population of needed protein. In this series of studies we used as a focus fish quality--more specifically, the freshness of fish--and then reviewed two techniques which are utilized in the area and which offer, if methods were improved, the possibility of significantly increasing the availability of fish to the population.

In these an initial attempt was made to assess the condition of fish from the point of capture to the point of consumption. In Costa Rica fish were sampled first as they were caught, again before being taken to the market in the capital city, and then finally when displayed for sale. Samples were assayed for freshness using several techniques including microbiological assay. Observations were made under sanitary conditions in the distribution process for the fish in Costa Rica. In Guatemala fresh processed fish in various markets of the capital city were examined and observations were made relative to the sanitary conditions. While these surveys were by no means exhaustive, the reports are indicative of how the handling methodology might be improved, and this would significantly increase the availability of food in the Central American region.

The food science group worked very closely with CITA in Costa Rica and ICAITI in Guatemala. It was evident when this project was to terminate that interest had been generated to suggest that they would continue to work in the area.

Basically, since fish freshness was the determinant, we reviewed methods for measuring fish quality and freshness and for the preservation of fish. Three major topics were examined and summarized as follows.

1. Fish Freshness

Several books, chapters of books and booklets exist on these topics, expecially the latter two, hence the preparations were meant to be introductory and general. Freshness assessment is a timely topic and the use of the Torrymeter for this is a very recent advancement. The brief discussion of this topic should, therefore, be of value to those in developing countries, particularly laymen and technicians, who wish to get acquainted with the equipment and its use.

Simple, Fast, Inexpensive Methods of Assessing Fish Freshness

Freshness is important in determining the quality of fish and much effort has been expended in search for suitable methods of its assessment. In many countries, quality control of fish for human consumption has been based on the organoleptic assessment of characteristics and attributes which were found

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acceptable to the fishermen and the local population in the fishing districts. However, for reproducibility and precision, several objective as well as subjective tests have been proposed.

Freshness is the condition of the fish between the time it is caught (captured) and the time when spoilage is detectable. In general, the freshness of fish will be higher at the landing site than when it reaches the consumer at an inland marketplace.

The handling of fish between the time it is caught and delivery to the processor or to a central market place or bought by the consumer is critical and influences the quality of the final product. Marketability of fish influences the economica of the fish industry--that is, how much is sold--and this in turn determines the economic viability of the industry.

In addition, freshness ia indicative of the wholesomeness of the product. Microbial loads might be high or pathogenic organisms might be present, depending on handling and other post-capture conditions.

In cases where fish is processed in commercial quantities, used for canning, filleting, freezing, etc., the freshness of the initial product will determine the quality of the end product. That is, if the raw fish is not of high quality, the canned product will not be of first grade.

Handling and processing facilities on the fishing vessel and on shore may sometimes be grossly inadequate. The temperature at which the fish is kept after it is caught, whether it is kept on ice or not and the time between catching and processing or aelling, have significant effecta on freshnesa.

Fresh fish will deteriorate if it is stored too long or is stored at too high or variable temperatures. Loss of quality (freshness) during ice storage may be due to inadequate cleaning, the fish being thrown or dropped on deck, struggling of the fish and bruising of flesh, or to microbial and enzymatic deterioration.

Sampling Requirements for Assessing Freshness

In order to measure fish freshneas properly, the correct number, size and kind of sample must be used. Inspection of every fish for freshness is too costly. It is necessary, therefore, to resort to ssmpling procedures; that is, inspect a sample of the product and infer that the condition of the entire lot is similar.

Measurements may be worthless without the application of a properly designed sampling scheme. The larger the number of samples, the lower will be the risk of misrepresenting the true nature of the batch.

Fish subjected to crushing and high temperatures at the bottom of a big pile often will be poorer in quality than those at the top. In order to gain a correct impression of the overall quality of the pile, representative samples must be taken throughout the depth of the pile or stack. The samples should be drawn at random.

The vendor would need to have a level of defects of less than 10% to ensure that nearly all of his product is acceptable. This means 10 defects maximum per 100 units. When the quality of lots submitted for inspection is 16 defeats per 100 units, practically none of the lots is expected to be acceptable.

How many sample fish must be inspected before it is reasonably certain that one defective fish can be found? Using the Poisson distribution table, the following sample size and probability percentages apply:

Sample Size	2	15	35	55	80	110	170	300	600
% Probability	0	1	5	10.5	19	30	50	80	89.3

Types of Methods Used

Subjective and objective tests are used for checking fish freshness.

Subjective (organoleptic) criteria:--The oldest and still most widespread means of evaluating the acceptability and edibility of fish are the senses: sight, smell, taste and touch. The consumer, obviously, uses only his senses in deciding what he likes. It can be argued, therefore, that sensory as opposed to non-sensory methods offer the best opportunity of getting a valid idea of what the consumer wants. The reasons for the preferential use of sensory tests are obvious: no special laboratory equipment is needed. The fish can be examined wherever they happen to be; the tests can be carried out quickly, and many samples can be evaluated in a relatively short time. These obvious advantages, however, are to a great extent counterbalanced by a number of disadvantages inherent in the organoleptic method that detract significantly from its usefulness. The use of the senses is a subjective procedure and is highly qualitative. The demand upon the senses becomes most critical and difficult when they are required to distinguish and assess the so-called borderline stage of freshness (that is, when a fish sample to be judged is in the last stages of freshness or in the first stages of spoilage). This task is well recognized as a difficult one, and even experienced judges often differ in their evaluations.

Sight:--In almost all cases, the detection of deteriorations and defects is acomplished very efficiently and rapidly by sight. Instruments or machines have so far found little or no application in this area. For example, it would be very difficult if not impossible to make a machine capable of detecting poorly trimmed fillets or fillets possessing too large an area of skin. The matching of color can be done very effectively by the eye. The use of instruments to measure the color of fish is very limited because of the technical problems involved.

In making visual assessments, the appearance of the skin, eyes and gills are noted.

Smell:--This sense is a powerful tool in assessing freshness. Almost anyone can readily distinguish between the smell of fresh and spoiled fish. With some practice, the whole pattern of changes in odor between very fresh and very spoiled can be differentiated easily and rapidly, thus enabling the degree of freshness to be rather accurately determined. Similarly, off-odors (cold storage, rancidity) taints and unusual intrinsic odors may be readily detected and their intensity judged reproducibly. Up to the present time, there is no substitute for the human nose as detector and assessor in any of these situations. The value of this test is less exact and less consistent when applied to fish at the stage between the end of freshness and the beginning of spoilage, the area of so-called incipient spoilage.

Touch:--In assessing textural attributes (firmness, softness, mushiness, rubberiness, woodiness, succulence, dryness), the sense of touch is used as occasion demands. Testing with the fingers and the eyes is an effective way of detecting bones and scales.

An example of a freshness grading scheme for whole fish in general (like cod, whiting, etc.) based partly on the freshness odor scale is shown in Table 1. Grade A is considered to be very fresh, Grade B not so fresh, Grade C less fresh, and Grade D is unfit for sale. However, where lines should be drawn between acceptable and unacceptable or between a very fresh Grade A and a not so fresh Grade B, is a matter of opinion and experience at any given time.

Judgment:--Judges should be experienced or trained. Otherwise, to be of value, assessments must be obtained from a large group, perhaps greater than 50. Some precautions should be taken because sensory judgments are sometimes influenced by external factors. The color of the product will appear different under different types of lighting. Therefore, in order to carry out careful color comparisons, standardized lighting conditions should be used. The detection of a special odor in a working environment like a market can be hampered by extraneous odors. Therefore, practice is usually needed so that the interference can be ignored. Ideally, tests should be conducted in a

TABLE 1. Sensory Criteria

	Grades			
	A	B	C	D (unfit)
A. Sight:				
1. Skin	bright, shining, no bleaching	waxy, slight loss of bloom	dull, some bleaching	dull, gritty, marked bleaching and shrinkage
2. Eyes	clear, dark appearance, convex shape	plane, slightly opaque pupil slightly opalescent cornea	slightly concave gray pupil, opaque cornea	completely sunken gray pupil, opaque, discolored cornea
3. Gills	bright red, mucus, translucent (herring and mackerel brown)	pink, mucus, slightly opaque	gray, bleached mucus opaque and thick	brown, bleached, mucus yellowish, gray and dotted
B. Smell:				
1. Gill and Body Odors	fresh, strong, seaweedy, shellfishy	no odor, neutral odor, trace of musty, mousy, etc.	definitely musty, mousy, etc. bready, melty, etc.	acetic, fruity amines, sulfide, faecal
C. Touch:	fish flesh elastic, scales stiff			

separate area or in a room isolated from processing and other industrial operations.

Use of the Torrymeter for Measuring Freshness

The Torrymeter is an instrument that measures changes in the dielectric properties of fish. It has been tested extensively in England and results have shown the applicability of the instrument compared with chemical and sensory tests. The instrument requires a larger sample than the chemical tests for the same precision and is sensitive to the position of the fish in the pile or box. On the other hand, it has the following advantages.

1) It is not destructive and so samples can be used for other tests.
2) It is a very fast method.
3) The equipment is simple to operate (requires only one operator).
4) It is a very economical method, though the equipment itself costs about $1,200.
5) So far, no breakdowns of the instrument have been reported.

It is unnecessary to know the detailed history of the fish in order to interpret meter readings in terms of freshness. The meter, besides grading whole fish, can also be used to grade fillets, since the dielectric behavior of both muscle and skin tissue is affected by spoilage.

Electrical methods for assessing fish freshness are not only rapid and non-destructive but are also free from observer bias.

Figure 1 shows the front view of the meter and the probe head. Between the measuring electrodes are a further two electrodes. They have three functions: to sense proper contact of the probe head with the fish, to measure the temperature of the fish and to act as battery charging terminals. Figure 2 shows the back and side view of the meter and Figure 3 shows the proper position of the meter on the fish.

The following guidelines will aid in the use and proper functioning of the instrument.

1) Always charge the Torrymeter for 24 hours maximum before using it.
2) In order to get readings, turn the mode switch on the top of the Torrymeter to position 1.
3) Press the reset button on the front of the meter.
4) Place the base of the meter on the fleshy part of the fish parallel to the backbone.
5) Press the red button on the back of the meter and hold it. Write down the reading.
6) Press the reset button again and go to the next fish.
7) Keep the Torrymeter clean and maintain the probes free from slime before measuring the next sample.

Care should be taken with respect to the following:

1) There should be no ice on the fish while measurements (readings) are being taken.
2) The surface of the fish should not be dry.
3) The meter should not be placed on the belly of the fish while taking readings.
4) For skin-on fillets, the measurements should be made on the "skin" side.

Anyone using the meter should read carefully the manual supplied by the manufacturer or distributor. The equipment and/or more information on it may be obtained from G. R. International Electronics Ltd., 99 Frimley Road,

Camberley, Surrey GU15 2PP, England.

Freezing has a drastic effect on the cellular constituents of the muscle. It is not possible to determine the original freshness of thawed fish since meter readings are invariably in the range 0-3, irrespective of the quality of the fish before freezing. In fact, this characteristic can be used in many cases to determine whether fish has been frozen at some time or the other in its history.

Brining also lowers the reading, though not quite as much as freezing. It is therefore not possible to check the freshness of brined fish.

Results from studies that were conducted in the Food Science Laboratory at the University of Rhode Island are shown in Table 2. Torrymeter readings were taken on whole, dressed and skin-on fillets of yellowtail flounder, whiting, scup and butterfish and compared with sensory analysis of a scale of 1-9. A sample of a score sheet is shown in Table 3.

Objective criteria:--Objective tests are chemical tests used to measure the degree of freshness or the lack of it. These tests include measurements of trimethylamine, hypoxanthine, histamine, lipids, etc. The first two methods, widely used in testing the freshness of fish, are described.

Trimethylamine (TMA):--The TMA test is the one that has been most widely used in marine fish. TMA is produced in decaying fish muscle by the bacterial reduction of the trimethylamine oxide present, and its rise parallels that of the bacterial population. TMA, then, can serve as an index of spoilage of raw fish.

TMA is generally not found in freshwater fish, consequently this method cannot be employed with this category of fish. It has been suggested that TMA is a product of the early satges of spoilage and that it may be lost during storage. TMA levels are usually different for different species of fish.

However, because the correlation between TMA values and sensory appraisal is not a direct one, and because TMA values reflect increasing spoilage rather than loss of freshness, the test cannot be considered an adequate guide to early loss of quality.

Hypoxanthine:--Nucleotide degradation in fish muscle commences at death or early postmortem and proceeds throughout storage. The autolytic processes involve dephosphorylation and deamination of adenosine triphosphate to form inosine monophosphate, which is degraded to inosine and finally to hypoxanthine. Measurement of the accumulation of hypoxanthine has shown potential as an index of freshness, especially in marine fish. Although information on hypoxanthine formation in freshwater fish is less abundant, its increased levels during storage have been demonstrated and its usefulness in assessing freshness has been noted. No other chemical test holds as much promise as the hypoxanthine test as an index of freshness for freshwater fish. However, there are many factors which could affect not only the rate of production of hypoxanthine but also its extrapolated starting value. These would include, among other thinga, pre-chilling delays, actual temperatures of storage, variations in enzyme activity from one stock of fish to another, seasonal variationa, size of fish and pH of flesh.

An indicator method for hypoxanthine developed at URI (Jahns et al., 1976) employs an enzyme test strip which is moistened with fish extracts and then compared with color changes obtained with strips dipped in known amounts of hypoxanthine. The application of enzyme methods in fish tissue as an index of freshness can provide objective, inexpensive and rapid approaches to the assessment of seafood quality.

The preparation of the enzyme test strip is as follows: Resazurin is dissolved in 100 ml of hot 0.17 m phosphate buffer (pH 7.6) at a concentration of 11.6 mg. The solution is cooled to room temperature and 7.598 gr of ammonium sulfate is added. Gelatin 50 mg/ml is dissolved in boiling water, cooled to room temperature and 0.5 ml is added to 4.0 ml of the Resazurin solution, followed by 0.5 ml of xanthine oxidase solution (10 μ/ml). Chromatographic paper strips, dried at 100°C over night, are soaked for 10 sec in

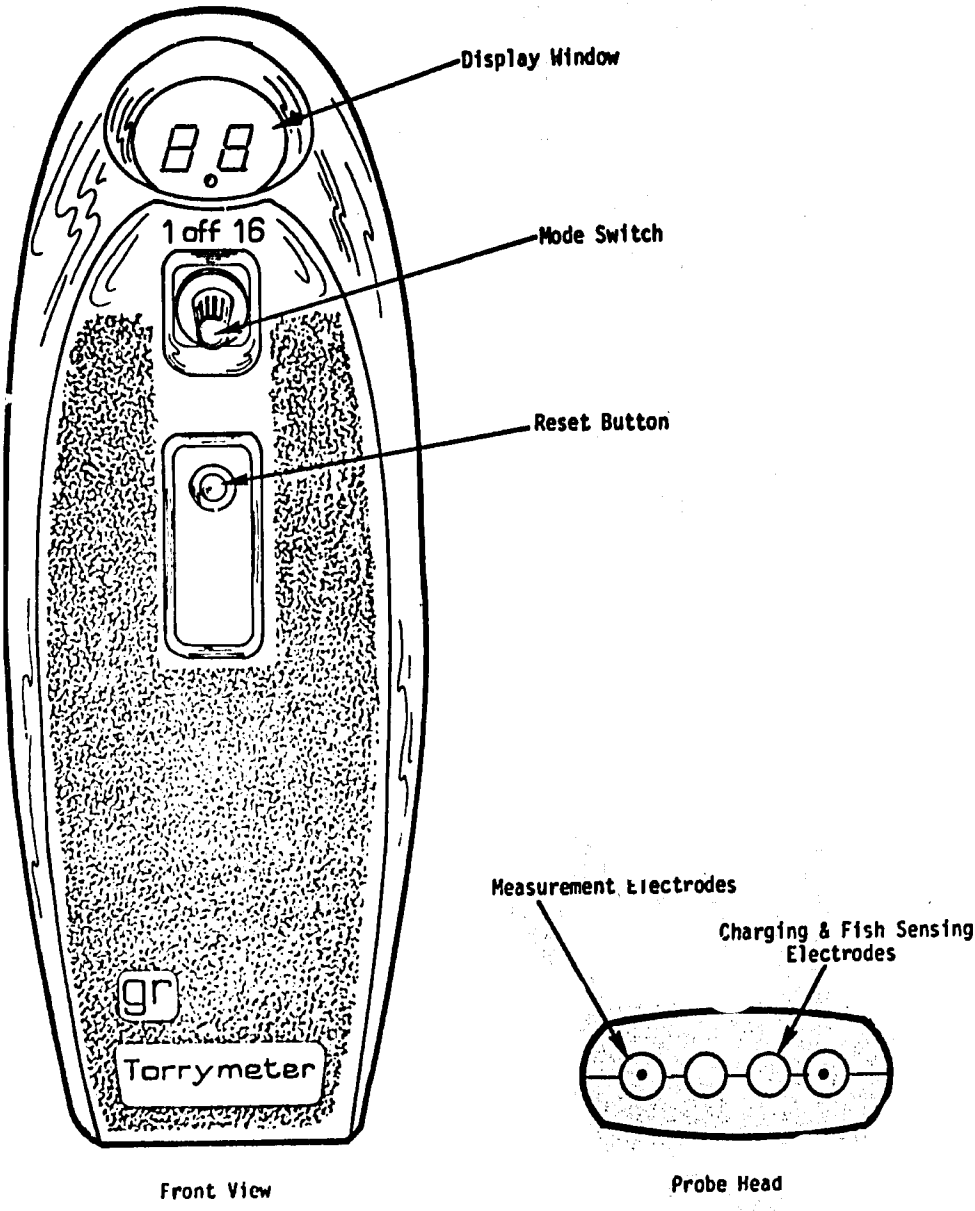


Fig. 1 TORRYMETER, FRONT VIEW & PROBE HEAD

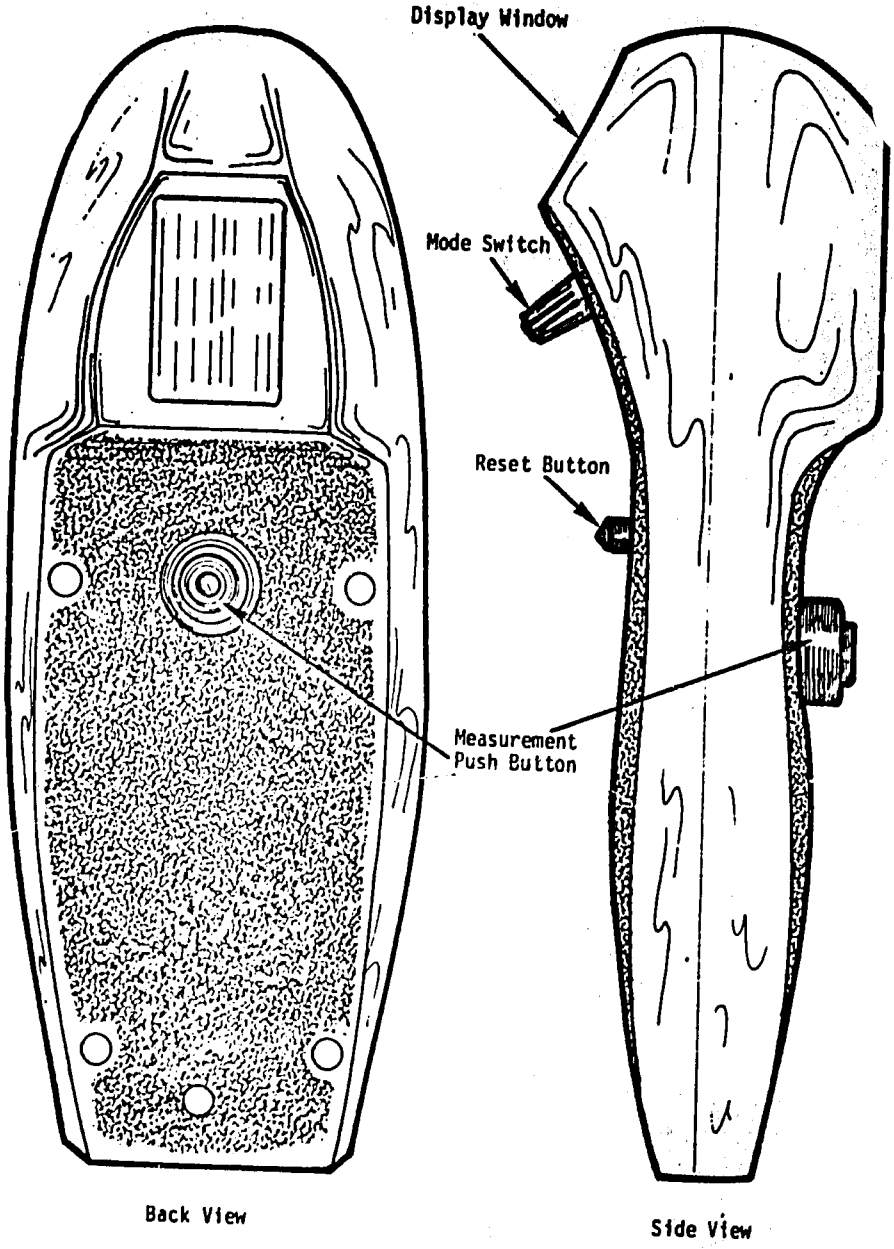


Fig. 2 TORRYMETER, BACK VIEW & SIDE VIEW

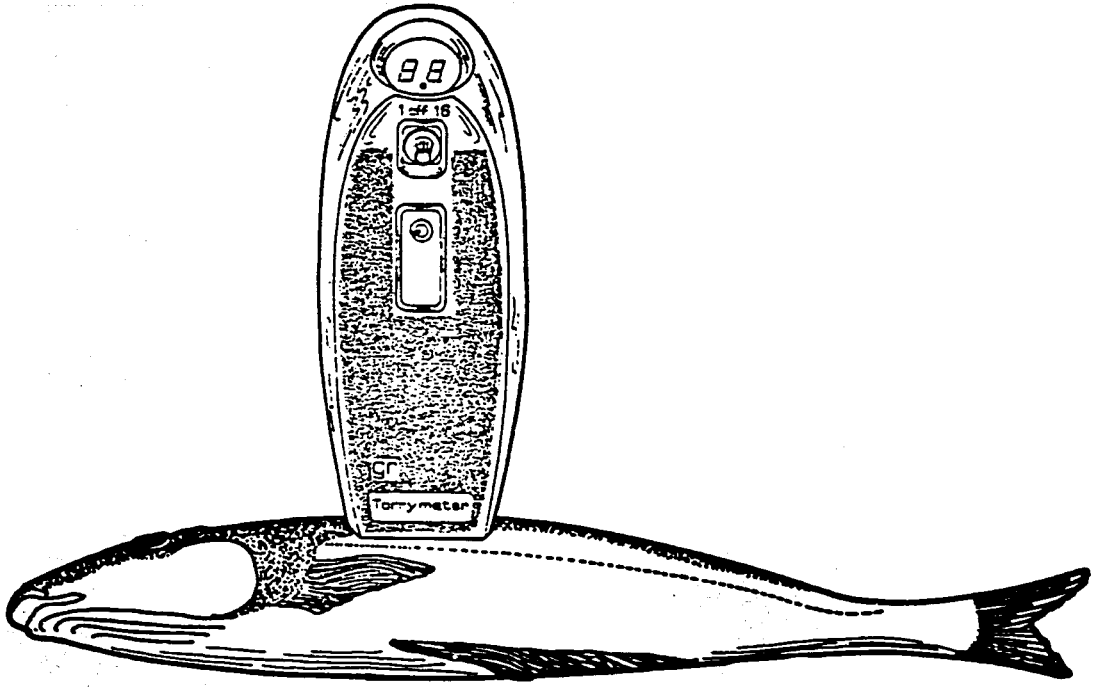


Fig. 3· PROPER POSITION OF TORRYMETER ON FISH

TABLE 2. Relationship between Sensory Scores for Freshness and gr Torrymeter Readings*

	General		gr Torrymeter Readings		
	days	appearance	whole	dressed	skin-on fillets
Flounder	1	9	15	15	15
	4	6.6	13	13	13
	6	6	12	12	12
	8	4	11	11	12
	11	3	11	11	11
Whiting	1	9	13	13	14
	4	6.4	9	7	10
	6	6.2	5	5	9
	8	3	4	2	9
	11	2	3	2	7
Scup	1	9	12	11	11
	4	7	11	10	9
	6	7.5	11	9	8
	8	5.4	10	9	9
	11	2	9	9	
Butter-fish	1	9	12	11	11
	4	7	6	5	7
	6	6	5	4	4
	8	5.4	4	4	3
	11	3	4	4	2

* These values merely indicate trends and relationships which resulted from limited experimental trials.

TABLE 3. Outline of Organoleptic Score Sheet

NAME		DIVISION	DATE
CODE Taste	CODE Texture	CODE Appearance	CODE Odor
9 LIKE EXTREMELY	9 LIKE EXTREMELY	9 LIKE EXTREMELY	9 LIKE EXTREMELY
LIKE VERY MUCH	LIKE VERY MUCH	LIKE VERY MUCH	LIKE VERY MUCH
LIKE MODERATELY	LIKE MODERATELY	LIKE MODERATELY	LIKE MODERATELY
LIKE SLIGHTLY	LIKE SLIGHTLY	LIKE SLIGHTLY	LIKE SLIGHTLY
NEITHER LIKE NOR DISLIKE	NEITHER LIKE NOR DISLIKE	NEITHER LIKE NOR DISLIKE	NEITHER LIKE NOR DISLIKE
DISLIKE SLIGHTLY	DISLIKE SLIGHTLY	DISLIKE SLIGHTLY	DISLIKE SLIGHTLY
DISLIKE MODERATELY	DISLIKE MODERATELY	DISLIKE MODERATELY	DISLIKE MODERATELY
DISLIKE VERY MUCH	DISLIKE VERY MUCH	DISLIKE VERY MUCH	DISLIKE VERY MUCH
1 DISLIKE EXTERMELY	1 DISLIKE EXTERMELY	1 DISLIKE EXTREMELY	1 DISLIKE EXTREMELY
COMMENTS	COMMENTS	COMMENTS	COMMENTS

the above solution, immediately frozen at -40°C, and dried in a freeze dryer for 12 hours. The strips were then stored in jars containing silica gel desiccant at approximately -20°C until used in the analysis.

A very useful compilation of methods used to assess fish quality has been prepared recently by Jhaveri et al. (1979).

II. Preservation of Fish by Salting

The use of salt to preserve fish has been known for hundreds of years. Preference for other methods as they developed has led to a decline in the popularity of salting, but there is a big market and enthusiasm for salted fish in recent years. Where salt is available in sufficient quantity, is cheap and of good quality, then the process is simple and effective and requires no elaborate equipment or techniques. In many underdeveloped countries, fish is the main source of dietary protein, and salted fish is an integral part of the diet.

The smoking of fish is usually preceded by a period of salting (also known as rousing). However, the finished product is said to be smoked because this is the major part of the process.

Besides serving as a flavoring agent, salt reduces the amount of moisture in the fish. Water is extracted from the fish tissues and salt passes into them. This action is known as osmosis. Most microorganisms (except halophiles) do not grow in salt solutions of relatively high concentrations. Salt retards enzymatic action and thus halts bacterial spoilage.

Common salt is sodium chloride. Salt deposits are distributed over the world. Seawater is one of the principal sources. The different salt types are known as solar salt, rock salt, grain salt, sterilized salt, etc.

Solar salt is produced by dyking low-lying lands adjacent to the sea, flooding them with seawater and allowing the sun to evaporate the water so that the salt residue may be recovered. This is one of the oldest methods of salt production. This salt is crude. It is used for salting fish because of its low cost.

Natural deposits of rock salt are formed in seas that dried up many millions of years ago and were subsequently covered with sedimentary matter. Rock salt is not suitable for direct addition to any food product.

Sterilized salt, used by the fishing industry, is prepared by a process which frees it of contaminating microbes.

Salts of various origins have the following general average composition:

	%
NaCl	97.7
Water	2.4
Calcium sulfate	1.08
Calcium chloride	0.24
Magnesium chloride	0.30
Magnesium sulfate	0.17

Yellow and brown discolorations of the salt indicate the presence of iron in more than traces. Such salt should not be used for fish preservation since iron and cooper catalyze the formation of a brown or yellow stain in salted fish.

Effect of Quality of Salt on the Fish

Commercial salt is obtained from evaporation of seawater and contains sodium, calcium and magnesium. Calcium and magnesium have a bad effect on the preservation of fish because they reduce the penetration of sodium chloride.

So, if fish are somewhat stale when processed, it is unlikely that an effective cure will be obtained unless the salt is pure.

Another effect of calcium salts is the coloration produced which may range from pale yellow to white. A yellow color is obtained with pure sodium salt, but as the amount of calcium salt is increased, so the color ranges toward white.

Salting Methods

Depending upon climate conditions and geographical location, various methods of salting have been developed. The principal ones are:

1) brine salting
2) dry salting
3) kench salting
4) pickle salting
5) mixed salting

1) Brine salting (brine cure, wet cure):--This is preservation of fish by immersion in brine. This method was known to the Phoenicians on the Spanish coast, to the Greeks, and the Romans. Brine is heavily saturated salt solution. This fish are cleaned and put into large wooden containers partly filled with strong brine. After being struck through, they are tightly repacked in wooden barrels, the air space of which is filled with new brine. Dry salt is added to the top layer. These salted fish are not dried but are sold in the brine.

2) Dry salting (dry cure):--This is the curing of non-fatty fish by adding dry crystalline salt. Dry salting is used mainly in the barrel salting of herring. There are two stages:

a) The fish is split, removing most of the backbone. It is placed in piles with salt interspersed between the layers. The pile of fish and salt are left for up to one month, thereby extracting the fish fluid through plasmolysis. The extracted fluid is called pickle. The fish at this stage is called green-cured; its water content being reduced from 82% to about 54%.

b) The green-cured fish is hung on racks to dry in the sun and wind, or dried artificially over a coal fire. With salt content at about 2 , the moisture of the finished product may vary from 25-38%.

3) Kench salting (kench cure):--This is salting fish in piles which consist in split fish and salt placed in alternative layers, thus allowing the pickle which has formed to drain off freely. More salt is put on thick fish and thick parts of normal ones. In the lower layer, the fish are placed with the flesh side up, the top layer is spread skin up. In spite of this precaution, bacterial contamination, manifested as slime, occurs easily with light salted cod, because the total surface exposed to the air is larger than in pickle or brine salting. Limitation of space, as for instance on board schooners, is the only reason that this method is still used. Contrary to pickle salting, products obtained by kench salting contains an adhering salt layer, which must be removed before drying.

4) Pickling or pickle salting:--This is treating fish with dry salt in watertight containers and curing in the pickle which forms as a result. In pickle salting, the fish remain in the brine, and due to the tendency to approach an equilibrium, salt enters the fish muscle and water is extracted. Thus, in pickle salting, the water of the brine comes from the fish.

Coagulation of the fish protein sets in when the salt concentration in the muscle has reached 10%. Light salted fish is prepared by adding salt only at the center, where the backbone has been removed.

5) Mixed salting:--Here, the fish is salted simultaneously with salt and with brine. The fish is rolled in salt, loaded into the barrel and a certain amount of salt solution is added. The salt on the surface of the fish prevents the brine from becoming diluted.

Quick Salting Process for Fish

Conventional commercial techniques for salted fish require constant handling of the fish and the process could take up to three months to complete.

Quick salting methods have been developed recently by a few researchers (Del Valle; Mendelsohn). Quick salting is less expensive and requires less equipment. Furthermore, quick salted fish can be stored at ambient temperature for a long time without deterioration.

In general, decreasing salting time would result in the following:

1) Increased production of the final product.
2) It would prevent or lessen decomposition in warm climates, since salting would be completed before serious microbial action could occur.
3) A high quality product capable of long-term room temperature storage would result.

The quick salting process has four steps: 1) mincing; 2) mixing; 3) pressing; and 4) drying.

A flow sheet for the preservation of fish by the quick salting procedure is shown in Figure 4.

The quick salted process has been applied to preserve the following species of fish: shark, dolphin, carp, mullet, mackerel, red snapper, and sardine.

The salt content values from as low as 22% in the case of shark to as high as 100% of the weight of the wet flesh in the case of the sardine.

Prerequisites for Obtaining Good Salted Fish

In order to obtain good salted fish, processing of the already caught fish should proceed as follows:

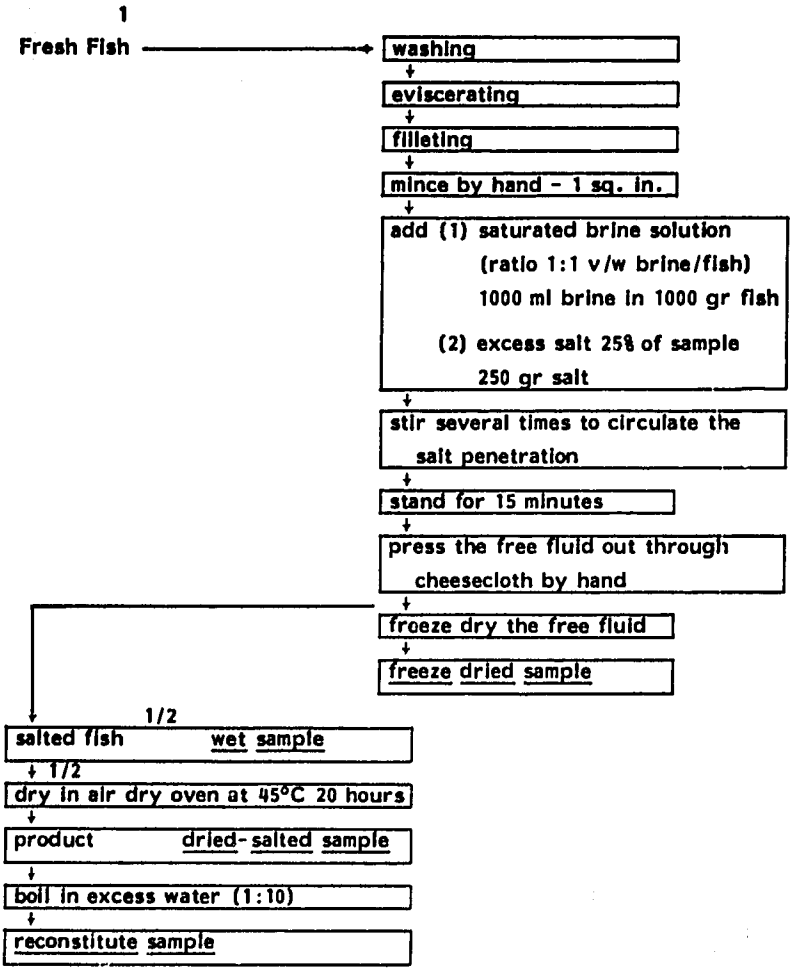
1) If ice is available, the fish should be placed on ice immediately after they are caught to eliminate bacterial growth.

2) Behead, gut and split the large fish along the backbone. This way, fish may be preserved better from microbiological attack. Changes will be particularly rapid, if fish are not gutted.

3) Put enough salt between each layer and sprinkle with crushed ice. The sooner salt is applied to the tissues, the better the preservation will be. It is advisable to use equal weights of ice and fish.

4) Only the purest grade of salt should be used, if possible, for the cure. Calcium or magnesium salts should be absent.

5) When fat-rich fish is salted and stored for longer than a month, the fat oxidizes and develops objectional odor. In order to prevent the oxidation, antioxidants can be applied. For example, BHA should be added to salt at 0.01% of the weight of raw fish.



This is a combination of the Mendelsohn and Del Valle methods.

Figure 4.--Flow Chart for Quick Salting of Fish

Uses of Salted Fish

Salted fish is used in different ways in different parts of the world. The salted product is prepared for use in fish cakes by adding water, bringing the mixture to a boil and discarding the free fluid. Almost all the salt can be leached out by boiling the salted fish twice in excess water and discarding the liquid. Also, the salted product can be used as fried fillets, fish casseroles, salads, etc.

The desalted product has a bland, practically neutral flavor, and can be cooked as desired. In countries where use of species is frequent, their incorporation into the cake is easy and desirable. Salted cod fish is used widely in many tropical countries to prepare many delicious and even national dishes.

Principal Kinds of Fish Preserved by Salting

The principal kinds of salted fish are as follows:

1) Herring is heavily salted. Salt is added at above 25% by weight of the whole raw fish. The fish is cured for 20 days, then drained and additional salt over 5% by weight of the drained fish is added.

2) Sardines. About 15% of salt is added by weight of the whole fish and stored for six months. After storage, the fish are drained and 5% additional salt is added.

3) Mackerel are gutted and eviscerated (mackerel, of which the length is less than 18 cm, may be salted without being gutted and eviscerated). About 15% salt is added and the fish is stored for six months.

4) Cod is split at the back or belly side. If they are prepared without removal of head, they are gutted and eviscerated. About 20% salt is added to the prepared fish and they are cured for five days or longer.

5) Salted salmon are prepared usually from pink salmon. The fish are gutted and eviscerated. To the prepared fish is added 25% of salt and they are cured for 10 days or longer. After curing, the fish are drained and 5% additional salt is added.

6) The yellowtail is gutted, eviscerated and cured with about 20% salt. Sometimes the split or fillet of this fish with the backbone removed is salted.

7) Flat fish. If the fish are less than 15 cm long, they need not be eviscerated. If they are longer, they are eviscerated and cured with about 20% salt for three days or longer. After curing, the fish are drained and 5% salt is added.

8) Shark. In order to produce salted, dried fillets, sharks are beheaded, eviscerated, and bled. They are then washed and stored in ice (belly down) until ready for use. Later they are filleted, and the fillets are cleaned of blood spots, skin, etc., and ragged edges are trimmed. The washed fillets are then drained for a few minutes and layered with salt in boxes containing drain holes, taking care that fillets do not overlap without salt between them. The boxes are held in the shade for about six days. At the end of this period, the fillets are removed and excess salt is brushed off. The fillets are then dried by any of the available methods (tunnel drying, sun drying, etc.). Sun drying, which takes about one week, is the least desirable method because this process subjects the product to various types of contamination, and there is no way to control the precipitation, temperature, humidity, etc. Thus, when precipitation occurs or when the humidity is high, the fish, which are generally dried on racks or trays, must be removed to a covered drier area. In tunnel drying and cabinet drying, the product is protected against contamination and there are various conditions that are controllable (temperature, air flow, humidity, etc.), depending on the facilities. When conditions are controllable, the recommended temperature

is about 113°F (45°C), and the recommended relative humidity is about 35%. Under these conditions, the drying time is much shorter than that required for sun drying and the quality of the tunnel dried product is correspondingly better.

Fins are also preserved by salting. To produce lightly salted, dried fins, they must be trimmed of all flesh and skin, washed and held for about 10 hours in a 3% salt solution (about 1/4 pound of salt for every gallon of water). The fins are then sun dried on wire mesh in single layers for about two weeks. When the drying is completed, the fins will be very stiff. Then they are packed in boxes.

To prepare for consumption, the salt is leached out by boiling in fresh water two or three times.

In the developing countries, there are many and varied procedures for salting local fish and for storing and using them. In the State-of-the-Art report a brief description of preservation by salting in Guatemala was presented. Caurie et al. (1977) discuss salting in Ghana and it is possible to encounter many other variations in Latin American countries and in Asia.

Keeping Quality of Salted Fish

The stability of the salted product is due to its high salt and low moisture content. Salting will inhibit the growth of bacteria.

Reduction of the water content of fish containing little fat drastically reduces the possibility of spoilage and so the product will keep well. In fatty fish, though, some off-flavors due to rancidity may occur, because during processing, either in salting or in drying step, the fish might be exposed to excessive air and heat. Rancidity can be avoided by the addition of antioxidants such as ascorbic acid, tocopherol or BHT.

It is most advisable when salting fish, especially in the tropics, to observe the following rules:

1) Use the purest grade of salt available.
2) Use sufficient salt.
3) Store the fish in a sufficiently dry condition to slow down bacterial activity. If the fish is oily, store it in cold storage or in brine.
4) Combine salting with another method of preservation, such as smoking or drying. Salting will reduce the water content rapidly; heat will increase the drying process, inhibit the enzyme and bacterial activity, and smoking will complete the cure while imparting the characteristic flavor.

Nutritive Value

Protein:--Dried, salted fish contributes almost double the concentration of protein with respect to the fresh fish, 30% vs. 14%. The reconstituted product can be even as high as 48%.

It has been established that quick salted fish cakes are a good protein food, which keep well in the tropics without refrigeration. Quality wise, freshly made cakes that have been desalted surpass casein, while cakes stored during 18 months at an ambient tropical temperature and then desalted are slightly inferior to casein in PER values.

Fat:--Fish oils are interchangeable to some extent with vegetable oil. They are good source of calories and fat soluble vitamins, such as vitamin D and vitamin E. In dried salted fish the fat is more concentrated; 24% compared to the fresh fish with 11%.

III. Preservation of Fish by Smoking

Smoking is a very important means of preserving fish in many parts of the world. Originally, alone or in combination with salting, it was done primarily to preserve fish. With the availability of refrigeration, such lightly smoked fish products as salmon have become quite popular and have a fairly widespread distribution, especially near centers of production. Whereas the chief reason for smoking fish had been formerly to preserve it, it is now done in many cases mainly to impact a pleasant mild smoky flavor to the product.

When fish is smoked, chemicals in the smoke are deposited on the fish and confer on them the characteristic smoked flavor. Some smoke constituents may act as antioxidants. In addition, smoke has a germicidal effect and might either fill some spoilage organisms or at least inhibit or retard their growth.

Each country or region, especially in the developing areas of the world, has its peculiar variation with respect to equipment and the species of fish used for smoking. However, the basic action of smoke as a preservative and the objectives of smoking remain the same universally.

Processes Involved in Smoking Fish

The whole smoking operation involves three processes: 1) Salting. This extracts some of the body liquid, thereby assisting the drying process. 2) Smoking. This gives the fish its flavor and characteristic dark brown color. The keeping qualities are improved by the antiseptic action of the smoke. 3) Drying and Cooking. The skillful use of different quantities of wood for heat and smoke will give the type of cure desired.

The above-listed three processes determine the time necessary for curing the fish and the final flavor developed.

Types of Smoking

Two types of smoking are in general use: cold smoking and hot smoking.

Cold smoking is usually done at 27-54°F (15-30°C). This temperature is not enough to cook the fish. Cold smoking is a form of curing rather than one of preservation and the fish will keep for a few days only. The sole advantage of fish processed by this method is its good flavor.

The whole fish, if small, may be used or a fillet where large fish are being dealt with. This process is not generally used in the Tropics because at high temperatures and humidities spoilage is likely to overtake the cure and ruin the fish completely. Kippers and smoked haddock are examples of modern cold smoked fish. A kipper is a herring which is split open, cleaned and then smoked by hanging it on a rack after a short brining period. Haddock is a white fish of the cod family and is preserved in a similar manner to the kipper. The only cold smoked herring of historical importance is red herring. This is the well-salted herring, smoked for several weeks until it is well dried and of a reddish brown color. The resulting product has a very strong flavor.

Hot Smoking

In hot smoking, the temperature of the smoke is raised so that the flesh is cooked. Hot smoking requires more heat than cold smoking. The heat barbecues the fish and sets up hot air currents over the fish to conduct moisture away. Temperature control is achieved by increasing or decreasing the intensity of fire beneath the smoking racks, or altering the height of the rack in relation to the fire below.

Hot smoking involves two processes to remove moisture from the body tissues:

1) Application of salt in which osmosis extracts liquids from the tissues and penetrates the cells. The water content of the tissues is thus reduced.
2) There is further reduction of the moisture content by the action of the hot air currents.

The types of material usually used to hot-smoke fish varies but in certain processes, in Ghana particularly, preservation is usually completed with a different type of wood which increases the smoke and imparts a stronger flavor to the preserved fish.

Production of Smoke

In preparing a fire for cold smoking, a layer of chips is put down. A layer of sawdust is placed on top. The layer of sawdust collapses continuously due to the burning of the chips underneath and thus dampens the flames leading to the production of smoke rather than flames. The type of wood used varies greatly from place to place, depending on what is available, and practically anything can be used. Hardwoods, particularly oak, are generally preferred to those of soft, coniferous woods, such as fir, which give a marked color but impart a resinous flavor to the fish. Mahogany and redwood give good color and flavor. Driftwood, hickory, cedar, eucalyptus woods and rice husks are used in some parts of the world as a source of smoke. Soft woods give fish a more resinous flavor, and color develops more rapidly than with hardwood, and it is therefore usual to add some softwood dust to the fires when smoking white fish, but not kippers.

The selection of wood for smoking was originally based on empirical findings. Today the preference for hickory in North America and oak and beech in Northern Europe can be explained by the high yield of the preserving agents, acetic acid and creosote. Along with formaldehyde, these substances act as anti-bacterial agents. The more concentrated the smoke, the higher is the penetrating power. Smoking gives the fish the flavor, color, and has a preservation effect.

The type of wood or material used for producing smoke depends to a great extent on the locality, the availability of material and on the types of cure desired. In certain areas where the supply of wood has decreased drastically due to the clearing of forests for housing and agricultural development, other materials such as mangrove, coconut husks, corn stalks, and the so-called wood waste or sawdust from mahogany and cellar operations may be used.

Facilities for Smoking Fish

Facilities for smoking fish vary from very simple to quite sophisticated depending on the size of the operation, the geographical location and to some extent tradition. Fish can be smoked by simply hanging them over open fires. The fish are hung on sticks and placed over a fire.

Kilns of various types, sizes and sophistication may be used also to smoke fish. So-called chimney kilns may be constructed very simply using a barrel or more elaborately by erecting a brick or metal structure. In such chimneys the fish may be kept for varying periods of time ranging from overnight, typically, to a few hours or even a week.

The principal problem is to control the process in such a way as to secure reasonable uniformity of product. Temperature, relative humidity, rate of airflow, and the smoke intensity above an open fire are subject to wide fluctuations as a result of the outside weather conditions, size and construction of the kiln, and the building housing it, t: and moisture content of sawdust, etc. Smoking involves some experience, such as taking out the

sticks of the fish and turning them around at least once during the smoking, removing those nearest the fire which are finished first and moving down the upper ones.

The old type of kiln is constructed as a vertical rectangular chamber with three main sections. The lower section has a fire burning directly under the middle section, where the fish hang on spits arranged in frames. The upper section narrows down, with a fan installed to circulate air and gases in the kiln and then to blow the smoke out to the chimney. The size is moderate and each processor has his own construction. The rectangular dimensions are about .75 meters by 1.25 meters. The flames should not reach higher than about 50 centimeters below the fish. The section where the fish hang is about 2.1 meters above the floor.

The Kraerner Continuous Kiln consists of a horizontal tunnel with three separate heating furnaces outside. The frames loaded with fish are placed in conveyor trolleys which pass through the tunnel on rails and are driven by an endless chain belt. Every car has a wall of steel plates of the same dimensions as the cross-section of the tunnel. Each car constitutes a separate chamber and the smoke is forced to pass through there up and down consecutively. The final drying and smoking occur in the rear part of the kiln. The processing time is from 40 to 50 minutes and the capacity is about 6-7 metric tons per 8 hours.

The Sterner Kiln is designed as a tower and is divided into two chambers. The frames are inserted at the bottom of the left chamber and elevated by chains. During the passage upward they travel in the same direction as the fuel gases from the bottom. At the top of the left chamber, the frames are carried over to the right chamber where they move downward meeting the smoke from the second furnace.

The Torry Kiln is a simple wind tunnel operated by an electric fan into which smoke can be drawn from an external smoke producer. Fresh air can also be sucked into the kiln and the portion of the circulating wet smoky air mixture can be blown up the chimney. Heaters, usually electrically operated and thermostatically controlled, are used to maintain the temperature of the smoke circulating in the kiln. Smoke is produced in a special type of firebox. This firebox is normally constructed of mild steel supported on a frame of angle iron and lined with firebrick. The power consumption of the Torry Kiln depends not only upon its size, but also upon what it is to be used for. If it is to be used for the preparation of hot smoked products, the power consumption will be higher than if it is to be used for cold smoking of such products as kippers or haddock.

In less developed countries the facilities for smoking are quite simple and, at times quite expensive. In Ghana, West Africa, for example, cylindrical and rectangular mud ovens or metal ovens are used. Likewise, the fuel used for producing the smoke may be hardwoods of various types, sugar cane pulp or wet grass. The latter two fuels are burned to generate smoke for providing a final desirable color to the smoked fish. An extensive and detailed account of smoking as a means of preserving fish in Ghana has been prepared by Caurie et al. (1977).

Example of a Complete Operation for the Smoking of Fish

Commercial smoking of fish follows definite and precise steps. Outlined below are the steps involved in the smoking of a typical smoked fish, e.g., sardines.

Step 1. Landing. The landed fish are stored in wooden boxes with ice and are brought as quickly as possible to the canning plant.

Step 2. Temporary Storing. The fish should be quite fresh when processed. To maintain freshness, they may be stored under refrigeration for a

day. If no measures are taken to maintain freshness, processing must proceed immediately.

Step 3. Salting. Fish are immersed in brine, the strength of which varies with the fat content of the fish. The salt concentration of the brine is controlled and salt is added after each lot of fish to restore the original brine strength.

Step 4. Spitting. During smoking the fish must hang freely without sticking together. They are hung on spits, which is usually done by manual labor. The spits with the fish are arranged on a wooden frame so that every fish hangs freely. The frames are then brought to the smoking kiln either directly or placed in cars, depending on the type of kiln.

Step 5. Smoking. Different kinds of smoking processes and different types of smoking kilns can be used. After smoking, the fish should show a very light brownish color and be firm and easy to handle. The skin should be smooth and not blistery. It must not burst.

Step 6. Trimming. The frames with the smoked fish are brought to a head cutting machine. A knife cuts off the head just below the gills.

Step 7. Packing in Cans. The fish are sorted by size and arranged in the cans with the dorsal side down, the cut ends alternately toward one of the other end of the can. Only the silver white part of the fish is visible and the general appearance is most attractive. The number of fish in each can depends on the size of the fish.

Step 8. Covering with Oil or Sauce. A small amount is first put into the empty can in order to bring the fish in contact with the covering medium. The completing fill is made after the sardines have been placed in the can.

Step 9. Closing the Cans. High speed automatic sealing machines are used to a large extent.

Step 10. Washing the Cans. When cans have been sealed, oil or sauce sticking on the can surface must be removed by washing in water with detergents.

With some fish, smoking is done without the beheading step and canning is not done in many cases.

Many kinds of saltwater, as well as freshwater, and fatty, as well as non-fatty fish, are smoked by either the cold smoke or the hot smoke process. Several of those fish which are generally smoked are discussed briefly below.

Salmon:--Salmon is the leading smoked fish in the U.S.A. After mild salting, it is cold-smoked. The mildly cured salmon is either soaked overnight in freshwater or freshened by immersion in running water for about 10 hours, washed, drained and trimmed. The salmon is then smoked at about 27°C (never above 58°C) for 24 to 48 hours in light smoke. The density of the smoke is then increased as smoking is continued for another period of 48 hours or longer. An innovation is the use of thawed frozen salmon in place of mildly cured fish for smoking. Such salmon has a milder flavor, because of the absence of salt. Small quantities of salmon are smoked in other ways, the most important of which is hot-smoking to produce kippered salmon.

Herring:--Ocean herring is the most important smoked cured species on a global scale. A wide variety of smoked herringa are made, including lightly kippered herring, a dressed, split, lightly cold-smoked product. Hard-smoked

herring (sometimes smoked after skinning and boning), which is given a long cold-smoke, produces relatively long keeping quality.

Red Herring:--Red herring is prepared by first soaking the split and eviscerated fish in strong brine made of 70 to 80% saturated salt solution. The salted fish (8% salt) is then hung in warm wood smoke for 8 to 10 days. The salt inhibits microbial growth while the smoke induces surface drying as well as some coagulation of protein in the outer layers. This explains the glassiness of hot-smoked products.

Eels:--Eels, a popular delicacy, are commonly smoked in Scandinavia and the Netherlands. De-sliming is necessary to insure adequate smoke penetration to bring out the silver or golden color in the finished product and to insure proper flavor. The de-slimed eels are washed with cold water and pickled in a solution containing about one pound of salt to 10 gallons of water. The eels are sorted into equal sizes and from 9 to 16 are threaded on two .25 inch diameter rods. One rod pierces the eels just behind the head, the second a few inches lower through the body. These give stability to the carcasses and keep them evenly spaced throughout the smoking process. In modern smoke installations the eels undergo pre-drying for 15 minutes and are then submitted to smoke treatment for an additional 20 minutes.

The smoked eeks remain in first-class condition for 14 days, after which the quality deteriorates. One of the most attractive features of smoked eels, in addition to the flavor and texture of the flesh, is that no further preparation other than removing the skin is necessary.

Haddock:--The haddock is prepared by beheading and opening out the abdominal cavity to the vent. The gut cavity is cleaned to the extent of scraping or brushing of the black skin (peritoneum) and removing the blood and kidney lying beneath the backbone. This brushing and scraping must be done carefully since haddock flesh is softer than cod fish and is more easily torn. The fish are then split by cutting them open, all the way down the backbone from neck to tailfin. The thick part of the flesh is cut in such a manner along the side of the backbone that the flesh stands up and gives the fish a plump appearance. This method of cutting also opens out the thick part of the flesh and exposes a greater surface for smoke penetration.

The split fish are brined by soaking them for 7 to 15 minutes in an 80°F brine. The brining time depends upon a number of factors, size being the most important. A one pound haddock, for example, would require 10 minutes in the brine. The brined fish are then either tentered like kippers, or they are threaded onto metal rods or speats. If the fish are large, small hooks are also inserted into the flesh in order to prevent them from tearing under their own weight.

The gloss that develops on fish that have been brined is mainly due to the swelling of the protein of the fish under the influence of the brine, and to the dryness of surface. Consequently, the longer the brined fish are allowed to hang before they are smoked, the better the gloss that develops. Smoking is varied according to the size of the fish. A one pound fish will take about 4 hours, a smaller fish 3 hours, a large haddock, about 6 hours.

Cod Fillets:--Cod and large haddock are filleted and most of the lug removed. Cod fillets are normally skinned but the skin is left on haddock, both because the flesh is softer and tends to tear more easily, and because it serves to differentiate between the species. The fillets are brined in an 80°F brine 4 to 10 minutes depending upon size. Dye is usually added to the brine bath. The brined fillets are then laid over banjoes. The brined fish should be allowed to stand and drip on the trolleys for at least 2 hours before smoking. Smoking varies from 2 to 5 hours depending on the size.

Since white fish fillets are generally dyed, the smoking process should be aimed at giving flavor and texture and not color. As a consequence, if the fillets are too heavily smoked, they will develop a very dark color on cooking and may also have a tough skin on the cut surface.

Trout:--Small rainbow trout are gutted and the gut cavity cleaned out,

care being taken to remove all black skin and blood along the backbone. The fish are brined in an 80°F brine for one hour. The brined fish are then pierced through the eyes with metal speats. Small strips of wood like matchsticks are placed between the lug flap to keep the gut cavity open and to allow drying and smoke penetration. After a half to three-quarters of an hour when the skins have dried off, the temperature is raised to 180°F and the trout are cooked. This takes about 2 hours. The trout have a lower fat content than herring and in consequence they should be dried less or they will tend to be somewhat dry and hard and will lose their soft texture.

Sprats:--Sprats for canning are first washed and then soaked in an 80°F brine for 15 minutes. The fish are then threaded through the eyes on thin speats which are fitted into frames. Smoking takes about one hour. The finished product should be cooked and have a silvery appearance. After smoking, the sprats are beheaded before they are packed in the cans.

The quality of the smoked fish depends greatly upon the freshness of the raw material. A good product cannot be made from stale fish. Much depends, also, upon the care that is taken in the splitting and cleaning of the fish before smoking it. Experiments have shown that although it is possible to disguise stale fish to some extent by smoking it, the unpleasant odors and flavors soon become apparent again within a day or two.

Fish of good initial quality is plump and firm. Those that are in poor biological condition, such as spring herring that are deficient in fat or haddock that have spawned recently, cannot be expected to make first-class products. If whitefish, such as cod and haddock, are in good condition when they are caught and after careful gutting and washed are properly stored in ice, then they will remain in first-class condition for smoking for about a week. Herring, which are fatty fish and are not gutted by the fisherman, spoil much more rapidly. They should be smoked on the day of catching and are no longer their best after 48 hours, even if they are stored in sufficient ice at catching. After preparation, the fish are salted either in solid salt or in brine, depending upon the product. After brining, prepared fish are generally allowed to drip for a period before smoking commences so that excess liquid can run off and an attractive gloss develops.

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CHAPTER 8. AN ECONOMIC SURVEY OF THE MARKETING SECTOR - EL SALVADOR

BY M.D. Shank and J.G. Sutinen

This chapter describes and evaluates a survey of the marketing sector in San Salvador, the capital city of El Salvador. The survey used random sampling and interview procedures to collect the data. Data collection occurred over a three month period, including Easter, from February 28 to May 8, 1977.

1. Description of the Survey

Planning. The objective of the survey was to collect data that can be used to estimate and explain the costs and earnings associated with the marketing of fish. The marketing firm, therefore, was selected as the unit of analysis. Not all firms were treated equally in the survey; those estimated handling a larger flow of fish (in value terms) were given more attention than those firms handling a smaller flow. The frame consisted of 25 wholesalers and 136 retailers, determined by a census of the city's public markets. Street vendors were not considered part of the population as they were assumed to handle an insignificant fraction of the total fish marketed.

The data collected were of two types. The first dealt with the economics and technical characteristics of the marketing firms: firm's size, operating methods, capital and labor inputs, entry and exit conditions, product mix, geographic considerations, overhead, inventory, services provided and problems of the industry. These data were gathered at both the wholesale and retail levels, and became known as the "intensive" data set. The second type concerned daily market transactions: quantities and prices of purchases and sales by species. This information was collected over a three-month period (February 28 to May 8), and became known as the "extensive" data set.

The personnel available to conduct the survey consisted of a Peace Corps volunteer assigned to the Ministry of Agriculture, General Directorate of Natural Resources, and a newly-hired staff member. Each had previous experience with interviewing to collect economic data, but neither was intimately familiar with modern survey methods. At a later stage of the survey, a third staff member was added who conducted some interviews and regularly drew samples. Only local public transport was used (funded by ICMRD). One individual was provided by the Information Service of the Directorate for coding and transcribing the data. In addition, office space and limited supplies were made available by the Ministry.

The time period for the survey was dictated by two concerns: an interest in monitoring fish marketing activities during the Lenten season (where in this Catholic country, demand for fish increases as Easter approaches) and the length of time for which personnel could be available. By coincidence, the personnel could be made available during the Lenten season.

The personal interview method for collecting the data was deemed most appropriate for the setting. Other methods, such as self-enumeration, were ruled out as not feasible. Self-enumeration would have required time for recruiting and training for the wholesalers and retailers--time that was not readily available in this short-term survey. Also, we expected self-enumeration would meet with a great deal of resistance, resulting in little data collected. (In a long-term survey, where there is ample time to win the confidence of the participants, self-enumeration may indeed be the least costly method, however.)

Both types of data gathered required a distinct instrument for collecting the data. The intensive data were gathered by means of a personal interview

of about 40 minutes in length. Separate questionnaires were developed for the wholesale and retail levels (see Appendix 1). The questionnaires were modeled on a questionnaire used in a similar survey in Costa Rica. Even though the model questionnaire was also in Spanish, local differences in uses of the language and colloquisms required substantial changes. Also, the marketing system in El Salvador was sufficiently different to require changes in the questionnaire.

The extensive data set did not require a questionnaire structured with questions; rather, a form was used which allowed the interviewer to quickly and accurately record the necessary data. This form is in Appendix II.

Since random selection yields results superior to judgmental and other non-random methods, and sampling rather than taking a census is more economical a random sampling procedure was used in the survey. A simple weighted sample was drawn from the universe of 136 retailers (once for the intensive data and weekly for the extensive data). Since the number of wholesalers was small and the firms quite heterogeneous, we attempted to survey all of the fish wholesalers in the city.

Sampling Program Design. Designing a sampling program involves determining the sample size, calculating sampling weights, and selecting the respondent. These important steps are described below for the fish marketing survey.

Three samples sizes had to be determined: one each for the intensive interviews of the retailers. The objective in choosing a sample size was to minimize the variance of the estimated means subject to the resources available (Cochran, 1963). The primary resource constraint was the number of man-hours available for interviewing during market business hours. For the first two weeks there were two individuals available for interviewing, and in the third week a third person was added to the interview team. One person (the Peace Corps volunteer) was able to interview on weekends as well as weekdays while the others were limited to weekdays only. Each was able to put in an eight-hour day, beginning as early as necessary (sometimes at 5:00 a.m.). On average the three people available were able to conduct nine intensive interviews per day (between the market business hours of 8:30 a.m. to 1:30 p.m.). The weeks were allotted for the intensive information. Since each firm required at least two 20-minute interviews, we set out to interview the 25 wholesalers and 36 of the 131 retailers.

Later, with two interviewers and a shorter questionnaire, approximately 16 extensive interviews were conducted per day (from 11:30 a.m. to 1:30 p.m.). The extensive survey initially was projected to cover ten weeks with Easter week in the middle of the period, allowing monitoring of the fish marketing system during the increased activity expected throughout the Lenten season. For the first week of the extensive survey we set 100 interviews as our sample size goal. This estimate was based on personnel available, travel time between markets, our a priori estimate of the time required for contacting the respondent and interviewing him or her, and no information on the degree of cooperation we could receive. The strategy was to aim for a high number of interviews in the first week and to adjust the goal for the following weeks as we gain experience and could make better estimates.

Our sample was weighted by flow values. To do so required that we begin with an estimate of the fish sales for each market. At the beginning of the survey, the flow values were estimated by observation. Adjustments were made during the data collecting period as the data became available, allowing for more accurate estimates.

The flow estimate was obtained from informal conversation with the proprietors and observing what appeared to be the volume of each, with each firm being classified as large, medium or small. Small was defined as a firm having less than ¢50[1] a day in sales, medium ¢51-150, and large was greater than ¢150.

A production flow sum for each market was obtained by multiplying the

Figure 1

EXAMPLE:

MERCADO X

Firm No.	Category	Estimated Daily Sales (¢)
1	L	176
2	M	80
3	M	65
4	L	200
5	S	32
6	M	70
		623

In Category L

176
200
376

$\bar{X} = 188$

$\frac{376}{623} = 60\%$

Category M

80
65
70
215

$\bar{X} = 71.66$

$\frac{215}{623} = 35\%$

Category S

32

$\bar{X} = 32$

$\frac{32}{623} = 5\%$

Figure 2

Sub-sector	Market Name	Code	Estimated Daily Sales	Percent of City Total Sales
1	Central	02	¢4930	45%
2	San Miguelito	03	1950	18
3	Sta. Tecla	12	450	
	San Marcos	11	140	
			590	5
4	Tinetti	04	1025	
	Sta. Lucia	09	255	
			1280	12
5	San Jacinto	05	990	
	Modelo	06	365	
			1355	12
6	5 de Nov.	07	175	
	Soyapongo	10	236	
	Mejcano	08	500	
			911	8

Estimated city total sales ¢11,016

number of firms in a category by the average size of that category. The flow values of the three categories summed gave the preliminary estimated flow value for the market. The aggregate of the markets in turn gave a flow value for the city. An example of the computation follows (representative data are given in Figure 1).

In this example we have a market consisting of six, firms, with a sales total of ¢623 as our base. Following the same procedure for each market provides an aggregate for the city, which at the beginning of the survey was estimated to be $11,016 in daily sales (see Figure 2).

In most cases the selected respondent was the owner of the marketing operation. In El Salvador, most fish marketing is conducted by women who are fully involved in their business (i.e., few if any are absentee owners) and are clearly the most knowledgeable, making them the best individuals to interview.

In planning an economic survey of this type the cooperation of the group to be investigated cannot be taken for granted. The degree of cooperation actually received can largely determine the outcome of the survey. To increase the chance of success we sought to secure the most cooperation possible under the circumstances.

An important step was to secure approval and support of the market administrators. While the survey was being conducted under the auspices of one governmental agency, another governmental agency was in charge of the public market systems. Proper channels were followed by taking a letter of request from the sponsoring agency (The Directorate of Natural Resources) to the head administrator of the markets. The administrator subsequently prepared letters of identification and introduction for the survey team that were shown to the administrators of the individual public markets. In addition, each administrator was asked to personally introduce the survey team to the proprietors in his market.

Following a few obvious revisions in the Costa Rica version, the intensive questionnaire was tested four times in actual interviews with marketing firms. The testing identified problems of poor phrasing, reduntant questions, questions that received poor responses because they had no clear answer, and unnecessary questions.

Testing also demonstrated that a three-step interview process was most desirable. The first step was intended to be exploratory with the interviewer establishing rapport with the respondent and gathering general and immediately necessary data. After introducing himself and establishing his legitimacy, the interviewer explained the purpose and nature of the survey. The data collected in this first step included volume of fish bought and sold, costs, capital investment, prices and sources of supply. Step two was intended to probe deeper into those areas of the firm's operations that proprietors tended to be more sensitive about (credit, mark-ups). The third step was used to fill any gaps in teh information required, resolve ambiguities and to thank the proprietor for his/her cooperation.

The host-country personnel assigned to the survey (excluding the data processing staff) were semi-experienced in interviewing. One member of the team had received training in economics and statistics. Still, training all participants was necessary to insure their ability to properly conduct the survey. The objective of the training was to have the interviews (i) be well prepared. (ii) have a good presentation, and (iii) be able to explain thoroughly the reasons for the survey. The questionnaire testing process provided an opportuity to coach the interviewers, to work on rough spots in their presentations, and to get a feel for the interview and the instrument. Lansing and Morgan (1971) and a Spanish edition of a marketing research textbook by Boyd and Westfall (1973) were followed viz the do's and don'ts of interviewing.

In conjunction with point (iii) above, a list of reasons for the survey interview was prepared (see Appendix III). The reasons were discussed in

detail with the interviewers so they could explain them with confidence and sincerity. In the end this preparation paid off significantly, allowing the survey to be conducted with a minimum number of objections to the interviews.

Initially, each interviewer was supervised during his first few attempts in order to identify and eliminate any apparent systematic errors.

Implementation. After calculating the sample size and weights, the sample was drawn. We began with the size of sample to be drawn (e.g., in the case of intensive retail questionnaire n = 36). We used a table of random numbers and devised a listing for our subsectors. Continuing to use our framework as illustrated, the numbers listed or assigned to each subsector corresponded to its percentage of market share and appeared as follows:

Subsector No.	Percent	No's. Assigned
1	45	1-45
2	18	46-63
3	5	64-68
4	12	69-80
5	12	81-92
6	8	93-100

Using our random number table we selected the first 36 numbers, with replacement. In this case, replacement because a particular subsector could be chosen more than once. For our example the results were as follows:

Subsector No.	No. Interviews
1	16
2	6
3	3
4	2
5	6
6	3

To select individual firms within a subsector we repeated the same procedure for firms in each subsector. In this instance, however, the percentages of each category's share of the subsector was used in place of the percentages of a subsector's share of the aggregate.

Using another example, we have:

	Category L	Category M	Category S
Market share:	55%	35%	10%
of firms:	5	8	6
% of firms:	$\frac{55}{5} = 11$	$\frac{35}{8} = 4.38$	$\frac{10}{6} = 1.67$

The firm's share is used to determine the assignment of numbers to each firm, and is calculated by dividing the percentage in the category by the number of firms[2] (row 3 above). One problem arose with fractions, as only whole numbers are found in the random number table. For example, in category M, it is not possible to give each .38 of a point. Instead, with the remainder 3, an extra point was assigned to each of 3 firms chosen at random giving these 3 firms a weight of five. In category S, with a remainder of 4, one extra point was assigned randomly to each of 4 firms, giving these 4 firms a weight of two. The final table, being readied for the random number

selection would appear as follows:

Category L		Category M		Category S	
Firm No.	Assignment	Firm No.	Assignment	Firm No.	Assignment
L_1	1-11	M_1	56-59	S_1	91
L_2	12-22	M_2	60-63	S_2	92-93
L_3	23-33	M_3	64-68	S_3	94
L_4	34-44	M_4	69-72	S_4	95-96
L_5	45-55	M_5	72-76	S_5	97-98
		M_6	77-81	S_6	99-100
		M_7	82-85		
		M_8	86-90		

Suppose now that this particular subsector had been determined to have eight interviews assigned to it by the earlier sample. Thus, we would draw the eight numbers from our random number table--without replacement since a firm could be interviewed only once. A likely selection would appear as follows:

No. selected	43	02	30	61	56	83	77	26
Corresponding firm:	L_4	L_1	L_2	M_2	M_1	M_7	M_6	L_3

Repeating the procedure would result in the selection of each individual firm to be interviewed.

In the case of a refusal which could not be overcome, a firm exhibiting similar characteristics as the one intended to be sampled is selected.

In the case of the weekly extensive survey the same format was followed, with the exception that replacement was used since a firm could be sampled more than once in the course of a week.

For the weekly extensive survey of prices and volumes, the distribution of the sample by days of the week had to be determined. We assigned a higher sampling weight to the days when more business is transacted. Estimates of weekday transactions were obtained from the proprietors when the initial observations were obtained. Our results were somewhat inconclusive because of the high variation in the opinions of the proprietors as to which days were best. Only Saturday and Sunday were repeatedly given as answers. Other answers were payday, all being equal, the various days of the week. Interviews on Saturday and Sunday were limited as the number of survey personnel available was reduced on those days (government employees do not work on weekends). Taking all of this into account, we drew up a table of percentages for each week, depending on our resources available, any events expected during the week that would conflict, and our estimation of which days the market would be most active. For example:

Week One	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.	Sun.
%	12	12	12	14	14	14	12

These percentages were multiplied by the number of samples which were indicated within a given subsector. Suppose, for example, a subsector was determined to have 20 interviews in a week. Monday, Tuesday, and Wednesday would yield 12% x 20 = 2.4 price/volume observations each, Thursday and Friday 2.8 each, Saturday 2.8, and Sunday 2.4. Since partial observations were impossible, rounding was necessary: 2 + 2 + 3 + 3 + 3 + 5 + 2 = 20.

In trying to program and organize a complete week it might be that a sample became very spread out, resulting in having to go to several markets for a small number of interviews, which might be impossible given a time or personnel constraint. In such instances, some shifting and grouping was

performed to better coordinate and make for more efficient traveling. Each week, however, the sample would be drawn, and the deviations made by this juggling method would be recorded.

Data Processing. A survey of any magnitude can be made or lost by data processing. This can be of paramount importance in a developing country, where inmany instances data processing has only recently come into focus. Computerized tabulation of data for general projects is just now being implemented in El Salvador.

The Directorate has assigned a high priority to our particular project, and one person was available on a part-time basis. The person was trained to code and transcribe data from the questionnaire to code sheets for key-punching. The first step was to devise a coding system. For us, this meant three coding systems as we had three data collection forms: the two intensive questionnaires and the extensive form.

After deciding on our system any alterations were made in the data collection forms if needed to make them more compatible with the coding system. As mentioned previously, we changed our extensive form for precisely this reason.

Since the coder was available only on a part-time basis, a substantial period of time was required tc transcribe the data. The coder worked closely with the data collectors to know precisely what was to be recorded. Each week's information was checked for organization, completeness and clarity by the collectors before giving to the coder, who also kept accurate records of the coding process. Most problems encountered in this area were attributed to illegible recording, inconsistencies of the part of the data collectors or new categories that were not predicted ahead of time in designing the system.

II. Post-Evaluation of the Survey

Modifications in Implementation. The initial strategy described above worked well for the intensive interviews and we deviated little from it. The extensive interviews which were to go on for a ten-week period allowed us time to make adjustments where necessary to improve our methods.

The first week brought about only one change, which was that the survey would be reduced to nine weeks. This was a result of a set of intervening events which all but completely shut down the marketing system for four days.

During the second week we decided upon the following changes:

a) Set a limit on the number of times any single firm could be sampled within a week. This was brought about as a result of discussions and negotiations with the proprietors. It was difficult to explain to them why we would want to speak to one firm four times in a short period and not at all to another firm.

b) Eliminated one market from the survey. This was decided upon after the second week of failing to negotiate a compromise, and came about as a result of a strong coalition of proprietors within one market (Miguelito) deciding not to cooperate with us.

c) We altered the time of going to the market to be more convenient for the proprietors.

d) A master chart was designed for recording each attempted observation, result, and substitution in case of failure to get an observation. The chart contained:

1) Initial sample by firm, day and week.
2) Completion or incompletion of our interview.
3) Reason for incompletion.
4) Substitution record, whether it was by day of week or by firm.

e) Flow values were recomputed, this time based on purchases from the

data we were generating. Each firm was checked periodically to make sure it was in its proper category, using the best estimate of its average daily purchases.

f) Reduction of sample size. The first week of observation yielded only 62% of the target sample. This was due mainly to inexperience. We reduced the sample to 85 the second week. Subsequent weeks resulted in an increased percentage and we pushed the sample to 90. Twice the sample was reduced to 80 and once to 60 due to restrictions in personnel and a shutdown of the market for the celebration of Easter.

g) Computational work sheet. To simplify the flow value computation and shares of market, a work sheet was devised. It is shown in Appendix IV. It helped a great deal when drawing up a new sample each week.

h) Modified form. We redesigned our observation form to make it more complete, easier to fill out accurately, and less complicated for transcribing the data onto code sheets. The first form is in Appendix V, the modified form in Appendix II.

Additional changes made during the course of survey:

i) Days of the week. Experimenting, we found that not taking any observations on one day of the week added to our efficiency. Also, certain availability or unavailability of personnel would cause changes from week to week. We kept a complete table of our daily percentages; they can be found in Appendix VI.

j) Accuracy. We reached levels of achieving up to 95% of our sample. For five of the nine weeks we succeeded in getting over 90% of the sample. A chart showing the weekly sample and percentage of completion is in Appendix VII.

k) Time of observation. Late in the survey we tried going to the market early, before the vendors had even opened up for business and became busy. It was easier at times for them to speak with us since there were no clients, but the observations took longer because they were quite occupied preparing for the day. When we arrived near mid-day observing was difficult if the vendor had had a poor day as she did not feel like discussing the matter. In the early morning, however, the vendor usually had a good attitude, because he/she still had hope of having a good day.

Public Relations. Without a proper public relations effort, we most likely would not have succeeded in collecting information at all. As it was, we still had to overcome numerous objections, which we did through perserverence, time, honesty, communication and sincerity.

We implemented other techniques. One was emphasizing our long-range goal of increasing fish consumption, or demand for fish, a goal the proprietors readily supported. To illustrate, we mimeographed and distributed recipes for preparing and eating fish. After giving the proprietor the recipes he/she was asked to pass them on to his/her customers with the hope they would stimulate sales. This aided in breaking down some barriers that might arise between the proprietors and the interviewers.

Lastly, at the end of the survey a letter of thanks for participation, cooperation and endurance was written and distributed to all. Along with an expression of thanks, the letter contained an introduction to what the agency had planned for the future, explaining that on a less intensive basis the data collection process would be ongoing throughout the year.

Cooperation from Firms. It was truly and understandably difficult for any of the proprietors to completely believe that the data collected were going to be of direct benefit to him. To many, we were just out to see how much money they were making, so we could decide how much we wanted to take. Or, perhaps, we were sitting up a large firm to try and monopolize the industry.

The cooperation we received was due to the cooperation of the Government of El Salvador, our public relations efforts previously outlined, and by becoming known and friendly with them through time. There is the belief that

a majority of people gave us data not because they thought good would come to them as a result of it (which we claimed) but because they wished to do a favor for their friends. Thus, communication and time spent with the proprietors proved to be an extremely important aspect of the survey.

Interview Monitoring. Although interest and desire were high among the survey teams, on several occasions changes, new situations and various other adjustments were not always easily handled by the personnel. Thus, a close monitoring was necessary to ensure proper, consistent execution of the survey.

Time/Work Schedule. Another problem was the conflict of the markets engaging in greater amounts of transactions on Saturday and Sundays and the government agency not operating on these days, nor prepared to allow their employees to exchange days. It might also be added that the employees were not interested in exchanging days, without an increased wage rate. This type of conflict seems to be one which needs to be worked out ahead of time with the personnel department of the agency, the employees, and their supervisor.

Personnel. Of the personnel made available for the survey by the Directorate, one had university training in economics and statistics. Onehalf of his time was spent computing and drawing samples, performing general statistical work and writing the methodology report. The remainder of this time was used in data collection.

The other individual assigned to the project had a high-school education and was used for helping to test questionnaires and to collect data. The Peace Corps volunteer's time was distributed among all phases; design, training, sampling, writing and coordination of the other personnel over a sixteen week period.

It took 230 hours for coding and transcribing steps, which were performed by a trained member of the data processing department of the Directorate.

Costs of the Survey. To evaluate a survey of terms of costs, Kish (1965) gives a general cost equation for surveys which focuses attention on the costs of certain key components. This formulation is more useful for evaluation than a total cost figure or an itemized accounting list of costs.

Our criteria for evaluation is the quality and quantity of information per dollar spent on the survey. The basic nature of our survey problem was to maximize statistical precision subject to a set of budgetary and resource constraints. This section reports on the trade-off between costs and statistical precision observed in the survey.

Kish's general cost equation for surveys is:

$$\text{Total Cost} = K + Kv + nc + ncv, \qquad (1)$$

where K = Constant costs which do not change with either number of elements nor with type of design. Applied to the survey at hand, the construction of questionnaire and instruments, mimeographing, writing survey methodology reports, secretarial services, freight, photocopying and the cost of personnel to perform these tasks.

Kv = Variable costs in design but not sample elements. In the present survey, computation of sample estimates, drawing thet samples and training of field workers are included in this category.

nc = Costs which are proportioned to sample size but do not vary with design. Tha actual making and recording of the interviews as well as coding and transcribing the data from this survey are categorized in this grouping.

ncv = Costs that are proportional to the number of sample elements that also vary with changes in design. Only transportation for

implementation of this survey entered in this group.

In summing up the costs for this survey, the costs included in nc (costs that vary with sample size) have been broken down into per unit costs to examine the marginal costs for one additional piece of information. As the survey handled two types of information--extensive and intensive--the category has been further broken down into per unit costs (c_1,c_2) for n_1 (extensive observations) and n_2 (intensive questionnaires). n_1 = 625 and n_2 = 47; c_1 = ¢3.27 (U.S. $1.31) and c_2 = ¢26.17 (U.S. $10.47). Equation (1) becomes TC = K + KV + (n_1c_1+n_2c_2) + ncv. In this survey total costs incurred were ¢5,970 (U.S. $2,388), where:

K = ¢ 875 (U.S.$350)
KV = ¢1,405 (U.S.$562)
n_1c_1 = ¢2,044 (U.S.$818)
n_2c_2 = ¢1,230 (U.S.$492)
ncv = ¢ 415 (U.S.$166)

Therefore, the average added cost of another extensive observation is ¢3.89 (U.S.$1.56), and of another intensive observation is ¢26.79 (U.S. $10.72). (The estimates are obtained by adding ncv/(n_1 + n_2) = ¢.62 to c_1 and c_2, respectively.)

An interesting aid for assessment is to see how costs would vary with alternate designs in the survey. Design refers to two aspects of the survey: (1) the collection method and/or instrument and 2) the sampling method. Figure 3 presents a matrix showing some combinations of possible design changes. In discussing changes the sample size is assumed to remain the same.

The personal interview generally is more costly since each respondent is interviewed each time data are obtained and thus requires more collectors per given quantity of data collected. The advantage of personnal interview, however, is more precise data and being able to obtain information on more complex issues. The observation method involves recording data by a collector who observes the activity. In this case the collector records his judgement of prices, weights, costs, etc. While observation can be useful where a few variables are readily observed, the accuracy of the information obtained generally suffers. Self-enumeration involves sending or leaving a form for the respondent to fill out. The major problems with this method are the high non-response rate due to the participant's inability or unwillingness to cooperate, and the information collected cannot be too complicated. The advantage of self-enumeration is its low cost.

The costs of combination (2), a random sample with observation, would likely have been greater than combination (x) since the interviewer would have had to spend much more time at the site. Also, it doubtful that data of the same precision could be gathered by observation.

Combination (3) could be a way to lower costs, given a universe where this is feasible. Although self-enumeration is a possibility in the future, at present it is not feasible due to the interviewees' lack of education, experience and confidence in such a method.

Combinations (4), (5) and (6) all involve a stratified random sample. A stratified sample will, for the general case increase precision, especially if the variance in some markets or divisible groups is much greater than others. Costs could go up, down or remain the same when compared to simple random sampling. By properly allocating resources and taking the optimum sample for each stratum, it could turn out that less travel and time would be necessary for certain geographic areas as opposed to a sample taken by a simple random sampling. The opposite or a neutral effect could also occur. The effects of the other methods; personal interview, observation or self-enumeration, would be the same as mentioned previously with random sampling.

Combinations (7), (8) and (9) involve quota sampling. Quota sampling

Collection Method / Sampling Method	Personal Interview	Observation	Self-Enumeration
Random	X	2	3
Stratified	4	5	6
Quota	7	8	9
Systematic	10	11	12

Figure 3: Matrix of some alternative survey designs. The X indicates the combination used in this survey. The numbers are for reference and are not qualitative.

allows the interviewer some freedom in selecting the respondent and also an ability to cut costs. Depending on the structure of the sample, a quota sample can lead to very poor quality of information, with an inherent tendency to ambiguity and uncertainty as to exactly what is done (Kish, 1965). There is no easy method of estimating the precision of a quota sample (Lansing and Morgan, 1971). It is quite doubtful that there would be any gain from a quota sampel when speaking of information per dollar spent. A quota sample-observation method combination would be even worse in terms of precision, and so could a self-enumeration, in that it would be very easy for their interviewer to ask only the most agreeable proprietors repeatedly to fill out the form.

The last combinations in the matrix, (10), (11) and (12), concern systematic sampling. The application of systematic sampling is easier than either the random or stratified, especially in the field and hence might possibly reduce costs. Precision would be lower than with the simple random method only when the variance of the systematic samples is greater than the population as a whole. It is difficult to give general advice about the situations in which systematic sampling is to be recommended; a knowledge of the structure of the population is necessary for its more effective use (Cochron, 1963). Should this knowledge be available, or can be obtained cheaply, a systematic sample might prove a way to gather more information per dollar with just as much precision.

III. Summary and Conclusions

This chapter has described and evaluated an economic survey of the fresh fish marketing sector in San Salvador. The principal result that emerges is that careful planning, design and implementation can produce cost-effective data on fish marketing. We estimate that the average variable cost of market transaction data (prices and quantities) is U.S.$1.56 per observation. The estimated average variable cost of detailed data on the economic and technical characteristics of marketing firms is U.S.$10.72. To these costs must be added certain fixed costs which for our survey amounted to approximately U.S.$900. These estimates should be useful in designing and planning future marketing surveys; however, their reliability remains to be tested. Only careful monitoring and analysis of other similar surveys will reveal the extent which our results can be extended to other settings.

Cost, of course, is but one of several considerations in conducting economic surveys. We have outlined here a step-by-step procedure for carrying out a survey. But even within this framework one must be flexible and especially pay attention to one's public relations. Without the cooperation of the individuals being surveyed no survey will succeed.

FOOTNOTES

[1]¢1.00 = $0.40, or ¢2.50 = $1.00, where ¢ = colones.

[2]In the case of a subsector with more than one market, they were grouped together.

LIST OF APPENDICES

No.	Appendix
I	Final Versions of Intensive Questionnaires for Wholesale, Retail and Transporter Interviews; Phases I and II
II	Final Questionnaire for Extensive Volume/Price Observations
III	List of Reasons for Survey
IV	Computational Work Sheet
V	First Extensive Form
VI	Days of the Week Percentages
VII	Weekly Drawn Sample and Percentage Completion

Appendix I.A GA-1

GUIA PARA ENTREVISTAS

FASE 1

MAYORISTA MINORISTA

COMPRADORES INTERMEDIARIOS

ZONA:_____

FECHA:_____

HORA:_____

NUMERO:_____

ENTREVISTADOR:___

_____

I- GENERAL:

1- Nombre del entrevistado_____

2- Nombre del propietario_____

3- Dirección y ubicación_____

4- Tipo de empresa_____minorista_____Mayorista_____

Ambos_____.

5- Tipo de expendio_____puesto fijo_____tienda_____

super mercado_____ambulantes_____otro_____

OBSERVACIONES:

II- Descripcion:

1- Fachada del puesto_____

2- Tamaño M^2, dimensiones_____

3- Vende otros productos además de pescado? Si____No____

Cuáles?_____

GA-2

4- Equipo	#	Edad	Capacidad	Valor Actual	Valor Neuvo	Prop/Alq.
Báscula						
Registradora						
Congelador						
Regrigeradora						

III- DE FUNCIONAMIENTO:

1- Años de vender pescador._____

2- Días laborables durante la semana._____

3- Horas de operación._____

4- Períodos más activos de día._____

5- Días menos activos de la semana._____
Por qué?_____

6- Días más activos de la semana._____

7- Trabaja todo el año en la venta de pescado? Si____No____
si no, Cuándo cierra el negocio?_____

8- Qué clase de registros lleva en relación a las compras y las ventas
_____
mental o anota.

IV- Maneras de operaciones generales.

1- Cuántos días de la semana compra usted pescado?_____
Por qué?_____

2- Adónde y de quién compra el pescado?__ _____
_____

GA-3

DONDE	QUIEN	REG/OCASION	OBSERVACIONES

3- Cuáles clases de pescado compra?_____

_____

4- Cuánto pescado de cada especie compró la semana pasada?

ESPECIE	UNIDAD DE MEDIDA	CANTIDAD EN PESO O VALOR

5- Cómo está el mercado estos días?

El precio:_____Alto_____Normal_____Bajo_____

Subiendo_____Bajando_____

La oferta:_____Abundancia_____Normal_____Bajo____

La demanda de clientes:_____Lenta_____Normal_____

Alto_____.

6- A quien le vende su producto?

GA-4

	Se vende a:		Reg/ocas.
Mayorista:	_____	Consumidor	_____
	_____	Hoteles	_____
	_____	Detallistas	_____
	_____	Restaurantes	_____
	_____	Ambulantes	_____
	_____	Toponeros	_____
	_____	Otros	_____
	Se vende a:		Reg/ocasiones
Minorista:	_____	Consumidor	_____
	_____	Hoteles	_____
	_____	Otros	_____

V- Costos -A

1- Cuales son sus costos por unidad de tiempo por cada insumo siguiente?

INSUMO	UNIDAD DE TIEMPO	CANTIDAD	COSTO	OBSERVATIONES
HIELO				
AGUA Y ELECTRIC.				
CAJONES				
PAPEL BLANCO				
PAPEL PERIODICO				
BOLSAS PLASTICAS				
TRANSPORTE				
ALQUILERES				
CARGADORES				
IMPUESTOS				
Int.SOBRE DEUDAS				
PAGO DE CAPITAL				
OTROS				

GA-5

2- Dependientes familiares: _____
Numero

VI- Consideraciones: A

1- Cuáles son sus problemas mayores o más frecuentes en sus negocios? _____

2- Que se necesita para estos problemas? _____

_____

3- Cuáles cambios ba visto usted en los últimos años en elmercado de pescado? _____

le afectaron a usted? _____ Cómo? _____

_____

4- Qué son los problemas mayores en la compra, venta global de pescado? _____

_____.

OBSERVATIONES:

GA-6

Appendix I-B

GUIA PARA ENTREVISTAS

FASE 2

MAYORISTA MINORISTA

COMPRADORES INTERMEDIARIOS

VII. COMPRAS

1- Se abastece ud., por medio de un contrato verbal o escri to con algún proveedor del pescado? Si____No____ Quién?_____

2- a) Como establece los precios de compra?
regatean ( )
fijo ( )
contrato ( )

b) Quién fija los precios de compra?
1) Corrientemente_____
2) Estación de escasez_____
3) Estación de abundancia_____

c) En que forma paga ud. el pescado?
1) Contado_____
2) Crédito_____De quién?_____
3) Cambio de bienes_____

d) En su ultima compra, en que precio compro cada especie?

ESPECIE	UNIDAD DE MEDIDA	ULTIMA COMPRA PRECIO/CANTIDAD

GA-7

3- Si compra al crédito

a) Cuántos días después de recibir el pescado, tiene que pa gar?

_____

b) Cuántas veces pueden obtener pescaso sin pagar?_____

_____

c) El precio del crédito es diferente al precio de contado?

_____

d) Que parte de sus compras son al crédito?_____

_____Por qué?_____

VII- VENTAS

A-MAYORISTA O MAYORISTA-MINORISTA

1- Cuáles son sus ventas promedio (peso o valor)

	ÉPOCA ABUNDANCIA	ÉPOCA ESCASEZ
DIARIAS		
SEMANALES		
MENSUALES		

1.5- Qué pescado es más popular entre sus clientes?_____

_____

2- Han aumentado sus ventas año con año? Si____No____Por qué?

_____

3- Cómo se entrega el pescado: entero, filete, etc? Qué por ciento en cada forma?_____

4- a) Cómo establecen los precios de ventas?_____

_____

b) Es el mismo para todas las especies?_____

_____

5- a) Da ud. crédito on sus ventas? Si____No____

b) Cuántos días después de la compra, deberá ser pagada la cuenta?_____

c) Cuántas veces puede comprar pescado un cliente sin pagar?

_____

d) Qué parte de sus ventas es al crédito?_____

GA-8

6- Si también vende al por menor, qué parte de sus ventas son al por mayor?_____

7- Si ud. vende otros productos:

a) Qué parte es pescado de sus ventas totales?_____

_____

b) Qué parte de sus instalaciones son dedicadas para el pescado?

_____

c) Por qué vende ud. otros productos con pescado?_____

_____

8- Si ud. no vende otros productos:
Por qué no se venden solo los otros productos?_____

_____

B-MINORISTA

1- Cuántas personas atiende al día?_____

2- Qué pescado es más popular entre sus clientes?_____

_____

3- Cuál fue el total de sus ventas ayer?_____
_____Fue una cantidad: alta_____ PESO O VALOR
regular del normal_____baja_____

4- Qué promedios obtuvo de las ventas en:

una semana buena:_____y una _____

5- Tiene clientes fijos? Si____No____Cuántos?_____

6- Da ud. descuentos por ventas grandes?_____
Cuánto?_____

7- a) Hay veces cuando tiene que rebajar el precio de pescado?
Si____No____Por qué?_____

b) Alguna vez ha tenido que vender el pescado más barato - que lo que pagó por él? Si____No____Porqué y Cuántas veces?

_____

8- a) En que forma le pagan sus clientes?

Crédito_____Contado_____

b) Cuántos días después de la compra, deberá ser pagada lacuenta?

_____

c) Cuántas veces puede comprar pescado un cliente sin pagar?

_____

d) Qué parte de sus ventas son al crédito?_____

_____

9- Si ud. vende otros productos:

a) Qué parte es pescado de sus ventas totales?_____

_____

b) Qué parte de sus instalaciones son dedicadas para pesca do?

_____

c) Porqué vende otros productos con pescado?_____

_____

d) Por qué no se vende otros productos solamente?_____

_____

IX- MARGENES

1- A que precio vende cada especie?

ESPECIE	UNIDAD DE MEDIDA	PRECIO HOY

2- Cómo establece ud. el precio de sus productos?

a) Precio de compra más una suma fija ( )

b) Porcentaje fijo sobre precio de compra ( )

c) Según la competencia_____ ( )

d) Según los precios de otras plazas_____( )

e) Según la época_____ ( )

3- Si compra el producto a ¢1.20, Cuál es lo mínimo que puede vender?

_____

4- Varían sus márgenes durante el año?_____

Cuándo?_____ _____

GA-10

X- CONSIDERACIONES TECNICAS:

1- Cuáles son sus pérdidas por descomposición?_____

_____

2- Qué hacen con las pérdidas? ralean y secan_____

botan_____otros_____

3- Por cuánto tiempo guarda varias especies de pescado?

Especie	en hielo	refrigeracion	congelación	nada

4- Cuánto dinero necesitó para comenzar en su negocio?_____

_____Hace cuánto tiempo?_____

Appendix 1-C GB-1

GUIA PARA ENTREVISTAS

FASE 1

TRANSPORTISTAS, MAYORISTA, COMPRADOR

DESDE EL PRODUCTOR

ZONA:_____

FECHA:_____

HORA:_____

NUMERO:_____

ENTREVISTADOR___

_____

I- GENERAL:

1- Nombre del entrevistado:_____

2- Nombre del propietario:_____

3- Dirección y ubicación:_____

4- Tiene el negocio otros puestos:_____
LUGAR Y NOMBRE

_____

5- Años de establecido_____

6- Años bajo el dueño actual:_____

II- DESCRIPCION

1- Fachada del puesto:_____
Equipo, edificios, facilidades

_____
muebles, etc.

2- Tamaño, área, M^2 del puesto:_____

_____

GB-2

EQUIPO	#	Edad	Capacidad	Valor Actual	Val.Neuvo	Prop/Alq.	Observ.
Báscula							
Registradora							
Congelador							
Regrigeradora							
Hielera							
Cámaras							
Frizer							
Chorro, cañería							
Canastas							
otros							

3- Equipo de transporte:

Camiones- Capacidad, marco, #, año:_____

_____

Ca ro : utilizado en el negocio, marco, #, año_____

_____

Embarcaciones de pesca:_____

Otros:_____

III- MANERAS DE OPERACIONES GENERAL:

1- En cuáles localidades compra usted su producto?_____

de particulares_____de Cooperative_____ambos_____

A cuántos proveedores compra ud. en cada localidad?_____

2- Cuántas veces por semana visita esas localidades? en verano_____

en invierno_____

3- a) Cuánto Producto de cada especie compró la semana pasade?

ESPECIE	UNIDAD DE MEDIDA	CANTIDAD

GB-2

b) Compró una cantidad alta?_____regular?_____
o baja del normal?_____.

4- Cómo está el mercado de pescado en estos días?_____

El precio _____alto _____escaso _____normal La oferta? _____alta _____escasa _____normal Las ventas _____altas _____lenta _____normal

IV- COSTOS- A

1- Cuáles son sus costos por una unidad de tiempo para cada in sumo siguiente?

INSUMOS	UNIDAD DE TIEMPO	CANTIDAD	COSTO	OBSERVACIONES
Hielo				
Agua				
Electricidad				
Transporte				
Cargadores				
Patentes				
Impuestos				
Renta				
Prop. y Equipo				
Otros				
MAINTENIMIENTO a- Combustible				
b- Aceite				
c- Mano de Obra Mantenimiento				
d- Llantas				
e- Baterias				
f- Filtros				
g- Otros				
REPARACIONES a- Motor				
b- Transmission				
c- Carroceria				
d- Otros				

GB-4

EMPLEADOS

TIPO DE EMPLEADO	TIEMPO COMPLETO O PARCIAL	SALARIO/SEMANAL	TIPO DE LABOR

Dependientes familiares: _____

V- CONSIDERACIONES

1- Cuáles son sus problemas mayores? o más frecuentes en su nego cio

_____

_____

2- Qué se necesita para resolver esos problemas? _____

_____

_____

3- Qué cambios ha vistos ud. en los últimos anos an el mercado do pescado? _____

Qué le afectó a ud? _____

4- Qué son los problemas mayores en el mercado de pescado? _____

_____

_____

OBSERVACIONES

Appendix I-D GB-5

GUIA PARA ENTREVISTAS

FASE 2

TRANSPORTISTA COMPRADORES

DEL PRODUCTOR

ZONA:_____
FECHA:_____
HORA:_____
NUMERO:_____
ENTREVISTADOR:
_____

VI- COMPRAS

1- Se abastece ud., por mdelo de un contrato verbal or escrito con algún proveedor del pescado? Si____No____, Con quién? (es)es(son)?_____
Qué clase de contrato?_____

2- Cuánto tiempo puede esperar el producto antes de hacer un viaje?
_____
Antes de venderlo?_____

3- Cuánto tiempo dura comunmente para cargar el vehículo?
_____

4- Como establece los precios de compra
a) vegateo ( )
b) fijos ( )
c) contrato ( )

5- Quién fija los precios de compra:
corrientemente?_____
en época de escasez?_____
en época de abundancia?_____

6- En que forma paga ud. el pescado?
contado:_____
crédito:_____
cambio de bienes:_____

GB-6

7- a) Recibe ud. adelantos en efectivo o préstamos en las compras?

_____

b) Con qué propósito y poracuanto tiempo?_____

8- A que precio compra dcada especie?_____

ESPECIE	UNIDAD DE COMPRA	ULT. COMPRA PRECIO CANTIDAD	SEMANA PASADA PRECIO

VII- VENTAS

1- Le vende ud. de manera regular a alguien? Si____No____
A quién, dónde y con qué frecuencia?_____

_____

2- Existe alguna clase de arreglo o contrato?_____

_____.

3- Han aumentado sus ventas año con año? Si____No____
Por qué?_____

4- Es el mismo por todas las especies?_____

_____.

5- Le paga el mismo precio a todos los compradores por la misma clase de pescado? Si____No____Por qué?_____

6- Cómo arregla los precios con el comprador?
( ) Regateo
( ) Fijo
( ) Contrato

7- En qué forma le pagan el pescado?
( ) contado
( ) crédito
( ) cambio de bienes.

GB-7

8- a) Si vende al crédito, Cuáles son las condiciones del credito?

_____

plazo para pagar, condiciones minimas o máxi

_____

etc.....

b) Es el precio al crédito mayor que al contado?_____

_____

9- Le da ud. adelantos en efectivo o préstamos en las ventas?_____

_____

10- Hace ud. ventas condicionales? Si____No____, Bajo cuáles condiciones?_____

_____

11- Ha vendido, o a veces vende, a precios menor que el costo?
Si____No____Por qué?_____

_____

Cuántas veces occure así?_____

_____

VIII- COSTOS-B

1- Pidió algún préstamo para su vehículo?_____

a) Hace cuánto tiempo?_____

b) Cómo son sus pagos mensuales?_____

c) Hace ud. préstamos a otras personas en general?_____

Si____No____Bajo cuáles condiciones?_____

_____

2- Cuánto dinero necesitó para comenzar en su negocio?_____

_____Hace cuánto tiempo?_____

a) Que parte de éste, dedicó a la adquisión del equipo?

_____

b) Que parte de éste dedicó a la adquisión del local?

_____

3- Tiene ud. otros gastos una o dos veces al año, tales comopago de pólizas, Seguros contra incendios, seguro de vehiculos, etcl.; si los tiene, cuáles son?_____

_____

4- Paga ud. Seguro Social?_____
Cuándo y Cómo?

GB-8

5- Paga ud. seguro de riesgos profesionales?_____

_____
Cuándo y Cómo?

6- Cuál es su capital de trabajo? (operaciones)_____

_____

7- Cuál es su inversión total en facilidades en tierra, equipo,vehículos?

_____

IX- MARGENES

1- A que precio vende a cada especie?

ESPECIE	UNIDAD DE MEDIDA	PRECIO HOY	PREC. SEM. PASADA

2- Cómo establece ud. el precio de sus productos?

a) Precio de compra mas una suma fija ( )
b) Porcentaje fijo sobre precio de compra ( )
c) Según la competencia ( )
d) Según los precios de otras plazas? ( )
e) Según la época? ( )

3- Si compra el producto a ¢0.80 lb. cuál es el precio mínimo que puede vender?_____

X- CONSIDERACIONES TECNICAS

1- Cuáles son sus pérdidas por descomposición?_____

_____Por qué se echa a perder?_____
por día o por semana

_____

2- Qué hacen con las pérdidas?_____Ralean y secan_____
botan_____otros_____

3- Cuáles son sus pérdidas por merma, etc.?_____

_____

GB-9

4- Por cuanto tiempo guarda varias especies da pescado?

ESPECIE	EN HIELO	REFRIGERACION	CONGELACION	NADA

5- Tiene planes para expender su negocio o para cerrar su negocio?

_____

_____

OBSERVACIONES

APPENDIX II

NOMBRE:_____ NUMERO:_____ ENTREVISTADOR:_____ FECHA:___/___ HORA:_____ DIA: D L M M J V S
Entrevistado — día - mes

Especies de pescado que tiene para vender hoy	fecha de compra	cantidad y medida de compra	precio de compra	forma de venta	precio y medida de venta	Especies de pescado que tiene para vender hoy	fecha de compra	cantidad y medida de compra	precio de compra	forma de venta	precio y medida de venta
corvina gr med peq				L/E		camaron grande del rio del mar cabeza cola				entero	
mojarra de mar gr med peq				L/E		camaron mediano del rio del mar cabeza cola				entero	
mero gr med peq				L/E		camaron pequeño del rio del mar cabeza cola				entero	
pargo				L/E		tiburón				lonja	
robalo				L/E		moralla				entero	
pacuna				L/E		bagre del mar				entero	
boca colorada				L/E		bagre agua dulce				entero	
chimbera				L/E		jalva				entero	
ruco				L/E		punche				entero	
macarela				L/E		guapote tigre				entero	
cuin				L/E		pescado revuelto				entero	
mojarra grande agua dulce				L/E		gorreon				entero	
mojarra mediana agua dulce				L/E							
mojarra pequeña agua dulce				L/E							

Cual fue el total de sus ventas ayer (o ultimo dia de venta)_____lbs_____Fecha_____

Appendix III

Reasons for the Survey

1. Increase demand.
2. Measure the efficiency in the marketing system and compare one market to another.
3. Improve product quality.
4. Improve market quality/Sanitary conditions.
5. Diminish product losses.
6. Measure the seasonal increase in demand, so as to assist the production sector with adequately increasing supply.
7. Understand more about the activities and attitudes of
   a) consumer
   b) retailer
   c) wholesaler/transporter.

APPENDIX IV

HOJA DE COMPUTACION; PROGRAMACION SEMANAL, OBSERVATIONES EXTENSIVAS, PESCADO FRESCO

Semana No. _____
Fecha _____ hasta _____

Mercado Codigo	Puestos Total	Categoria A	Categoria M	Categoria B	Promedio $ Compra	Flujo	%	No. de Observ. program	No. de Observ. hechas	Mercado Codigo	Puestos Total	Categoria A	Categoria M	Categoria B	Promedio $ Compra	Flujo	%	No. de Observ. program	No. de Observ. hechas

APPENDIX V

NOMBRE_____ FECHA_____ HORA_____ NUMERO_____ ENTREVISTADOR_____

Especies de pescado que tiene para vender hoy	fecha de compra	cantidad de compra	precio de compra	forma de venta	precio de venta	Especies de pescado que tiene para vender hoy	fecha de compra	cantidad de compra	precio de compra	forma de venta	precio de venta
corvina grande				lonja / entero		camaron grande del rio del mar					
corvina mediana				lonja / entero		camaron mediano del rio del mar					
corvina pequeña				lonja / entero		camaron pequeña del rio del mar					
pargo				lonja / entero		tiburón				lonja	
robalo				lonja / entero		moralla					
pacuna				lonja / enter		bagre del mar					
nero				lonja / entero		bagre agua dulce					
toca colorada				lonja / entero		jaiva					
chimbera				lonja / entero		punche					
ruco				lonja / entero		guapate tigre					
macarela				lonja / entero		pescado revuelto					
culn				lonja / entero		gorreon					
mojarra grande				lonja / entero							
mojarra mediana				lonja / entero							
mojarra pequeña				entero							

Cual fue el total de sus ventes ayer (o ultima dia de vento) $_____ lbs_____ Fecha_____

Appendix VI

Weighted Sample Percentage Values for Day of the Week

In Percent

Week	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
I	14	14	14	07	07	29	14
II	14	14	14	14	14	23	07
III	15	15	15	15	15	25	--
IV	--	18	18	--	18	28	18
V	25	25	25	--	--	--	--
VI	--	05	20	20	20	25	10
VII	18	--	19	19	19	25	--
VIII	--	18	17	18	17	20	20
IX	--	25	25	25	25	--	--

APPENDIX VII

PROGRAMACION GLOBAL

Mercados \ Semanas	I				II				III				IV				V **				VI				VII				VIII				IX			
	P		R		P		R		P		R		P		R		P		R		P		R		P		R		P		R		P		R	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
A	39	39	33	53	48	57	35	55	48	57	34	55	51	57	44	52	17	49	17	49	54	68	52	72	55	61	47	56	52	65	48	63	38	63	20	
B	26	26	4	7	10*	12	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
C	2	2	0	0	2	2	4	6	5	6	2	3	4	4	7	8	-	-	-	-	1	1	0	0	5	5	4	5	4	5	4	5	6	10	6	
D	9	9	7	11	6	7	7	11	12	14	9	11	9	10	10	12	-	-	-	-	3	4	3	4	7	8	9	11	10	12	9	12	4	7	4	
E	15	15	11	18	18	21	14	22	13	15	12	15	16	18	12	14	6	17	6	17	13	16	12	17	14	16	14	17	10	13	11	15	10	17	10	
F	9	9	7	11	1	1	2	3	7	8	13	16	10	11	12	14	12	34	12	34	9	11	5	7	9	10	9	11	4	5	4	5	2	3	2	
TOTALES	100	100	62	100	85	100	64	100	85	100	80	100	90	100	85	100	35	100	35	100	80	100	72	100	90	100	83	100	80	100	76	100	60	100	52	100
Porcentaje Realizado $\frac{R}{F} \times 100$	62%				75.30%				94.11%				94.44%				100%				90%				92.22%				95%				86.66%			

A = Mercado Central
B = Mercado San Miguelito
C = Mercado Santa Tecla
Mercado San Marcos
D = Mercado Tinetti - Mercado Sta. Lucia
E = Mercado San Jacinto
Mercado Modelo

F = Mercado 5 de Noviembre
Mercado de Mejicanos
Mercado de Soyapango

P = programado
R = Realizado

* = Se programaron 10; pero se tuvo problemas con las vendedoras, y unicamente se realizaron 2.
** = Pocas entrevistas por la Semana Santa, se hizo todo lo que se pudo aisstoriamente.

CHAPTER 9. AN ECONOMIC SURVEY OF CONSUMERS--GUATEMALA CITY

By R.Y. Coslit, H.C. Lampe and J.G. Sutinen

This chapter describes a survey of fish consumers in Guatemala City. The survey used random sampling and interview procedures to collect data from over 1,400 households during August, 1976.

I. Planning

The objective of the consumer survey was to provide data for an analysis of the determinants of demand for fish. Guatemala City was chosen for the present demand study for various reasons. One-fifth of the total population of the country lives within the city limits, and the bulk of the fish produced on the Pacific Coast is brought to Guatemala City. Because marketing channels for fresh fish are poor or nonexistant elsewhere, the fish supply in most areas is limited to dried fish that can be more easily transported; therefore, a study of present demand in these areas would be difficult. Given time and money limitations as well, Guatemala City was the most practical choice for this study.

The survey concentrated on the household as the unit of analysis because the decision to purchase fish was most likely related to the socioeconomic characteristics of the family, as well as the family's tastes and attitudes toward fish consumption. Some statistical precision may have been lost in the present study in defining the household, because it is not clear if "family size" responses referred solely to the immediate family, or included maids and relatives.

The total population of Guatemala City was used as the base from which to construct the sample. However, an earthquake the previous February had destroyed many homes and caused widespread movement of people causing census information to be inaccurate.[1] In addition, many of the poorer families were living on the mountainside or in newly developed colonies, or towns, and were not adequately represented on the census map. Thus, many areas were surveyed in advance to gain a better perspective of the population within the area.

The duration of the study was constrained to a month; therefore, the size of the sample was determined by the number of individuals who could be interviewed within this period of time. A total of 1,419 households were interviewed by 12 University of San Carlos students. Each student was expected to complete 3-5 questionnaires per day and was paid a fee for each questionnaire completed satisfactorily. The present study was conducted in August of 1976. Seasonality is an important factor in the determination of fish consumption. It was not possible to collect data during the Lenten season when consumption is known to be high relative to the remainder of the year. Also, because the present data were collected during the rainy season when catch is low, consumption figures may be biased downward.

II. Design

Because there was no previous information on the relation between Guatemalan consumers and fish, a comprehensive questionnaire was felt to be important. With consideration given also to time and resource limitations, an in-depth interview conducted in one visit would yield the most information. Telephone and mail questionnaires were impractical in Guatemala. The illiteracy rate is high, and many of the poorer residents lack proper addresses. Telephone service is very expensive and therefore enjoyed only by upper classes. Thus, door-to-door interviews were most practical for the

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present study.

Three broad categories of questions were incorporated into the questionnaire to yield information on demand:

1) present habits with regard to fish consumption;
2) attitudes toward fish; and
3) socio-economic characteristics of respondents.

The Fisheries Department had estimates of the total quantity of fish brought into the city, and the approximate percentage of this fish that was sold in each market. To supplement this information the present questionnaire was designed to elicit comprehensive information on present fish consumption habits (i.e., how often do Guatemalans eat fish, what kind of fish do they eat, where do they buy fish, how do they prepare fish, what day of the week do they buy fish, etc.). The goal of this study was to determine the characteristics of present demand and to identify possible barriers to increased consumption. Information on attitudes toward fish (i.e., do consumers like fish, which species do consumers dislike and why, how do they like to see fish marketed, do consumers feel that fish is good for their families, etc.) should point out possible deterrents to increased consumption. At present, Guatemalans consume relatively small quantities of fish. There are many possible reasons for this, including a dislike of fish, poor quality of fish offered, or unfamiliarity with fish. Depending on consumer attitudes, the Fisheries Department can provide consumer education regarding the nutritional qualities of fish, methods of preparation, and ways to discern good from spoiled fish. Advertising to help consumers become more familiar with species and prices is another possible way to increase consumption. Finally, questions were asked to elicit information on educational level, family size and age distribution, and income; all of which are hypothesized to be determinants of demand.

The questionnaire (see Appendix) was divided into four "levels." The first level included questions regarding the address of the respondent, family size, and ages of household members. Last purchase information was requested, and the respondent was asked if he liked fish. The questions in Level I were designed to provide basic information on the respondent, and were not difficult to answer. It was felt that beginning this way would build confidence in the respondent so he would be willing to continue with the questionnaire.

The questions in Level II referred to the respondents' general habits with regard to fish. These questions were more difficult to answer than the questions in Level I because they did not refer to a specific fish purchase, but required the respondent to generalize his behavior. Last purchase information from Level I can be compared for consistency with the "general" purchasing behavior from Level II. The two types of information can also be combined for a more accurate picture of consumer behavior.

The questions in Level III elicited more detailed information on consumer practices and attitudes with regard to fish, as well as practices and attitudes with regard to other meats.

The questions in Level IV were placed at the end of the questionnaire because a respondent might object to or become frustrated in answering them. These questions included "What is the total family income?". An "attitude" question requested respondents to decide between a pair of words which reminded him most of fish. Because the words were not those regularly associated with fish, it was thought consumers might refuse to answer.

Because the questionnaire was long (10 pages), it was anticipated that some respondents would not have the time, or perhaps the patience, to answer the full questionnaire. In such cases, respondents were requested to answer Levels I and IV which would provide sufficient information to include the questionnaire in some analyses. Respondents who did not eat fish also

answered only Levels I and IV, because they could not give responses on fish purchasing habits. Again, enough information was provided so that the responses of non-consumers could be included in some of the analyses.

Both "direct" and "indirect" questions were asked to elicit information on income and education. This was done to assure consistency of answers, as well as to obtain the most reliable responses, since it was not known which question would provide the best response. Indirect measures of income and education were important as a check on the reliability of the direct answers given. It was also felt that some respondents would be unwilling to discuss their actual income; therefore information on household goods and monthly expenditures would provide alternative measures.

Before finalization, the questionnaire was tested to identify any problems that respondents might have in interpreting the questions. The first testing concentrated on housewives who were familiar with the study. They were asked to evaluate critically the wording of the questionnaire, as well as the format. The questionnaire was later tested by randomly selected consumers and then revised to a final form.

III. Implementation

Random sampling is recognized as yielding superior statistical results, when compared to other sampling methods. It was utilized in the present study because only data from a random survey would be suitable to make inferences about the fish consumption habits, attitudes, and socioeconomic characteristics of the larger city population. Alternative methods included quota, systematic and judgemental sampling. Quota sampling, sampling from the estimated number of units in each subclass of the population (in this case income or zone might be the subclass), has the principal shortcoming of biased results. It is possible that the subclass is poorly estimated or that the interviewer is biased in his selection of respondent. Because fish consumption habits might vary by area of residence within the city, income and accessibility to fish, quota sampling by zone or income level would not reveal these distinctions. Judgement sampling relies on experts to choose the survey respondents; however, college students would not have been adequate for this purpose and systematic sampling may have introduced some unknown bias that could not be accounted for.

Although information on the standard deviation of income by zone was not available, census data in Guatemala provided figures for 1) population by zone; 2) average income by zone; and 3) income distribution by zone. Because income was known to vary by zone, the sample was stratified by zone, and therefore by income. The number of households sampled in a particular zone was porportional to the percent of the city population represented within the zone. Sample size by zone is presented in Table 1. In those zones where family income appeared to vary widely, a greater than proportional sample was selected to increase the reliability of the sample.

From city maps of Guatemala, all intersections within a zone were recorded. A fraction of the intersections was randomly selected, based on the sample size desired within a zone. One interview was conducted per intersection. Although this procedure is necessarily arbitrary, it was felt that this method was most likely to give all households in equal chance of selection.

The intersections within each zone were divided among a number of interviewers to control for possible interviewer bias. When the interviewer arrived at an intersection, he flipped a coin to decide his direction. A second flip of the coin determined the side of the street to be visited. Finally, a list of random numbers indicated which house to visit. If no one was at home, or the interviewer could not complete the questionnaire, he would go to the house corresponding to the next number on the list. Interviewers

were told to place emphasis on those people who might not be represented on a city map.

All students were required to attend an initial training period. Topics of instruction included: 1) how to administer a questionnaire using mock interview situations; 2) the sampling procedure to be used; and 3) information on the nature of the project. Because the quality of the completed questionnaires depended to a large extent on the interest of the interviewers, much time was spent familiarizing them with the project itself, and its significance to Guatemala.

Initial interviews were carried out and individually reviewed to assure that the students were conducting the interview properly.

Completed questionnaires were collected and checked daily so that any problems could be quickly discussed.

FOOTNOTES

[1]Many earthquakes victims were placed in government-built communities, not necessarily near their previous residence. It is not known to what extent this movement altered the population and income figures that were available for this study.

TABLE 1. Percent of Population by Zone in Guatemala City

Zone	1973 Census	Present Study
1	12.7	11.2
2	3.3	2.8
3	9.0	8.4
4	.8	1.6
5	12.3	12.8
6	10.8	11.0
7	12.3	14.7
8	3.8	3.2
9	1.0	.7
10	2.5	3.2
11	6.8	8.0
12	7.0	7.3
13	2.4	1.8
14	2.0	1.4
15	1.4	---
16	.5	1.6
17	.8	.8
18	4.0	3.0
19	3.8	4.8
21	1.8	1.2
22	.5	---
23	.4	---
24	---	---
Total	100%	100%

APPENDIX

Questionnaire

Proyecto de Pesca Maritima
y Artesanal
Division de Fauna
DIGESA
Agosto de 1976

Number: _____
Date: _____
Hour: begin _____
end _____
Interviewer: _____

This information is confidential and solely for scientific use.

Level I

1. Address _____

2. Person interviewed:

   a. Housewife b. Daughter c. Maid
   d. Other _____

3. Number of household members: _____ Male Female

   a. Children 0-10
   b. Juveniles 11-18
   c. Adults 19+

4. When was the last time you bought fish? _____
   (If you haven't bought fish, please turn to question number 13.)

5. What quantity of fish did you last buy? _____

6. In your last purchase, did you buy the fish whole or in another form?

   a. whole b. head c. filet
   d. steak e. different forms f. other _____

7. How was the fish displayed where you bought your last purchase?

   a. refrigerated b. frozen c. fresh with ice
   d. fresh without ice e. dry f. other _____

8. In your last purchase, how was the fish packaged?

   a. without package b. wrapped c. canned
   d. other _____

9. What species of fish did you buy in your last purchase? _____

10. What price did you pay for your last purchase? _____
    (per pound)

11. Where do you generally buy fish?

a. supermarket b. abarroteria c. market
d. fish store e. tienda f. ambulante
g. other_____ h. Why?_____

12. In what market do you buy your fish?_____

13. What do you think a pound of the following species of fish costs?

a. Corvina_____ b. Robalo_____ c. Julin_____
d. Mojarra_____ e. Boca Colorado_____ f. filete_____
g. otros _____

14. Do you like fish?

a. Yes____ No____
b. Why?_____
(if you answered no)

(If you responded negatively to question 14, skip to question 17 to see if it's possible to continue the interview.)

15. If you anrwered yes, how much do you like fish?

a. very much b. little c. regular
d. Why?_____

16. Why don't you eat more fish?_____

17. If you could regularly buy fish close to your house, would you buy more fish?_____

18. Do you think that fish is good for your family?

Yes____ No____ Why?_____

19. What is your biggest problem buying fish?_____
_____

20. What is your biggest problem preparing fish?_____
_____

If you cannot continue, pass to Level IV and ask all questions.

Level II

21. Generally, how often do you buy fish?_____

22. What quantity of fish do you generally buy?_____

23. What kind of fish do you usually buy?_____
Why?_____

24. In what form do you prefer to buy the fish?_____

25. Do you generally buy fish throughout the year?_____ _____

26. In what season do you buy more fish?_____

27. Before buying, do you compare prices with other vendors?

a. yes____ b. no____ c. why?_____

28. How do you decide if the fish is good or bad quality?_____

_____

29. Where you buy fish, the price is:

a. more expensive b. less expensive c. equally priced
d. I don't know

30. What species of fish is good this time of year?_____

Why?_____

31. Why do you buy fish?

a. I like it b. custom c. cheap
d. food value e. variety f. other_____

32. When you buy fish, you prefer to see it:

a. frozen b. refrigerated c. with ice
d. without ice e. other_____
f. Why?_____

Level III

33. Which of the following do you own:

a. radio b. refrigerator c. television
d. car_____ e. house_____
(make and model) (own or rent)

34. Who in the house buys the groceries?_____

35. In the case of the fish, who buys it?_____

36. When you buy fish, what day of the week do you buy it?_____

Why?_____

37. How do you prepare the fish?_____

In relation to other foods, we would like to ask you the following:

38. What meat does your family like most? Number from 1 to 5.

a. chicken b. fish c. beef
d. pork e. others_____

39. How often to you eat: (daily, weekly, monthly)

a. chicken_____ b. beef_____ c. pork_____

40. Generally, which is more expensive?

a. fish____ beef____
b. fish____ chicken____
c. fish____ pork____

41. How do you obtain information concerning the availability of fish?

a. personally b. by radio c. newspaper
d. other way_____

42. How do you obtain information about the price of fish?

a. personally b. by radio c. newspaper
d. other way_____

43. Is the price of fish high or low?_____

What kinds in particular?_____

44. What species of fish does you family like most?_____

_____

Why?_____

45. What species of fish does you family like least?_____

_____

Why?_____

46. Are the conditions satisfactory where you buy fish?

a. yes_____ b. no_____ c. why?_____

Level IV

47. How many years of school did the head of the family attend?

_____
(specify occupation and profession)

48. How many years of school did the wife attend?_____

49. In respect to the attitudes held with regard to fish, I'm going to read to you a pair of words. Indicate the one that most shows how you view fish.

a. hot_____	cold_____
b. sour_____	sweet_____
c. hard_____	soft_____
d. foul-smelling_____	fragrant_____
e. dirty_____	clean_____
f. weak_____	strong_____
g. dry_____	wet_____
h. ugly_____	pretty_____
i. profane_____	sacred_____
j. heavy_____	light_____

50. Approximately how much do you spend on groceries?

a. daily Q._____ b. weekly Q._____ c. monthly Q._____

51. What is the approximate income of the head of the family?

a. daily_____ b. weekly_____ c. monthly_____

52. Is the head of the family regularly employed?

a. yes_____ b. no_____

53. Do other members of the household have an income?

a. yes_____ b. no_____

54. How much do they make?

a. daily Q._____ b. weekly Q._____ c. monthly Q._____
d. other Q._____

55. If you haven't obtained information about income, observe the characteristics of the house, electrical appliances as indicators of the income.

_____
(estimate the income)

Observations:

CHAPTER 10 A SURVEY OF FISHERIES ADMINISTRATORS BY T.M. Hennessey

Little empirical research has been done on the attitudes and preferences of public sector managers. Perhaps this can be explained, at least in part, by the traditional distinction between policy making and administrative implementation and execution. For years, a sharp distinction persisted between the two. The issue of attitudes and behavior of administrators was not considered to be a relevant topic of research: administrators were simply neutral technicians who carried out policies so as to maximize the "Public Interest." Since World War II, there has been a growing recognition that administrators play a significant part in implementing policy via the establishment of critical regulations and procedures which establish the parameters within which policy can be carried out. As policy has become more complex, technical administrators have begun to assume a central role in formulating, as well as implementing policy.

This latter recognition has stimulated interest within the industrialized countries in the role played by administrators, and this is reflected in a growing body, albeit small, of research devoted to the attitudes and behavior of public sector administrators.

In the field of Development Administration, which is the field most relevant to our concerns, there has also been a remarkably small body of research devoted to the attitudes and preferences of administrators. This is unfortunate since underlying all of the programs conducted to accomplish development is one common element -- administration. In fact, a survey of the field found that only 9.8% of the articles dealt with the values and behavior of bureaucrats, Seligmen (1976:622).

Yet, public and private institutions have to be created and operated to accomplish policy goals. Problems in accomplishing development goals often lie in the management area: leadership may be lacking; programs are uncoordinated; staff personel are not offered incentives; etc. As Gable and Springer (1976:58) point out: "The really tough part of economic development is not fabricating improved technologies, but rather the organizational tasks of recombining human behavior under new rules that enable people to help each other in creating and putting to widespread use the more effective technologies."

To do an effective job of "recombining human behavior" (i.e. administering change,) requires commitment to clear and explicit policy goals, adequate resources, effective organization, and a high level of administrative skill and performance. And, as Gable and Springer note: "Many administrative systems in the less developed countries do not measure up to the requirements for the effective and efficient fulfillment of development goals. Because the goals of individual units may not be clear, there may be confusion over functions and responsibilities, duplication of work, and lack of coordination." (Gable and Springer, 1976:60).

There are several explanations why attitudinal research is rarely conducted with development administrators. Government and individual officials are reluctant to extend permission for researchers to interview key decision-makers. This is the case because officials tend to view such research in essentially negative terms. They do not see any direct benefits from the research to their government or agency while there is at least a potential present for such activities to harm their position. Hence, they have a tendency to deny permission for research or to attach conditions for its conduct for its conduct which is highly restrictive.

Moreover, even if one can obtain the necessary permission and cooperation, several problems remain. Since administrators are intelligent and well-educated, they tend to view interviews in a strategy way; that is, as occasions for the outwitting of the interviewer. Through strategic responses

to questions, they attempt to reveal only that which tends to enhance the position of their agency and their place in it. Potentially harmful questions will simply be avoided or glossed over. This creates a severe problem of validity as well as missing data and limits or destroys comparability across respondents along critical conceptual dimensions.

Administrators also have a tendency to put the researcher off by questioning the validity of the study. They will explain that their situation is so complex and unique that only those who face these problems on a day by day basis can really understand what is going on. In short, they will argue that the researcher is not in a position to really understand the "true" situation. Yet, despite these basic difficulties, many scholars, including this one, are convinced that the future of comparative administration lies in examining the background, attitudes and behaviors of bureaucrats and those with whom they interact.

In the Costa Rican case, we did not experience the problems identified above. Permission to conduct the research was obtained and full cooperation was forthcoming from all the agencies concerned. As a result, we were able to conduct lengthy (i.e., up to 1 1/2 hours) interviews with eighteen carefully selected respondents who were directly or indirectly involved in one way or another with the Costa Rican Small-Scale Fisheries Project.

In order to determine the effectiveness of development requires careful analysis of the administrative system in question -- in our case the Costa Rican Small Fisheries Project. Key research questions were identified by this investigator after two years of intensive formal and informal interaction with government officials, private sector fisheries experts and former government officials, private sector fisheries experts and former government officials. In light of these interactions and conversations, a public choice approach to administrative analysis and design was deemed appropriate. In particular, administrative weakness was viewed as fundamentally a collective action problem in which coercion and selective incentives were not utilized to coordinate and manage the overall effort. As a result, the comprehensive development approach permitted a high degree of "free ridership" on the part of a significant number of departments. As a result, the project lacked the appropriate resources and coordination to accomplish the specified goals. The results of this approach are reported in a later chapter.

A. Converting Public Choice Theory into Management Terminology

The first requirement for constructing a reliable and valid interview instrument was to employ terminology that managers could understand and utilize. Theoretical concerns had to be reworded into management language. In other words, our theoretical perspective did not yield management principles which would relate directly to the tasks faced by agency heads and program leaders. But the basic collective action concepts do seem to rather clear management analogues.

In another chapter we noted the necessity of using coercion and/or selective incentives to minimize free-rider behavior. The concept in management which most closely approximates coercion is control. Controlling refers to the regulation of the organization to insure the achievement of program objectives and plans. Fundamental to control is performance evaluation based on a set of standards previously specified in the planning process. Evaluation must be employed in order to ensure that the quality and/or quantity of goods and services are up to expectations and, if there are deviations, to bring the program back into line with the original plan. It is imperative the the plans specify program objectives down to the lowest level of execution so that each manager, regardless of his or her level of responsibility, is clear about precisely what is expected from his or her operational unit.

Seeing that these performance goals are achieved is the task of the chief

executive who must use an appropriate schedule of punishments and rewards in order to keep the unit leaders performing at required levels. Such rewards are obviously such things as promotion, increases in budget, personnel, prestige, etc. Of course, on the punishment side they could include reprimand or transfer from the project.

The key feature of the relationship between planning, evaluation and unit performance is accountability. The creative use of evaluation for identifying levels of unit performance permits the organization or remain "on course" so to speak, by making whatever adjustments necessary to get "back on track." In this sense, accountability contributes to organizational flexibility and permits creative adaptations to changing environmental conditions.

It is important to note that the use of timetables, objectives, and unit goals to evaluate performance permits such accountability. And accountability is the management analogue of noticeability. You will recall that noticeability was the key element in collective action weakness and failure. As groups got larger, noticeability created the necessary condition for free-rider behavior. We suggested that large government projects have similar difficulties if noticeability is not present.

Accountability then, is a management mechanism in terms of which to advertise or enhance such noticeability by revealing the contributions of individual unit leaders to the overall goals of the organization. And evaluation serves to relate levels of individual contribution to rewards and punishment.

Thus control, use of planning, evaluation, and, ultimately, accountability, are basic management concepts. And these, in turn, are closely related to the collective action analytics of noticeability, coercion, selective incentives and free-ridership. In particular, we hypothesized that the program was severely weakened by an unclear specification of objectives, and timetables to accomplish these. Decisions regarding the amount of participation were left up to the individual agencies. Moreover, there was no permanent system of evaluation and control which would allow for information on the state of the program. Finally, there was no chief executive who could assume that program planning, organizing and controlling was carried out in the most effective manner. Since these basic management principles were not used in the planning and implementation of the small-scale fisheries project, this significantly contributed to project weakness.

Once the theoretical constructs were converted to management language, they were employed in the survey instrument which is presented below and the results analyzed in a later chapter.

"The small-scale fisheries program has failed to achieve its major objectives."

Agree Strongly Agree Disagree Disagree Strongly

"The major problems in the program were institutional in nature."

Agree Strongly Agree Disagree Disagree Strongly

"There was no clear specification of objectives and a time table to accomplish these for each of the participating agencies."

Agree Strongly Agree Disagree Disagree Strongly

"The participation of the various supporting agencies was not clearly specified in the program, leaving the decision regarding the amount of their participation to each agency itself."

Agree Strongly Agree Disagree Disagree Strongly

"Because of unclear specfication of authority and specific objectives some agencies participated fully while others did very little."

Agree Strongly Agree Disagre Disagree Strongly

"There was no permanent system of evaluation and control that maintained information on the state of the program."

Agree Strongly Agree Disagree Disagree Strongly

"The development plan overestimated the capacity of COOPEPES to implement the plan."

Agree Strongly Agree Disagree Disagree Strongly

"The original coordinating commission was made up of individuals that had limited authority to make decisions. This caused a failure to adjust to changing conditions.

Agree Strongly Agree Disagree Disagree Strongly

"As the chief executor BAC had a difficult time operating among public sector agencies since each participating agency had its own sources of funding and other responsibilities and jurisdictions."

Agree Strongly Agree Disagree Disagree Strongly

"Not all of the agencies executing the program had full-time personnel assigned to the program."

Agree Strongly Agree Disagree Disagree Strongly

"The agencies charged with implementing the Fisheries Development Plan lacked personnel who specialized in artisinal fisheries."

Agree Strongly Agree Disagree Disagree Strongly

"Judging from the budget, the government does not give the same priority to fisheries as to other sectors of the economy."

Agree Strongly Agree Disagree Disagree Strongly

B. The Self-Anchoring Scale

In addition to the structured questions listed above, we wished to give the respondents a chance to assess the state of the program and the resource (i.e., the fisheries) in their own terms. In order to do this we used the self-anchoring scale.

Designed by Hadley Cantril in collaboration with Lloyd A. Free (1965), this scale was used for a series of studies in eighteen countries between 1958 and 1964. A respondent is asked to define, on the basis of his own assumptions, preceptions, goals and values, the two extremes or anchoring points of the spectrum on which some scale measurement is desired. This self-defined continuum is then used as a measuring device.

Following Gable and Springer, (1976), we used the instrument for the purpose of having the fisheries development administrators assess dimensions of the project and the resource. For each of our dimensions they were asked to describe the best possible or ideal situation and then the worst possible situation. Then they were asked to locate a ladder which runs from Number 1-11 -- from worst situation to best, the position they think captures the state of the phenomenon in the past, they present and the future. Using this technique, we asked the following questions of eighteen administrators and outside experts.

"I should like to discuss the fisheries situation in Costa Rica."

"If you were to describe the best possible or ideal situation for fisheries in Costa Rica, what would it be like. Think of what could be missing that would make the fisheries situation measure up to the ideal."

"On the other side, if you were to describe the worst possible situation for fisheries, what would it be like?"

"Please imagine the worst possible fisheries situation, even if you know this could never happen."

(Introduce the ladder and instructions.)

"I have a ladder here which extends from 1 to 11. Think of 1 as the worst possible situation and 11 as the best possible situation. Do you understand?"

"In terms of the worst and the best on the ladder, the top is best, the bottom the worst: (select a number)

1.) Where would you locate the fisheries situation in Costa Rica at the present time?

2.) Could you locate your assessment on the ladder for the fisheries situation five years ago:

3.) Could you locate your assessment on the ladder for the fisheries situation five years from now?

"Let us not turn to the living situation of the small-scale fisherman in terms of income: (select a number)

4.) Where would you say the situation is now? (select a number)

5.) Where was it five years ago?

6.) Where will it be five years from now?

"Let us turn to the existence of fish as a living resource (i.e., the abundance of different types of fish):

7.) What would you say the situation is as far as quantity of fish available to catch is concerned today?

8.) Where was it five years ago?

9.) where will it be five years from now?

"Let us turn to government administration of small-scale fisheries development.

10.) How well would you say the government is doing in developing and administering fisheries today?

11.) Where was it five years ago?

12.) How will it be five years from now.

13.) Where would you say it is today on the scale?

14.) Where was it five years ago?

15.) How will it be five years from now?

"How about the processing of fish?

16.) How would you say it is conducted today?

17.) How was it five years ago?

18.) How will it be five years from now?

"Let us turn to commercial fisheries such as tuna as compared with small-scale fisheries."

19.) Where would you say the tuna fishing industry is today?

20.) Where was it five years ago?

21.) Where will it be five years from now?

"There currently exists a different scheme of program coordination for fisheries development (The National Fisheries Commission)

In order to clarify the actual situation today with that which existed three years ago and three years from now how would you rank the situation:

22.) Today?

23.) Three years ago?

24.) Three years from now?

The self-anchoring scaling technique described above was successfully administered to our eighteen respondents and the results are reported in a later chapter. Initially, there was some resistance, raising of eyebows, etc., as they were asked to describe the best and worst possible situations with respect to fisheries, and the presentation of the ladder. But as the process progressed, the respondents became more involved and seemed to enjoy the questions. In general, they were all optimistic about the future along all dimensions. They were, moreover, very candid in admitting that they really knew only a minimal amount about fisheries, which, after all, was only one of their many administrative responsibilities. Yet, even though they did not feel technically competent to deal with fisheries development, they felt administratively competent to judge success or failure of the program, the future of the resource, etc. This distinction between technical expertise and administrative competenc proved to one of the most interesting in the study and promises to be a potentially fertile area of enquiry for those concerned with the relationship between technology and administration of public programs for technical delivery.

In sum, the interviewing of development administrations proved to be a successful methodology for testing hypotheses drawn from a public choice -- collective action approach to administrative weakness and failure. While admitting that other competing explanations may be offered for the problems of the small-scale fisheries development project in Costa Rica, administrative weakness undoubtedly accounts for a significant amount of the variance.

Moreover, the self-anchoring scaling technique was successfully employed and promises to be a useful approach to determining the perceptions and evaluations of administrators toward public program and their implementation.

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CHAPTER 11. ASSESSMENT OF FISHERY RESOURCES - GULF OF NICOYA, COSTA RICA

BY D.K. Stevenson

1. Length Frequency Analysis

Length measurements collected by sample surveys of commercial landings in Puntarenas, Costa Rica, were compiled into monthly and annual length frequency distributions by gear type and fishing zone for fifteen species harvested by the artisanal fleet in the Gulf of Nicoya. Efforts to estimate growth and total mortality rates as required by the Beverton-Holt yield model were based on the analysis of these data.

Growth Rate Estimation. Growth was expressed by the von-Bertalanffy growth equation

$$\ell_t = (1-e^{-K(t-t_o)}) \qquad (1)$$

where ℓ_t = length of any fish at time (age) t,
L_∞ = the theoretical maximum asympototic length attained by each fish in the population,
K = average instantaneous rate of growth
t_o = theoretical time (age) at which growth begins.

Annual growth rates (K) were estimated from modal length progressions by means of a transformation of equation (1) to the following linear regression equation

$$\log_e(L_\infty - \ell_t) = \log_e L_\infty + Kt_o - Kt \qquad (2)$$

in which L_∞ was assumed to equal the length of the largest fish routinely observed during sampling, ℓ_t values were estimated as the modal lengths of individual groups in successive months[1] and t was recorded as the coded sampling time in months relative to time t=0 when the first modal length was observed. All ℓ_t values were determined by visual inspection of length frequency distributions and set equal to the lower limiting length of the dominant length classes in the corresponding length frequency distribution.

Monthly length frequency data for all species routinely sampled during this study were analyzed to determine the mean lengths of individual size groups by means of Hasselblad's (1966) "steepest descent" method as programmed for computer use by Tomlinson (1971) and Yong and Skillman (1975), but the results were generally unsatisfactory due to small sample sizes, and extreme overlap between adjacent size groups. For several species, the apparent constant recruitment of juvenile fish and use of size selective gill nets produced simple and uniform monthly length frequency distributions which prevented the estimation of growth rates based on size increments over time. (See Chapter 3 for a more complete evaluation of the procedures which were tested for growth and mortality rate estimation.)

Apparent annual K estimates were obtained from a limited number of observed ℓ_t increments for two species (Tables 1 and 2) exploited by the artisanal fishery in the Gulf of Nicoya. These two species (Cynoscion squamipinnis and Cynoscion albus) are important components of the artisanal catch in the Gulf of Nicoya. For both species, a range of possible K estimates was derived.

For C. squamipinnis, approximate growth estimates of 0.26, 0.37 and 0.65 were obtained from increments of two size groups sampled in Zone 1 by large-meshed gill nets and for increments of one size group sampled by the same gear in Zone 2 (Figure 1). However, modal length estimates for only certain months were used (see Figures 2,3). Furthermore, considering the large numbers of fish were measured, the resulting growth estimates were based on a very

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TABLE 1. Monthly Modal Lengths for Cynoscion squamipinnis, Interpreted Visually from Length Frequency Distributions Compiled from Samples of Commercial Landings in Puntarenas, Costa Rica, 1976-77*

12.5-15.0 cm mesh gill nets, Zone 1

Group A				Group B			
Month	Code	l_t	$\log_e(L_\infty - l_t)$	Month	Code	l_t	$\log_e(L_\infty - l_t)$
Aug. '76	0	32	3.33	Aug. '76	0	44	2.77
Sept. '76	1	34	3.26	Sept. '76	1	44	2.77
Nov. '76	3	36	3.18	Nov. '76	3	46	2.64
Feb. '77	6	40	3.00	Jan. '77	5	46	2.64

12.5-15.0 cm mesh gill nets, Zone 2

Group A			
Month	Code	l_t	$\log_e(L_\infty - l_t)$
July '76	0	32	3.33
Aug. '76	1	32	3.33
Sept. '76	2	34	3.26
Oct. '76	3	34	3.26
Feb. '77	7	36	3.18

*Modal lengths (l_t) were estimated as the lower limiting length of dominant length classes. The upper limiting length (L_∞) was assumed to equal 60 cm.

TABLE 2. Monthly and Bi-monthly Modal Lengths for *Cynoscion albus*, Interpreted Visually from Length Frequency Distributions Compiled from Samples of Commercial Landings in Puntarenas, Costa Rica, 1976-77*

Month	Code	l_t	$\log_e(L_\infty - l_t)$
Hooks, Zone 2, Group A			
Aug. '76	0	43	4.34
Nov.-Dec. '76	3.5	55	4.17
Jan.-Feb. '77	5.5	55	4.17
Mar.-Apr. '77	7.5	61	4.08
Hooks, Zone 2, Group B			
Aug. '76	0	67	3.97
Nov.-Dec. '76	3.5	73	3.85
Jan.-Feb. '77	5.5	79	3.71

*Modal lengths (l_t) were estimated as the lower limiting length of dominant length classes. The upper limiting length (L_∞) was assumed to equal 120 cm.

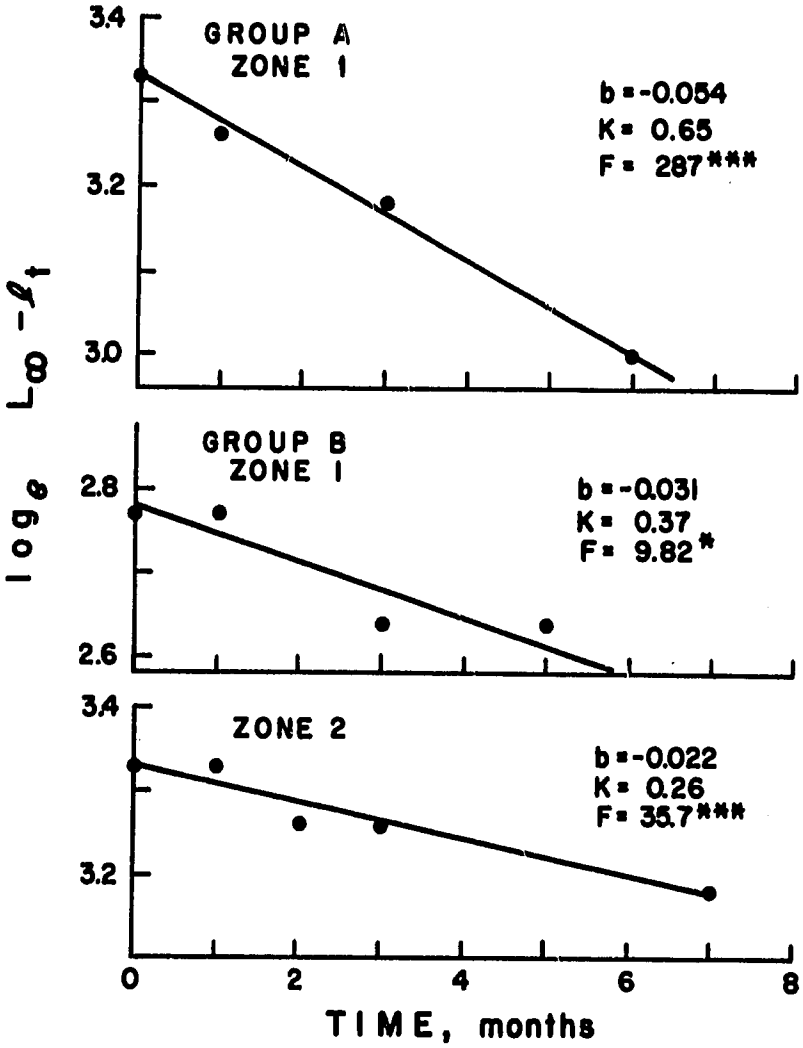

Figure 1. Growth rate estimation from length frequency data for two size groups of corvina aguada (Cynoscion squamipinnis) caught with 12.5 - 15.0 cm mesh gill nets in Zones 1 and 2, Gulf of Nicoya, Costa Rica, during 1976 - 1977.

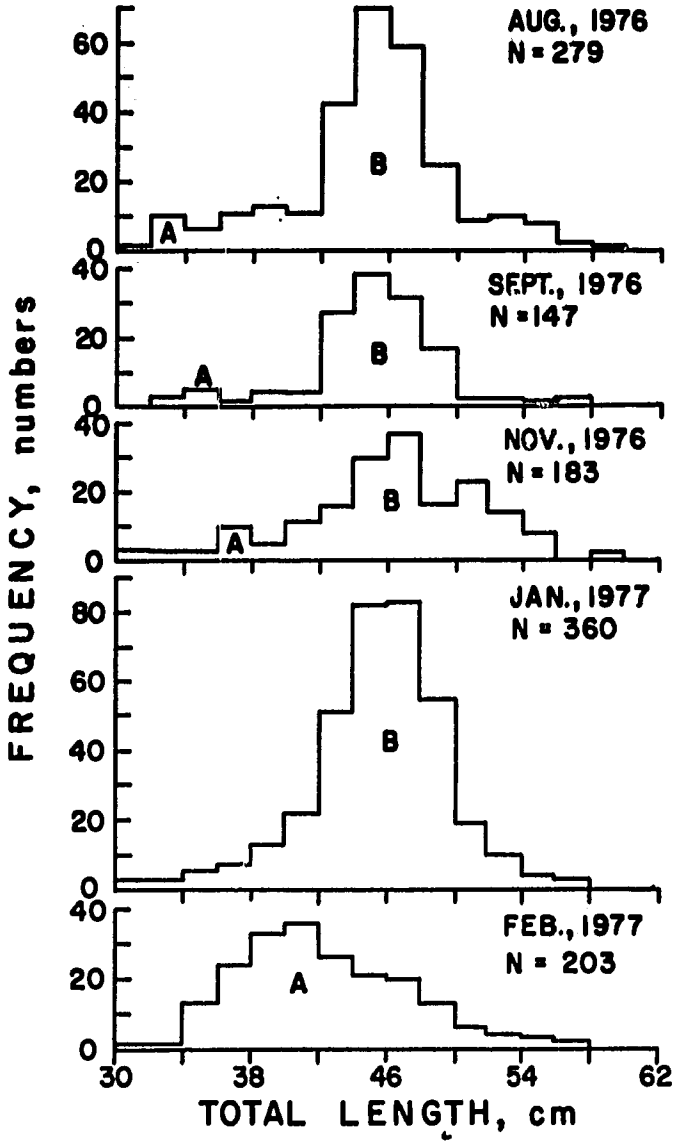

Figure 2. Monthly length frequency distributions used to estimate growth of corvina aguada (Cynoscion squamipinnis) caught with 12.5 - 15.0 cm mesh gill nets in Zone 1, Gulf of Nicoya, Costa Rica, during 1976 - 1977.

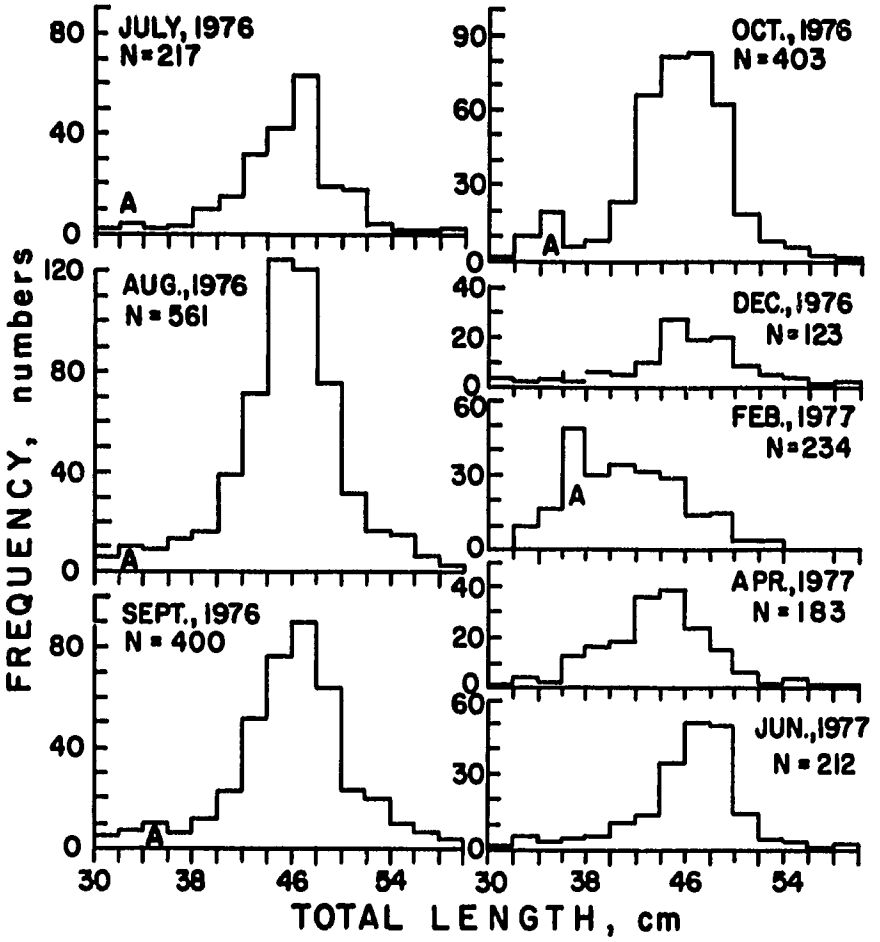

Figure 3. Monthly length frequency distributions used to estimate growth of corvina aguada (Cynoscion squamipinnis) caught with 12.5 - 15.0 cm mesh gill nets in Zone 2, Gulf of Nicoya, Costa Rica during 1976 - 1977.

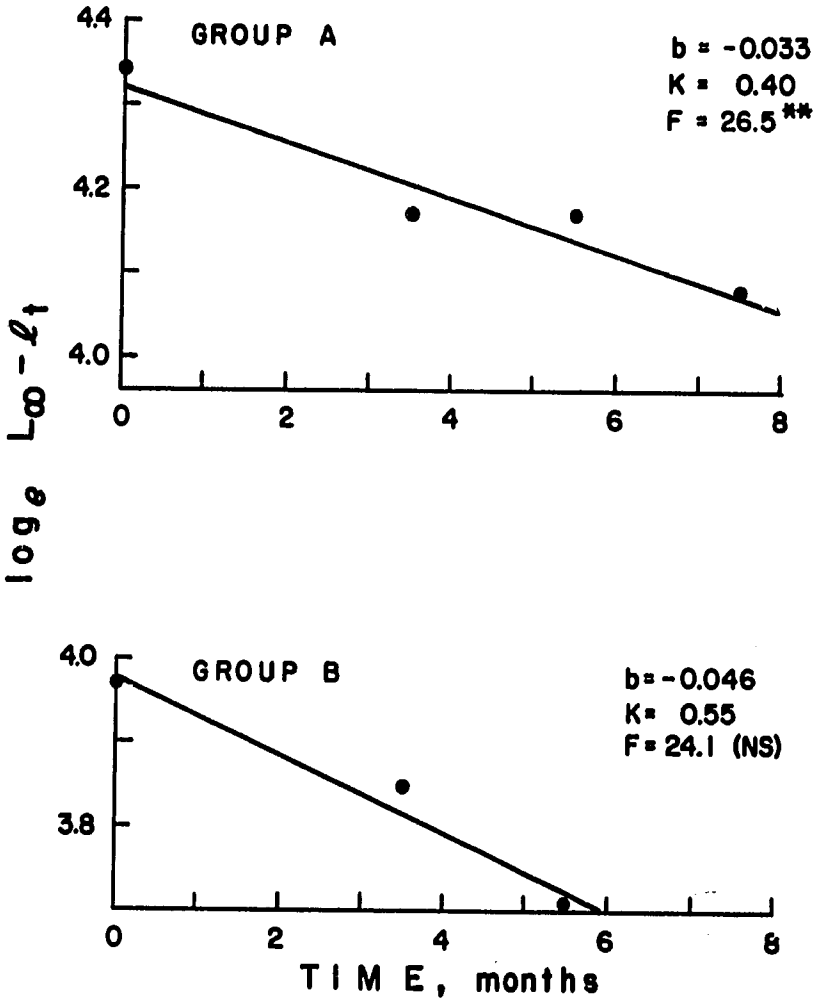

Figure 4. Growth rate estimation from length frequency data for two size groups of corvina reina (Cynoscion albus) caught with hooks in Zone 2, Gulf of Nicoya, Costa Rica, during 1976 - 1977.

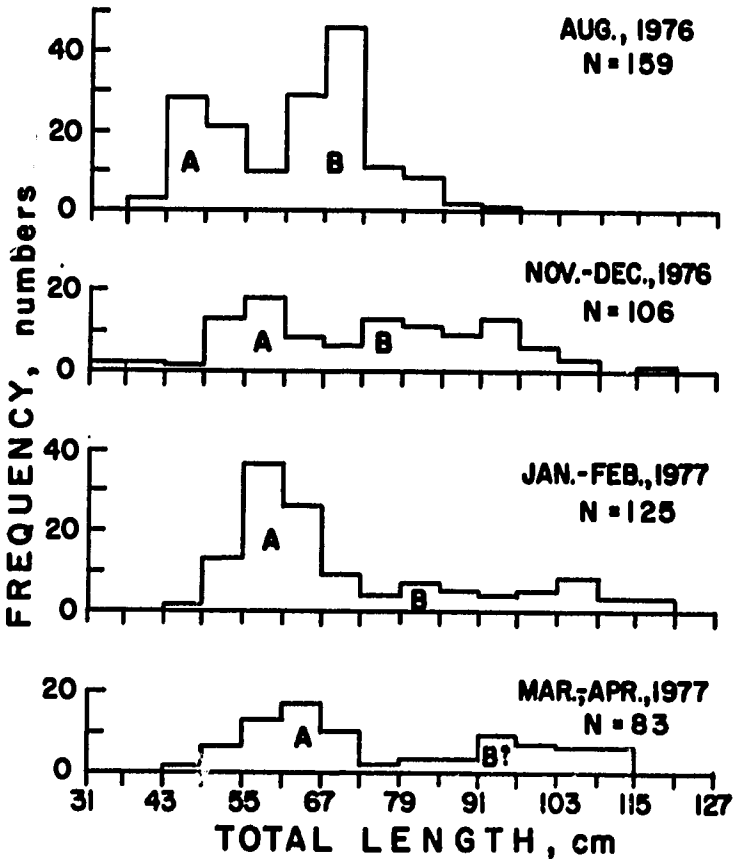

Figure 5. Monthly and bi-monthly length frequency distributions used to estimate growth of corvina reina (Cynoscion albus) caught with hooks in Zone 2, Gulf of Nicoya, Costa Rica, during 1976 - 1977.

limited sub-set of the total available data. Two linear regressions were statistically significant at 99 percent confidence levels and the third at 90 percent. L_∞ was assumed to equal 60 cm.

For C. albus, approximate growth estimates of 0.40 and 0.55 were obtained from increments of two size groups sampled in Zone 2 with hooks (Figure 4) after some monthly data sets were combined to increase sample sizes. The apparent modal length of group B in March-April was omitted from the regression analysis (Figure 5). The three-point regression (K = 0.55) was not statistically significant. L_∞ was assumed to equal 120 cm.

Preliminary growth rates for Micropogon altipinnis (Stevenson, 1978), based on mathematically-derived ℓ_t values from six months of data were discounted as being too high after repeating the analysis with a complete twelve-month data set. No satisfactory growth rate estimates were obtained for this species.

The lower annual instantaneous growth rates estimated for C. albus and C. squampinnis, although based on only a few observations, were generally similar to K estimates reported in the literature for other species of this genus (Pauly, 1978). A number of authors have studied the growth rate of C. nebulosus, an Atlantic species of corvina which attains a maximum limiting length of 57-85 cm, and have reported K values ranging from 0.15 to 0.36. Growth rates for three larger species (C. macdonaldi and C. nobilis in southern California and C. maracaiboensis in Lake Maracaibo, Venezuela) ranged from K = 0.13 to 0.30.

Total Mortality Rate Estimation. Total mortality was expressed by the negative exponential equation

$$N_t = N_0 e^{-Zt} \qquad (3)$$

where N_0 = number of fish in a given population cohort (e.g., year class) born at time zero
N_t = number of fish in the same cohort alive at later time t
Z = annual instantaneous rate of total mortality.

Annual Z rates were estimated from annual length frequency data with known growth estimates (K, L_∞) according to the following equation proposed by Beverton and Holt (1956):

$$z = k \frac{(L_\infty - \bar{\ell})}{(\bar{\ell} - \ell_c)}$$

where ℓ_c = the mean length at first capture
$\bar{\ell}$ = the average length of fish captured larger than ℓ_c.

The parameters ℓ_c and $\bar{\ell}$ were estimated from average annual length frequency distributions for C. squamipinnis captured in 12.5-15.0 cm mesh gill nets in Zone 1 and 2 (Figures 6, 7) and for C. albus captured with hooks in Zone 2 (Figure 8). Total mortality estimates ranged from Z = 0.96 to 2.41 for C. squamipinnis and from Z = 0.80 to 1.11 to C. albus (Table 3).

II. Tag and Recapture Study

A total of 2,264 fish were tagged during two separate six-week tagging periods in 1978. One species (Sciades troschell) accounted for 42 percent of all returns and was the only species returned in sufficient quantities to permit growth rate estimation. Of 25 total returns for this species, 10 were selected for analysis after eliminating measurements made by non-biologists and otherwise incomplete records (Table 4). The remaining observations were corrected for possible shrinkage of fish which were held on ice. Two observations were clearly erroneous and were deleted from the analysis.

Annual instantaneous growth was estimated by plotting the average daily increment in length between tagging and recapture versus initial length according to methods described by Campbell and Phillips (1972). This procedure assumes linear growth during the time at liberty and, for this

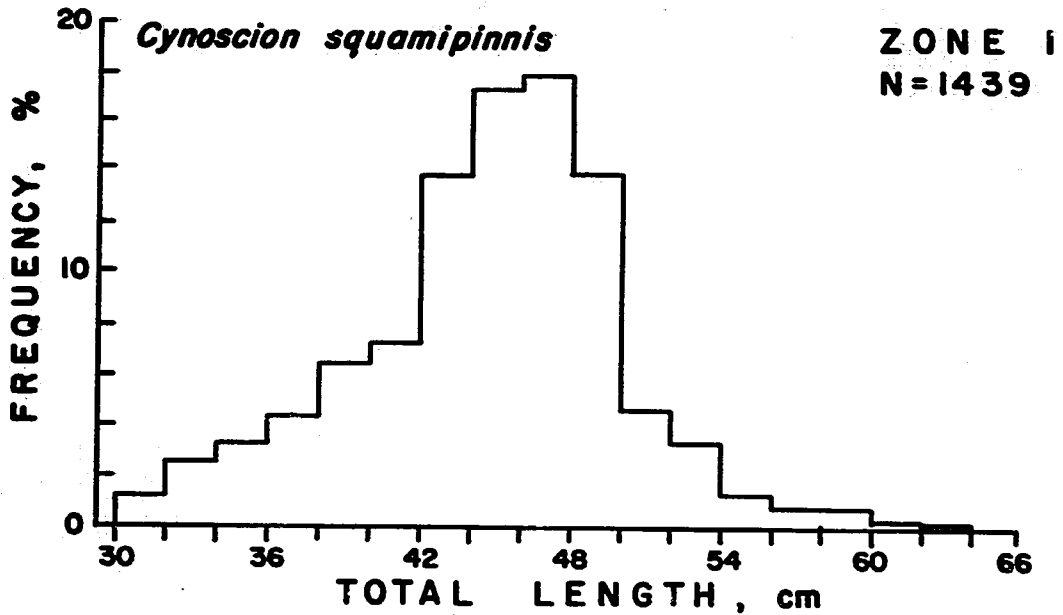

Figure 6. Average annual 1976 - 1977 length frequency distributions for corvina aguada (Cynoscion squamipinnis) caught in 12.5 - 15.0 cm mesh gill nets in Zone I, Gulf of Nicoya, Costa Rica.

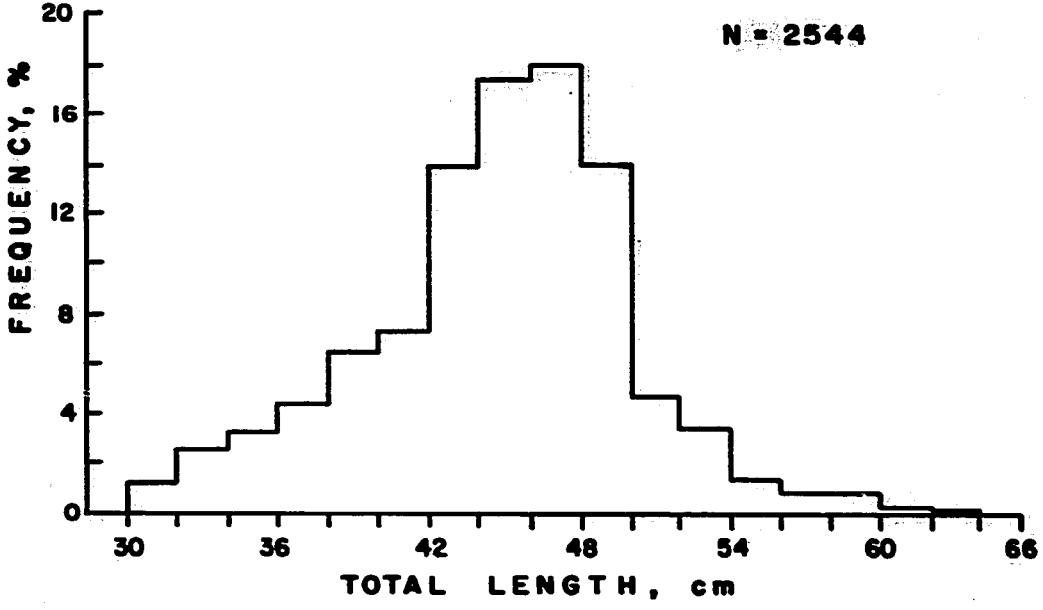

Figure 7. Average 1976 - 1977 length frequency distributions for corvina aguada (Cynoscion squamipinni) caught in 12.5 - 15.0 cm mesh gills nets in Zone 2, Gulf of Nicoya, Costa Rica.

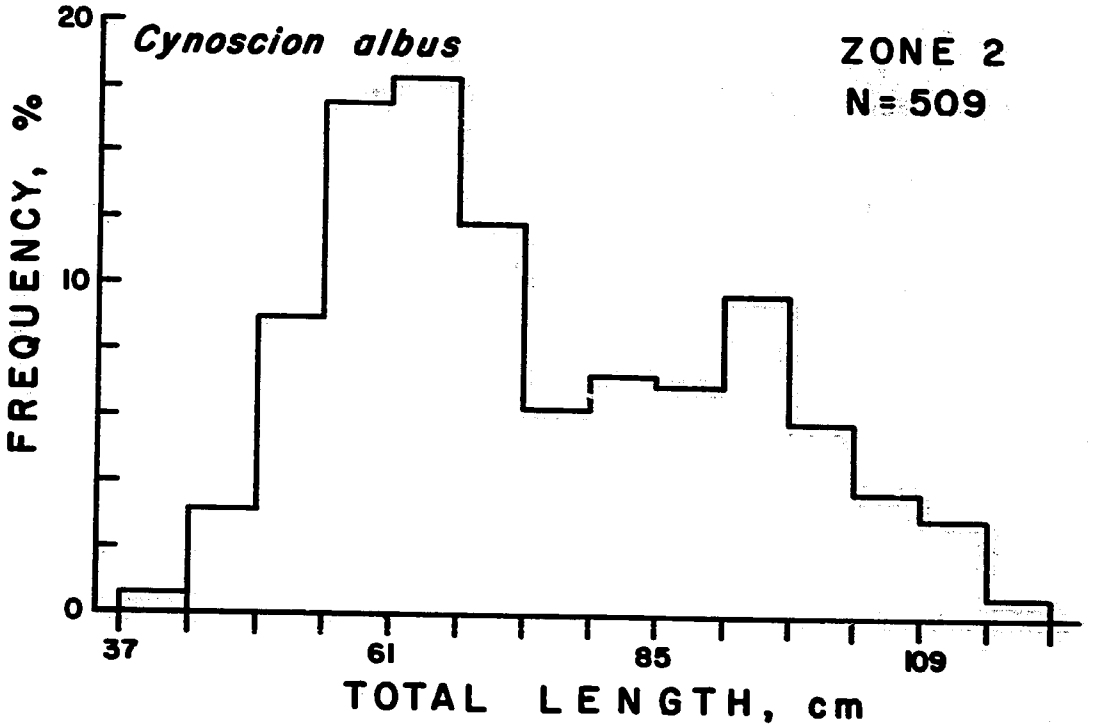

Figure 8. Average annual 1976 - 1977 length frequency distributions for corvina reina (Cynascion albus) caught with hooks in Zone 2, Gulf of Nicoya Costa Rica.

Figure 9. Growth rate estimation from tag and recapture data for cuminate colorado (Scianea troschelli) in the Gulf of Nicoya, Costa Rica, 1978.

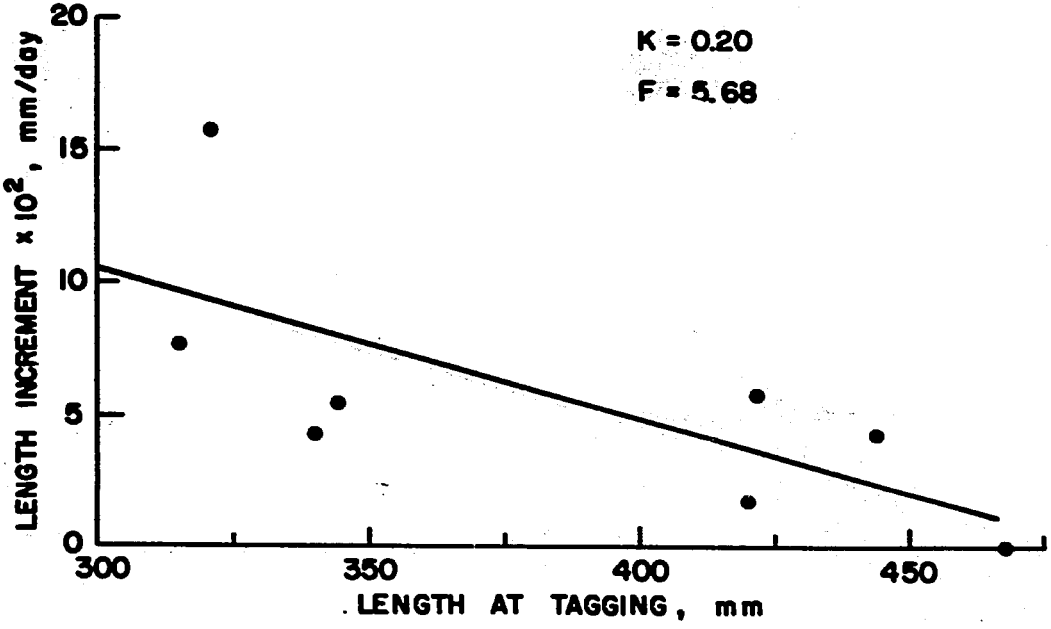

TABLE 3. Annual Instantaneous Total Mortality Estimates for *Cynoscion albus* and *Cynoscion squamipinnis* Obtained from Average Annual Length Frequency Distributions, with Corresponding Estimates of l_c and $\bar{l}$ and Known Growth Parameter Estimates

Species: *Cynoscion squamipinnis*

Gear: 12.5-15.0 cm mesh gill nets

Parameters: L_∞ = 60 cm; l_c = 45.4 cm; $\bar{l}$ = 48.5 cm

	Zone 1				Zone 2		
K	0.26	0.37	0.65	K	0.26	0.37	0.65
Z	0.96	1.37	2.41	Z	1.05	1.49	2.63

Species: *Cynoscion albus*

Gear: Hooks **Zone:** 2

Parameters: L = 120 cm; l_c = 62.5 cm; $\bar{l}$ = 81.6 cm

K	0.40	0.55
Z	0.80	1.11

TABLE 4. Lengths at Tagging (l_t) and Recapture (l_{t+T}) as Measured by Project Biologists for Ten Records of *Sciades troschelii* and Calculated Average Length Increments per Day at Liberty (mm/day)*

Length at Tagging (l_t)	Length at Recapture (l_{t+T})	Time at Liberty (days)	Corrected Length Increment (mm)	Average Length Increment/Day at Liberty
340	349	334	14	.042
420	417	112	2	.018
315	318	103	8	.078
422	426	153	9	.059
441	450	36	14	.389**
321	322	38	6	.158
444	442	72	3	.042
435	445	89	15	.169**
344	353	164	9	.055
468	463	140	0	.000

*Recorded lengths-at-capture were collected for shrinkage in ice by adding 5 mm.

**Not included in growth rate analysis.

reason, requires faily brief time intervals between tagging and recovery. The slope of the resulting linear regression is an estimate of K and the x-intercept an estimate of L_∞.

The annual K estimate for Sciades torscheli was 0.20 (Figure 9). The linear regression was significant at 90 percent confidence and the apparent L_∞ was estimated to be 48 cm. The largest specimens of this species observed aboard commercial vessels were 65 cm, suggesting that L_∞ was under-estimated and that growth may, in fact, be less rapid than estimated from tag and recapture data. In fact, a greater number of recoveries was required to obtain a more reliable growth estimate.

III. Yield Evaluations

A rough estimate of relative maximum sustainable yield was made for corvina reina (Cynoscion albus) based on direct estimates of growth parameters, total mortality and length parameters and a natural mortality estimate for two closely-related species. This was the only species for which a comparison of actual catch and potential maximum catch was possible. It is, perhaps the most important species in terms of value harvested by the artiaanal fleet in the Gulf of Nicoya and, due to its large size and high market value, a species which could be over-exploited before other species. Estimates of the current state of exploitation, therefore, serve as important indicators of what might be expected for other species if fishing effort in the Gulf increases.

Parameter estimates for C. albus caught with hooks in Zone 2 were the following:

ℓ_c (length at first capture)	62 cm
L_∞ (asymptotic maximum length)	120 cm
$c = \ell_c/L_\infty$	0.52
M (natural mortality)	0.30
K (growth)	0.40
M/K	0.75
Z (total mortality) when K = 0.40	0.80
F (fishing mortality	0.50
F/Z (exploitation rate)	0.63

Comparison of actual values of the variable c with maximum theoretical values when the exploitation rate F/Z equals 0.65 and M/K equals 0.75 (Beverton and Holt, 1964) revealed that this species was exploited beyond MSY with hooks in Zone 2. According to the yield model predictions, an increase in ℓ_c held constant, the same yield increment would follow a 50 percent reduction in fishing mortality.[2] C. albus harvested with hooks in Zone 1 were considerably smaller ℓ_c = 50 cm) and were presumably over-exploited to an even greater degree.

This species is exploited selectively with medium-sized and large mesh gill nets. The length-at-first-capture for medium-sized mesh nets in Zone 1 was 50 cm while ℓ_c in the large mesh nets in this zone approximated the optimum value (82 cm) at which MSY is achieved, suggesting that large-meshed gill nets are the most effective gear for obtaining maximum yields for this species without depleting the resource.

FOOTNOTES

[1]When L_∞ is unknown, it may be more precisely estimated as the value which produces the "best" least squares fit of $\log_e (L_\infty - \ell_t$ versus t. The number of ℓ_t observations generated in the present study did not justify such an analysis.

[2]Fishing effort (f) and fishing mortality (F) are directly proportional to each other according to the formula F = qf in which q = the vulnerability of the fish to capture. Thus, given a constant value for q, MSY would be achieved for C. albus only after fishing effort was reduced by 50 percent.

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CHAPTER 12. AN ECONOMIC ANALYSIS OF FISHERIES PRODUCTION IN THE GULF OF NICOYA, COSTA RICA

By Ahmed Hussen and J.G. Sutinen

Increasing the supply of fish is viewed by many as one important means of alleviating the acute protein shortage in the less developed countries of the world (Lampe, et. al., 1974). While a number of alternative approaches exist, an understanding of traditional capture techniques is essential for the design of effective programs to increase fish supplies in the less developed countries. Toward this and we attempt in this chapter to estimate key production parameters for the capture sector of the small scale fishery in the Gulf of Nicoya, Costa Rica. The analysis is intended to test the usefulness of the data generated by the economic surveys (see Chapter 4) and to provide relevant information to decision-makers in Costa Rica as they devise policies and programs to develop and manage their marine fishery resources.

The production analysis is based on data collected in a random sample over a one-year period (August 1976 - August 1977). The sampling unit consisted of a fishing trip; and in each case the fisherman at the end of his trip was asked, among other things, about his total catch and the production factors he utilized in the process of catching the fish. A total of 805 trip interviews were processed.

Of the 805 artisanal fishermen interviewed 21.7 percent were hand liners, 13.9 percent long liners and 59.6 percent gill netters. On the other hand, 12.5, 13.6 and 69.0 percent of the total catch from the sample data are harvested, respectively, by hand liners, long liners and gill netters. These proportions closely approximate the actual proportions that exist around the Gulf of Nicoya (Table 1).

The average catch per trip for these three gear types ranges from a low of 90.2 pounds (the average catch for hand liners) to a high of 190.4 pounds (the average catch for gill netters). On the other hand, the revenue per trip ranges from 158.75 Colones (the average revenue for long liners) to 365.59 Colones (the average revenue for gill netters). Note, even though the average catch of the long liners (111.0 pounds) is greater than the average catch of the hand liners (90.2 pounds), the reverse is true when comparison is made in terms of average revenue (Table 1). This is because, as shown in Table 2, hand liners direct their effort to catch higher value species than the long liners.

As shown below, crew size and fishing time are important production factors. Table 3 shows the utilization of these two production factors among the three gear types. From this Table it is clear that most of the hand liners and long liners use either 1 or 2 crew members, whereas, in most cases the gill netters use either 2 or 3 crew members. The average fishing time per crew is smaller for long liners than either the hand liners or the gill netters. As will be evident in the later discussion, these differences in crew size and fishing time among hand liners, long liners and gill netters will have important implications.

1. General Models of Fishery Production Functions

The yield or catch of fish from any given fishing ground at any given time is affected by several factors. One way of expressing the relationship between yield and the factors of production is to construct a production function as follows:

$$Y = f(K,L,T,Fs,Z,S,O), \qquad (1)$$

where:

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TABLE 1. Summary Statistics of the Artisinal Fishery in Costa Rica (Gulf of Nicoya) Based on Sample Data Collected Over One Year Period (Aug. 1976-Aug. 1977)

Items \ Gear Types	Hand Line	Long Line	Gill Net	Others*	Total
I Trips Sampled	175	112	481	37	805
% of the Total Trips Sampled	21.7	13.9	59.6	4.6	100
II Ave. Catch/Trip (lb)	90.2	111.0	190.41	267.9	121.2
% of the Total Catch	12.5	13.6	69.0	4.9	10.0
III Ave. Revenue/Trip (Colones)**	185.9	158.75	365.59	461.96	224.83
% of the Total Revenue	13.9	10.3	71.1	4.59	100
IV Ave. Weighted Price	2.06	1.43	1.92	1.72	1.85

1977 Census from the Ministry of Agriculture of Costa Rica
% of Total Catch by Gear Types

Hand Line	10.0	Long Line	13.0
Gill Net	71.0	Others	6.0

*Others include seine, harpoons or any combination of the three principal gear types.
**Local currency units.

TABLE 2:

Species by Commercial Classes	Average Price	Standard Deviation	Coefficient of Variation	% Composition of Total Catch		
				Hand Line	Long Line	Gill Net
1. Corvina Grande	3.55	0.53	14.92	23.0	(0.0)	15.0
2. Corvina Pequena	2.52	0.48	19.05	26.0	1.8	23.8
3. Classificado	1.34	0.27	20.2	5.7	2.7	3.9
4. Bolillo	1.65	0.24	14.64	3.3	21.5	10.9
5. Chatarra	0.55	0.09	16.37	13.9	8.9	10.2
6. Posta Negra	0.74	0.37	50.0	(0.0)	0.5	2.1
7. Posta Blanco	1.03	0.43	41.67	(0.0)	4.4	2.7
8. Cola	1.36	0.18	13.24	22.5	43.9	14.7
9. Agria	1.32	0.19	14.39	5.3	16.2	16.7

TABLE 3:

	- - - - Gear Type - - - -									
	Hand Line			Long Line			Gill Net			
Items / Crew Size	1	2	<2	1	2	<2	1	2	3	<3
Trips Sampled	77	37	22	45	38	9	9	264	74	7
% of the Sample by Crew Size Within Gear Type	56.6	27.2	16.2	48.9	41.3	9.8	2.5	74.5	21.0	2.0
Ave. Actual Fish. Time per Crew (Hours)	6.19	10.85	--	5.49	7.59	--	9.54	14.88	15.51	--

Y = Total yield for a given period (weight of catch),

K = Capital (a measure of the boats, hooks, nets and other equipment used for fishing),

L = Number of fishermen,

Fs = Fish stock for the period,

Z = Zones or areas fished,

S = Seasonal or atmospheric conditions,

O = Any other factors affecting yield that are not implicity included in the production model (e.g., the skill of the fishermen).

Estimation of the production function outlined above required detailed information which typically is difficult to obtain from available fishery statistics. To circumvent the problems associated with lack of data, researchers often use proxy variables of some kind of indexing procedures to represent the missing information (Carlson, 1973; Carlson, Bell and Waugh, 1973; King, 1977).

To date there have been several attempts to fit various fishery production functions. The manner in which the production models are specified varies depending on the availability of data, the objectives of the study, and whether the model is going to be used for short-run or long-run decision making purposes. For example, a model depicting the effect of fish population (stock) on yield will require a more complicated dynamic approach than a production model that is attempting to depict the effect of factors (labor and capital) on yield in the short-run (Carlson, 1973; Carlson, Bell and Waugh, 1973; Huang and Lee, 1976 and 197). Aside from these differences, the production model for the fishery has been generally specified as:

$$Y = f(E,H,D), \qquad (2)$$

where:

Y = Yield (catch or landing of fish for a period),

E = Biological factors determining the size and growth of fish stocks for periods under consideration,

D = Dummy variables representing seasonal variations, location of the particular fishing zone, etc.

Fishing effort generally is estimated as a product of fishing power (an index constructed to measure variability in capital and other capital related inputs used in fishing) and the total fishing time spent. Hence, fishing effort is a composite input constructed by combining capital, labor and fishing time. A major draw-back of using fishing effort as a composite input is that one cannot explicitly separate the effects of capital and labor on yield or the trade-off between capital and labor which would be possible if the production model in (1) were used.[1]

There are, however, legitimate reasons why researchers often express fishing effort as a composite input. Some of the major reasons are: a) lack of reliable data on the individual components of fishing effort; b) difficulties measuring capital in some standard unit when faced with an industry which is heterogeneous in its capital employment; and c) to avoid

estimation problems, especially multicollinearity when the stated objective of the study does not require the individual effort of capital and labor and their trade-off.

Finally, in multispecies fisheries the specification of the output variables (yield) can be as problematic as the specifications of the input variables. So long as considerable differences exist in the expected prices among the various species of fish caught at any given time, it is conceptually difficult to justify the catch measured in physical units as a measure of the yield. This problem has been indirectly resolved by converting the physical output (yield) into revenue (yield x price). Even through this approach is justified in some instances, the problem of specifying output in a multi-species fishery will not be satisfactorily resolved until we find a way to determine the allocation of fishing effort (in whatever way it is defined) among species.

II. Estimation of Short-Run Firm Production and Revenue Functions

Using the approaches outlined above, the production and revenue functions of the artisanal fishery in the Gulf of Nicoya are estimated. Functions (1) and (2) are fitted for the following Cobb-Douglas functional forms using the Ordinary Least Squares (OLS):

$$Y_{ij} = \beta_{jo} \tau_{ij1}^{\beta_{j1}} e^{\beta_{j2} S_{ij2}} e^{\sum_{k=4}^{K} \beta_{jk} Z_{ijk}} \varepsilon_{ij} \qquad (3)$$

$$Y_{ij} = \alpha_{jo} L_{iji}^{\alpha_{ji}} T_{ij2}^{\alpha_{j2}} e^{\alpha_{j3} S_{ij3}} e^{\sum_{v=5}^{V} \alpha_{jv} Z_{ijv}} U_{ij} \qquad (4)$$

where:

$i = 1, \ldots, n_j$, fishing trips sampled from a gear type j

$j =$ 1-Hand, 2-Long Line, 3-Gill Net

$k = 0, \ldots, K$; the independent variables including the intercept term in Model (3),

$v = 0, \ldots, V$; the independent variables including the intercept term in Model (4),

e = Euler constant or base of Napierian logarithm,

Y_{ij} = Yield (landings) in pounds for the ith trip by gear type j,

τ_{ij} = Effort or total labor hours spent for the ith trip by gear type j,

T_{ij} = Actual time spent fishing during the ith trip by gear type j,

$S_{ij} =$ 1 for wet season, 0 for dry season

Z_{ij} = The zone where fishing took place in the ith trip with gear type j. The Gulf of Nicoya is divided into seven fishing zones following the scheme employed by the fishing biologists (see map in Appendix 1). The fishing zones are represented by dummy variables.

Total revenue functions are estimated in the same manner as the total product functions in (3) and (4), the only difference being the Y_{ij} is replaced by R_{ij} (PxY_{ij}), the total revenue per fishing trip for gear type j. As discussed above, one advantage of fitting the total revenue function is that it implicitly accounts for the variation in species compositions through the introduction of price.

If Qrdinary Least Squares (OLS) is used to estimate the parameters (β_{jk} and α_{jk}), (3) and (4) can be transformed as follows:

$$\ln Y_{ij} = \ln\beta_{jo} + \beta_{j1}\ln\tau_{ij1} + \beta_{j2}S_{ij2} + \sum_{k=4}^{K} \beta_{ij}Z_{ijk} + \ln\varepsilon_{ij} \qquad (3A)$$

$$\ln Y_{ij} = \ln\alpha_{jo} + \alpha_{j1}\ln L_{ij1} + \alpha_{j2}\ln T_{ij2} + \alpha_{j3}S_{ij3} + \sum_{v=5}^{V} \alpha_{jv}Z_{ijv} + \ln U_{ij} \qquad (4A)$$

The β_{jk} and α_{jv} are the unknown parameters and $\ln\varepsilon_{ij}$ and $\ln_{ij}$ are are independtly distributed disturbances with mean one and variance $\sigma 2$ and $\sigma^2_{\ln U}$, respectively, where ln is the natural logarithmic function.

Since the specifications in (3) and (4) have multiplicative errors, the (OLS) etimators of β_{j1}, ..., β_{jk} and α_{j1} are the best linear unbiased estimators (Goldberger, 1964, 1968; Gildfield and Quandt, 1970; Kelejian, 1972).

However, because $E(\ln\varepsilon_{ij}) \leq (\ln E(\varepsilon_{ij}) = 0$, the OLS estimator of $\ln\beta_{jo}$ is biased. The expected value of $\ln\beta_{jo}$ under the present setting will be $[\ln\beta_{jo} + E(\ln\varepsilon_{ij})]$. The same result holds for $\ln U_{jo}$ and $\ln\alpha_{jo}$ in (4). Hence, unless the $E(\ln\varepsilon_{ij})$ and $E(\ln U_{ij})$ are zero--which we have no reason to expect--the estimators of $\ln\beta_{jo}$ and $\ln\alpha_{jo}$ ($\ln\beta_{jo}$, $\ln\alpha_{jo}$) using OLS will be biased upward.

If the objective in fitting the above production models is to estimate the coefficients of the independent variables (β_{j1}, ..., β_{jk}; α_{j1}, ..., , α_{jv}), the fact that the estimators of the intercept terms ($\ln\beta_{jo}$, $\ln\alpha_{jo}$) are biased causes no problem. However, if the production models are used to predict total output (Y_{ij}), estimate marginal physical products, or carry out any other analysis that in the process requires the inclusion of the estimated value of the intercept term(s) the bias could cause significant error.

Fortunately, the above problem is not unsurmountable. Goldberger (1964,1968) has developed a method that can be used to estimate the magnitude of the bias of the intercept term. Therefore, once we have a knowledge of the magnitude of the bias, the intercept coefficients estimated using OLS can be adjusted to yield an unbiased estimator.

Limitations. The production models in (3) and (4) are short-run production functions since the fish stock is implicity assumed to be constant. This assumption is necessary because insufficient evidence exists on fish stock abundance in the Gulf. This limitation is not too serious, however, since the production functions under investigation are firm production functions. The functions are fitted using trip data (the catch and the production factors of a firm for a single trip), where a firm is defined as an enterprise consisting of a crew, a fishing vessel and gear of a similar type.

In model (3) effort (τ_j) is defined as actual total labor hours spent in

fishing, i.e., (T x L). This definition of effort is slightly different from the conventional definition of fishing effort in (2) since it does not explicitly incorporate fishing power in the estimation of the effort input. This is possible since the production analysis in this study is performed by gear types, which reduces the degree of heterogeneity in capital within a given gear type. That is, the capital used within a given gear type is expected to be more or less homogeneous; therefore, the index of fishing power is assumed to be close to unity for all firms within a given gear type. While the assumption of homogeneous capital is particularly appropriate for hand liners and long liners, where traditional fishing techniques and strategies prevail, the assumption is difficult to defend in the case of gill-netters. Therefore, an index of fishing power is constructed to account for the variation of capital use among gill netters.

Finally, the production functions are estimated for the three major gear types: hand liners, long line and gill net. This scheme is used to facilitate comparison of the economic activities among gear types and to attain a more accurate specification of the production model.

Results. The total product and the total revenue functions are fitted for each gear type using the estimating procedures outlined in (3a) and (4a) above. The results are presented in Table 4. No major econometric problem was detected to warrant using estimating procedures other than OLS or changing the specification of the models.

As expected, yield (Y_j) and revenue (R_j) are positively correlated with effort (T_j), and the estimated coefficients of effort are highly significant for all the equations fitted. In Table 4, among the six dummy variables representing fishing zones (Z_s; s=2, ..., 7) only those which appeared to be statistically significant in explaining the variation of yield or revenue are reported; for example Z_2 and Z_5 in equation A. In equation A, Z_2 and Z_5 are positively correlated with yield. Hence, one can say that hand liners fishing on these two zones will have a higher yield on the average than those fishermen with the same gear type fishing in the other zones. Similar interpretations apply for all the equations in Table 4 where the variables for fishing zones are reported. Note, none of the zone variables is found to be significant in explaining teh variations of yield or revenue for gill netters. This may be due to the fact that unlike hand liners and long liners, gill netters are relatively mobile, enabling them to travel to the fishing zones that appear to be most lucrative during a given trip. In addition, information collected on fishing locations indicates gill netters operate in a more concentrated area of the Gulf than either the hand liners or the long liners, who fish in almost every corner of the Gulf.

Seasonal variation does not appear to have a significant impact on yield regardless of the type of gear used. However, for the hand liners and gill netters the coefficients of the seasonal variable of their respective total revenue equations are significant at $\alpha = .05$. The significance of the seasonal variable in both instances stems not from seasonal variation attributed to physical production but rather from variations in the prices of the products. As shown in Table 2, the species composition of the fish caught varies among the three gear types, with hand liners and gill netters catching higher priced species than long liners. Also, the prices for the species caught by hand liners and gill netters show higher variability over time than the prices of the species caught by long liners. The negative sign of the coefficient indicates the lower revenue in the wet season, ceteris parabis.

As shown in Table 4, the total product and total revenue equations for the gill netters include a variable (G) to account for variations in fishing power among gill netters. The variable for fishing power (G) is an index constructed using the ratio of the area of the gill net for a given gill netter to the mean value of the area of the gill nets used by all the gill netters in the sample. As expected, this variable is positively correlated

TABLE 4. Estimated Total Production (Y_j) and Total Revenue (R_j) Equations of the Gulf of Nicoya by Gear Types[a]

Gear Types		Constant[c]	Index of Fishing Power (G)[b]	Effort (τ_j)	Fishing Zone (Z_2)	Fishing Zone (Z_4)	Fishing Zone (Z_5)	Season (S_1)	$\bar{R}^2$	F	N
				Total Product							
A	Handline	2.118 (13.292)*	-	0.76614 (10.1753)*	0.4889 (3.5514)*		0.66027 (2.7108)*	0.1655 (-1.25867)	.77	59.5	75
B	Long Line	2.5503 (18.609)*	-	0.76098 (12.9588)*	-	0.2511 (2.546)*	-	0.007879 (0.00643)	.83	80.6	55
C	Gill Net	2.4552 (8.8279)*	0.2655 (2.48135)*	0.74829 (9.16894)*	-	-	-	0.08082 (0.74575)	.45	37.4	139
				Total Revenue							
D	Handline	2.631 (11.428)	-	0.83925 (7.7154)*	0.2576 (2.8936)*	-	0.7779 (2.2107)*	-.3884 (-2.045)*	.67	35.0	75
E	Long Line	2.5467 (14.948)*	-	0.85023 (13.366)*	-	0.2576 (2.333)*	-	0.01795 (0.0844)	.77	58.9	55
F	Gill Net	3.16093 (15.6038)*	0.177522 (1.565)	0.75844 (8.724)*	-	-	-	-0.2123 (-1.8375)**	.41	31.4	139

[a]The "t" values for the regression coefficients are presented in parentheses below their respective regression coefficients. Other statistics for each regression are: the adjusted coefficient of determination ($\bar{R}^2$), the F ratio and the number of observations (N). * and ** imply significance at α=.01 and α=.05, respectively.

[b]"G" represents the index for fishing power.

[c]The estimates of the constant terms for equations A-F when adjusted for the bias are: 2.0914, 2.5266, 2.4165, 2.5631, 2.51, 3.1405, respectively.

with yield, i.e., a gill netter whose index of fishing power is greater than 1.0 (are of gill net greater than the mean value of the area of the gill nets as a group) will on average catch more fish than gill netters with index of fishing power less than 1.0.

Finally, in the analyses to follow, all fitted equations in Table 4 will be used to estimate the expected total, average and marginal products both in physical and value terms. In the process of evaluating the expected total, average and marginal products, it will be necessary to use the estimated value of the constant term. However, as pointed out above, the estimated value of the constant term obtained using OLS is not a BLUE estimator of the population parameter. Therefore, to account for this problem, the constant terms in Table 4 are corrected accordingly for the bias using the scheme developed by Goldberger (1964, 1968). The value of the adjusted coefficients for the equations in Table 4 are: 2.0914; 2.5266; 2.4165; 2.5631; 2.51; 3.1405; respectively. Note, the values of the adjusted coefficients are smaller than their counterpart in Table 4. We would expect this to occur because, as demonstrated earlier, the bias is upward. In estimating the total, average and marginal product both in physical and value terms, the adjusted coefficients for the intercept terms are used.

III. The Marginal Physical and Value Products of Effort

The marginal physical and value products for hand liners, long liners and gill netters are derived from equations A-F in Table 4. Effort in each of the equations is defined as the product of actual time spent fishing with gear in the water and the number of crew who made the trip. Hence, the marginal physical and value products of effort are defined as the increment in total output and total revenue, respectively, resulting from one unit change in total labor hours expended for fishing purposes. To obtain these marginal products we differentiate total output (Y_j) and total revenue (R_j) with respect to effort (τ_j) for the fitted equations A-F in Table 4, holding the other variables constant at their mean values. Using this procedure, a set of marginal physical and value products of effort are generated for each gear type under various levels of effort and the results are in Figure 1 and 2, respectively. In addition, the average physical and value products corresponding to each one of the marginal physical and value products are plotted in Figures 3 and 4, respectively.

As expected, the coefficient of effort (τ_j) is less than 1.0 for all the equations reported in Table 4, which results in declining average and marginal physical and value products as increasing levels of effort inputs are utilized in production activities (Ferguson, 1969, 1972).

The average and marginal physical products for long liners is found to be greater than either the hand liners or the gill netters at given effort levels (Figures 1 and 3). However, since the total product function does not account for differences in species composition one cannot rely on this evidence to suggest that long liners are more productive at the margin than hand liners and gill netters. For comparison purposes the value of average and marginal products are more meaningful than the average and marginal physical products because the price of the product implicitly accounts for the variation in the species composition.

When comparisons are made in terms of value of average and marginal products the results are the reverse of those obtained using the average and marginal physical products (Figures 2 and 4). That is, from Figures 2 and 4 it is clear that for a given level of effort, the value of the average and marginal products of the long liners is less than either the gill netters or the hand liners. This result is expected since hand liners and gill netters on the average catch higher valued species than long liners (Table 2).

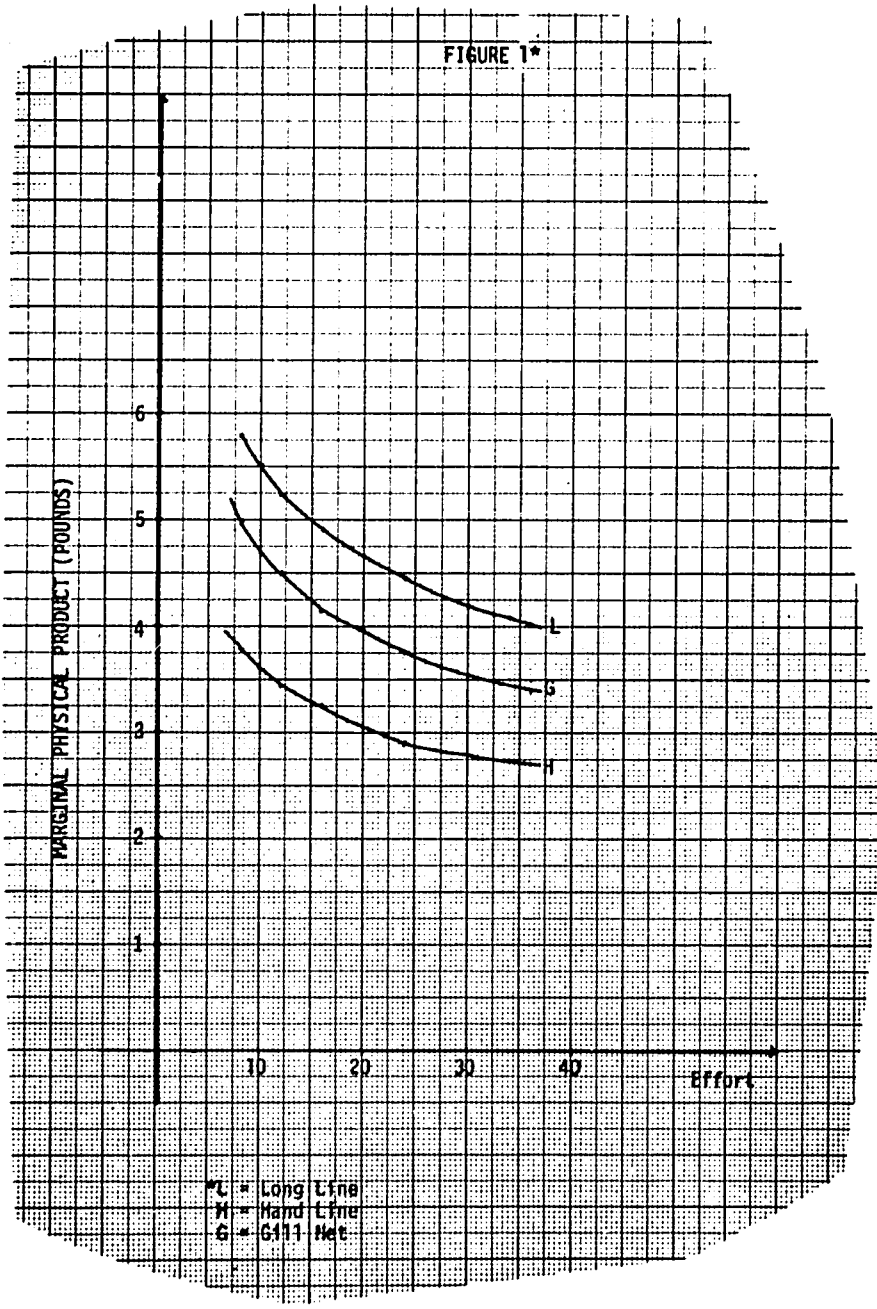


FIGURE 1*
MARGINAL PHYSICAL PRODUCT (POUNDS)
6
5
4
3
2
1
10
20
30
40
Effort
L
G
H
*L = Long Line
H = Hand Line
G = Gill Net

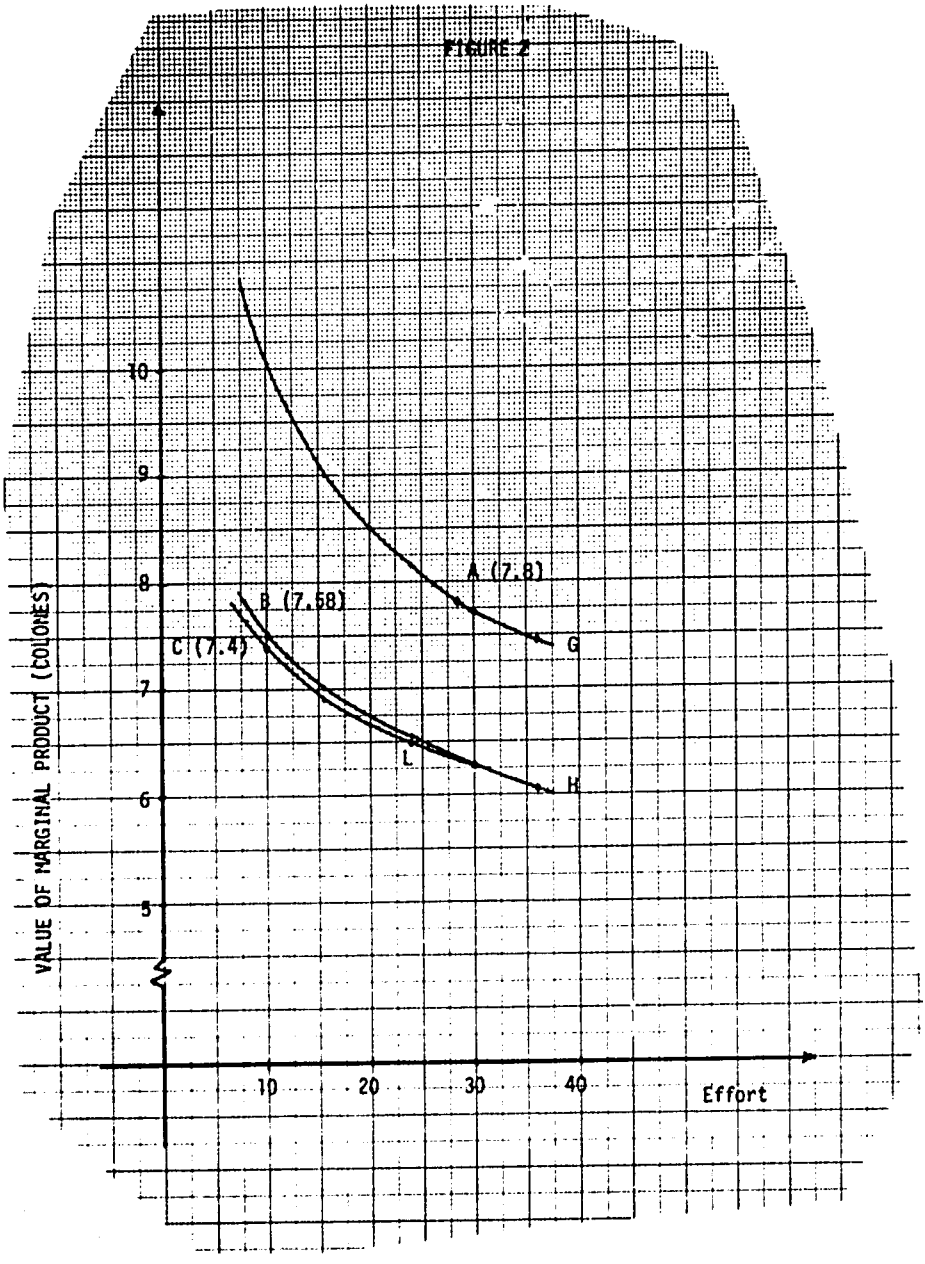


FIGURE 2
VALUE OF MARGINAL PRODUCT (COLONES)
10
9
8
7
6
5
A (7.8)
B (7.58)
C (7.4)
G
L
H
10
20
30
40
Effort

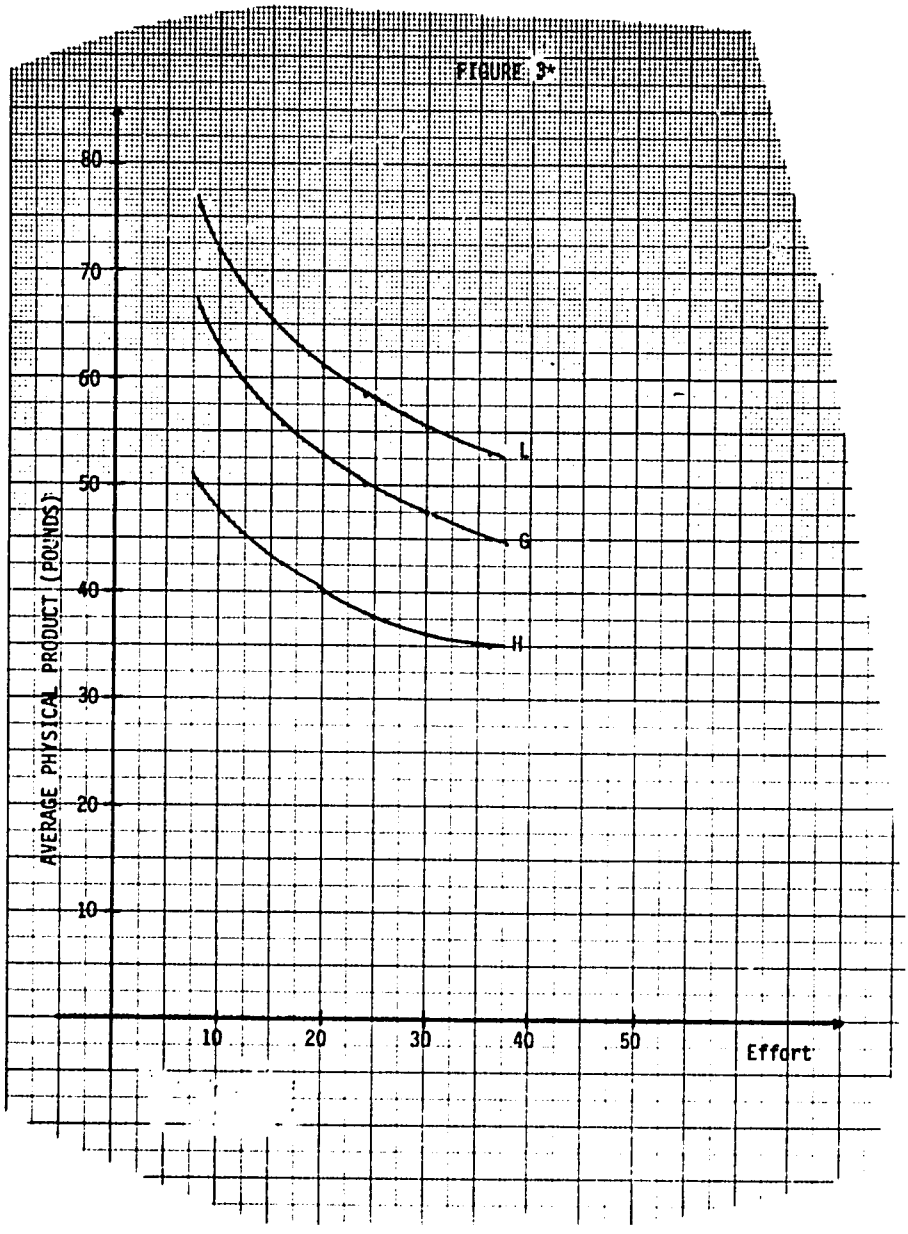
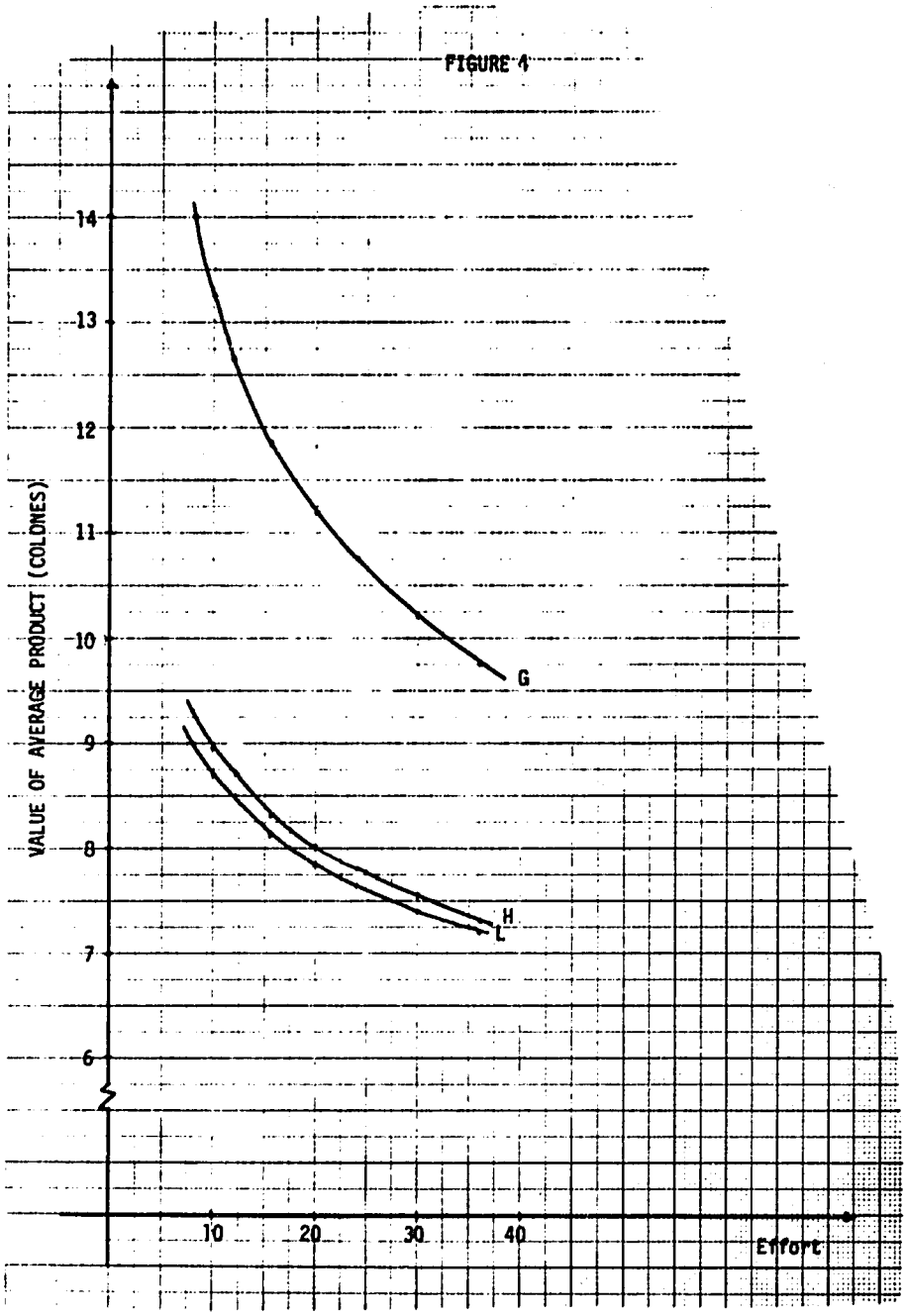


FIGURE 3*
AVERAGE PHYSICAL PRODUCT (POUNDS)
80
70
60
50
40
30
20
10
10
20
30
40
50
Effort
L
G
H

FIGURE 4


VALUE OF AVERAGE PRODUCT (COLONES)
14
13
12
11
10
9
8
7
6
G
H
L
10
20
30
40
Effort

Another point of interest is to compare the value marginal product of effort for each gear type at their respective mean value of production. A rational producer with the intent to maximize his expected return will employ each factor input to the point where its value marginal product is equal to its marginal factor cost (Ferguson, 1964,1972). Moreover, if perfect competition exists in both the product and input markets, economic theory predicts the value marginal product of a given factor input will be equal across all firms in industry utilizing this factor input. If this equality does not hold, efficiency can be increased by reallocating the factor input among firms within the industry.

To see if the allocation of effort is efficient for the artisanal fishery in the Gulf of Nicoya, the value of marginal products of gill netters, hand liners and long liners are evaluated at their mean value of production and the results are shown in Figure 2 as Points A, B, and C respectively. As expected, the difference in the value marginal products are very small indicating that fishing effort on average is allocated efficiently within the fishery.

IV. The Value Marginal Products for Labor

Thus far, effort (τ_j) has been treated as a composite input consisting of fishing time expended per crew and the crew size in a given trip. To evaluate the value marginal product of labor for each gear type, we decompose effort into its component parts and, using the framework developed in (4a), fit the total revenue functions for the three gear types considered in this study. Using the fitted total revenue equations shown in Table 5, we derive the value of the marginal product of labor (crew member) for each gear type by taking the partial derivation of the fitted equations with respect to the labor variable (L), holding the other variables constant.

In Tables 6A-C, Column 1 gives the range of the crew size considered. The crew size is allowed to vary from 1 to 3 because over 90 percent of the sampled data consists of crew sizes 1, 2 or 3 (see Table 3). At the top of columns 2-5 of each Table, four different values of fishing time are considered. The entries in columns 2-5 are the computed value marginal products of labor for various combinations of crew size and fishing time.

The results in Table 6A-C reveal that for a given crew size as the level of fishing time increases the value marginal product of labor increases. To show the impact of fishing time on the marginal productivity of labor more clearly, using the information in Table 6A, four different values of marginal product curves are plotted in Figure 5, each corresponding to the four values of fishing time considered. From this Figure it is clear that as the fishing time increases the value of the marginal product curve shifts upward to the right implying that for any given crew size an increase in fishing time increases the value of the marginal productivity of labor. For example, when fishing time is 5 hours, the value of marginal product for 1 crew member is 49.2 Colones (Point A in Figure 5); however, for the same crew size, as fishing time increases from 5 to 10 hours the value of marginal product of labor rises from 49.2 to 80.8 Colones (Points A and B in Figure 5, respectively), and the value of marginal product of labor continue to increase as we continue to increase the fishing time expended (Points A, B, C and D in Figure 5) without a change in crew size. Even though the results shown in Figure 5 specifically pertain to hand liners (Table 6A), this same property holds for the other two gear types considered in this study.

So far we have shown how a change in fishing time (in absolute terms) affects the value marginal product of labor. However, for policy issues it may be of interest to know the incremental change in the value marginal product of labor for each gear type resulting from a given proportional change in fishing time. In other words, we want to estimate the partial elasticity

TABLE 5. Estimated Revenue Equations for the Gulf of Nicoya by Major Gear Types[a]

Gear Type	Constant[b]	Fishing Power (G)	Actual Fishing Time (T)	Number of Crew (L)	Zone (Z_2)	Zone (Z_4)	Zone (Z_5)	Season (S_1)	F	$\bar{R}^2$
G Hand Line	2.8815 (9.1598)*	-	0.7165 (4.425)*	0.91397 (5.5559)*	0.50991 (2.5185)*	-	0.7085 (2.3647)*	-0.59016 (-2.122)**	35.2	.72
H Long Line	2.495 (13.349)*	-	0.8945 (0.88)*	0.7533 (4.927)*	-	0.26901 (2.397)**	-	0.0188054 (0.08825)	51.3	.81
I Gill Net	3.15314 (10.5924)*	0.1667 (1.4301)	0.730896 (7.01416)	0.86597 (3.68112)*	-	-	-	-0.23087 (-1.89395)	23.5	.41

[a]Note that the only difference between the three total revenue functions fitted above and their counterparts in equations D, E, and F, in Table 4 respectively lies on the way the variable effort is treated in the model. That is, in equation D, E and F (Table 4), the total revenue equations are fitted treating effort (τ_j) as a composite input, whereas, in equations G, H and I above, the total revenue equations are fitted by decomposing effort into its component parts; namely, fishing time (T), crew size (L) and fishing power (G).

[b]The estimates of the constant terms for equations G-I when adjusted for the bias are: 2.832, 2.4775, 3.1088, respectively.

TABLE 6A. Value of Marginal Products of Labor (in Colones) for Hand Liners for Various Combinations of Fishing Time and Crew Size

Crew # \ Fishing Time (Hr)	5	10	15	20
1	49.2	80.8	108.0	132.7
2	46.3	76.1	101.7	125.0
3	44.7	73.5	98.2	120.7

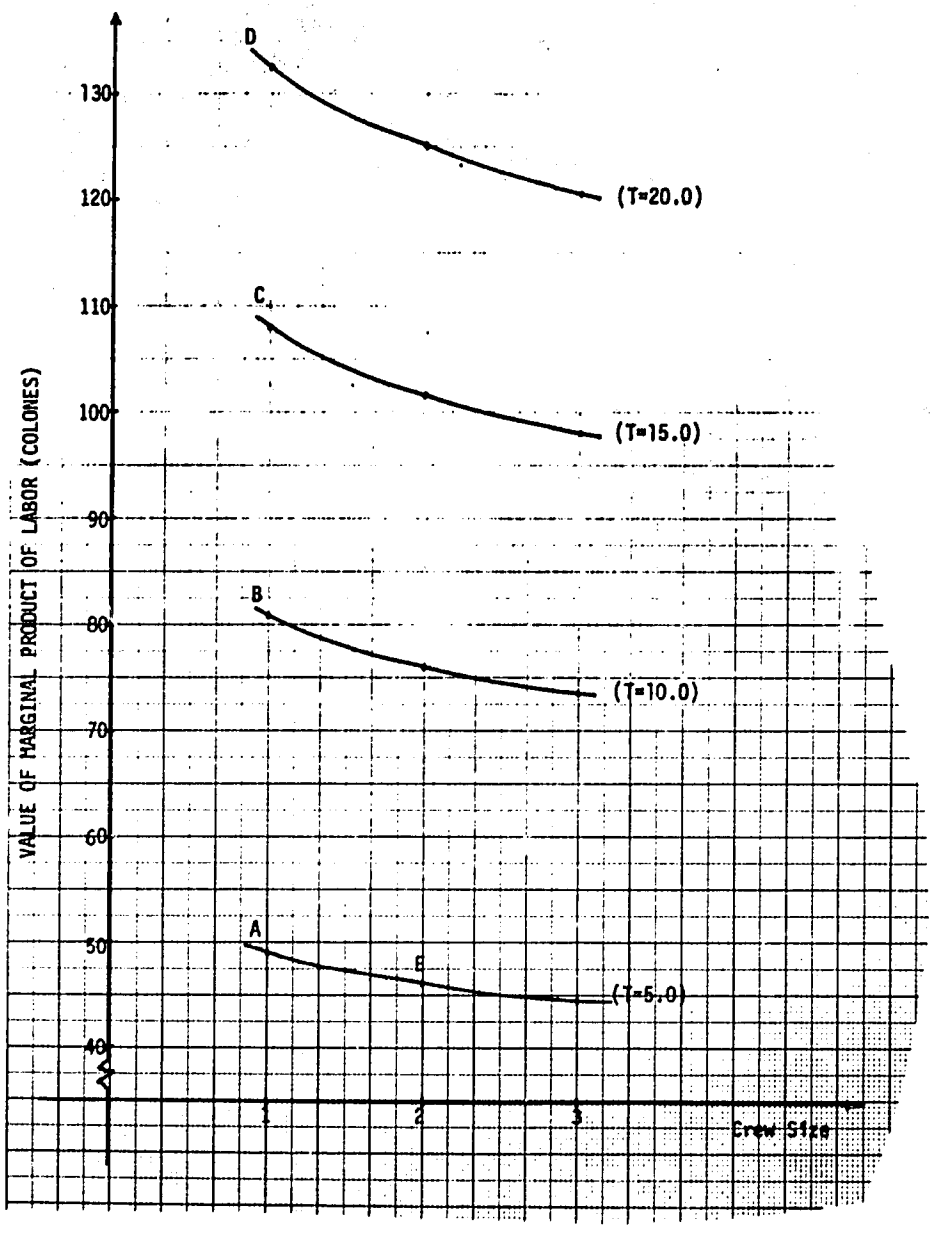
TABLE 6B. Value of Marginal Product of Labor (in Colones) for Long Liners for Various Combinations of Fishing Time and Crew Size

Crew # \ Fishing Time (Hr)	5	10	15	20
1	37.9	70.4	101.2	130.8
2	31.9	59.3	85.25	110.2
3	28.9	53.6	77.15	99.75

TABLE 6C. Value of Marginal Products of Labor (in Colones for Gill Netters for Various Combinations of Fishing Time and Crew Size

Crew # \ Fishing Time (Hr)	5	10	15	20
1	62.9	104.4	140.3	173.1
2	57.3	95.1	127.9	157.75
3	54.3	90.1	121.1	149.4

FIGURE 5


D
C
B
A
E
(T=20.0)
(T=15.0)
(T=10.0)
(T=5.0)
130
120
110
100
90
80
70
60
50
40
1
2
3
Crew Size
VALUE OF MARGINAL PRODUCT OF LABOR (COLONES)

of the value marginal product of labor with respect to fishing time. It can be shown that for the type of production function used in this study, the partial elasticity of the value marginal product of labor with respect to fishing time is equal to the estimated value of the coefficient of fishing time (T).[2] Hence, we can conclude that a one percent change in fishing time will increase the value marginal product of labor by .71, .89, and .73 percent for the hand liners, long liners, and gill netters, respectively. These results can also be verified using the information in Tables 6A-6C. For example, in Table 6B, the value marginal product for labor with one crew member and fifteen hours is 101.2 Colones for the same crew size increasing the fishing time from fifteen hours to twenty hours (a 33% increase) the value marginal product rises from 101.2 to 130.8 Colones (a 29% increase). In other words, a one percent increase in fishing time will increase the value marginal product of labor by 0.88 percent (29%/33%). Note the percentage increment of the value marginal product of labor from the above result (.88) is approximately equal to the coefficient of fishing time (T) for long liners (.8945). The small difference in these two estimates arises because in estimating the elasticity of the value marginal product of labor from the information in Table 6B we are using arc elasticity as opposed to point elasticity. The above result implies that, in general, the increment in the value of marginal product of labor resulting from a given percentage increase in fishing time will be greater for long liners than either the hand liners of the gill netters.

Thus far, we have established the effect of changes in fishing time (T) on the value marginal products of labor for each gear type in both absolute and relative terms. The next logical step is to find the effect of changes in the size of crew (L) on the value marginal products of labor for each gear type considered. For example, in Figure 5 the value marginal product of labor is 49.2 Colones when the crew size is 1.0 (Point A); and when the crew size is increased from 1 to 2 the absolute value marginal product of labor decreases from 49.2 to 46.3 Colones (Point E). Again, since the coefficient of the labor variable (L) is less than 1.0 for all the equations in Table 5, the property of diminishing marginal productivity of labor holds for all gear types. It can be shown that the partial elasticity of the value marginal product of labor with respect to crew size is equal to one minus the estimated coefficient of the crew size variable (L).[3] With the estimated coefficients of the crew size variable (L) for hand liners, long liners, and gill netters being 0.91, 0.75 and 0.87, respectively (see Table 5), the estimate of the point elasticities of the value marginal products of labor with respect to crew size for the hand liners, long liners and gill netters are -.09, -.25 and -.13, respectively. Therefore, increasing the crew size by one percent will decrease the value of the marginal product of labor of hand liners, long liners and gill netters by .09, .25 and .13 percent, respectively. (Again, these results can be verified using the information in Tables 6A-6C.) In addition, the above results suggest that decreasing the crew size will benefit the long liners and the gill netters more than the hand liners.

To compare the marginal products of labor among gear types the value marginal product curves are plotted in Figure 6, each corresponding to the gear types considered in this paper. From Figure 6 it is evident that, for any given crew size, the value marginal product of labor is higher for gill netters than hand liners or long liners. This result is consistent with the (casually) observed higher capital-labor ratio for the gill netters. However, the reason for the inefficiency of the long liners relative to the hand liners is not quite clear even though the analysis thus far indicates that the value of the marginal product of labor for long liners can be augmented substantially, relative to other gear types, by either decreasing their crew size or increasing their fishing time. If such is the case, the inefficieny of the long liners relative to the hand liners can be attributed in part to either excess crew size or inefficient utilization of fishing time. Note the

value marginal product curves in Figure 6 are drawn fixing the fishing time at 10 hours. The choice of 10 hours for fishing time is arbitrary and used for illustrative purposes. Similar results are shown to hold (Figure 7) when the value marginal product of labor is estimated using fishing time that is most commonly used (i.e., the mode) for a given gear type.

V. Summary and Conclusions

This chapter reports on our attempt to fit production and revenue functions for the three principal types of firms in the small-scale fishery of the Gulf of Nicoya, Costa Rica. The estimated Cobb-Douglas production and revenue functions provide estimates of average and marginal (physical and value) products for labor and fishing time by firm types. Similar estimates were obtained for an effort input, defined as a composite of labor and fishing time.

Using the estimates of the average and marginal (physical and value) products of effort, comparisons were made on the operational characteristics of the three major gear types. As expected, the average and marginal (physical and value) products decline as effort tends to increase regardless of the gear type under consideration and in each case the average products exceed the marginal products. In addition, at any given level of effort the value marginal average products of gill netters are higher than hand liners and long liners. This result is consistent with the observed higher capital-labor ratio of gill netters. The estimated value marginal product of effort for hand liners is found to be greater than the long liners up to a certain level of effort; beyond that level the difference in the estimated value marginal products of effort disappears. This finding implies that, at least for a certain range of effort, hand liners are more productive at the margin than the long liners. This same result is also evident when the value marginal product of labor for hand liners is compared with the value marginal product of labor for long liners. The reason for the lower efficiency of long liners appears to be due to either excess crew size or inefficient utilization of fishing time.

Aside from the above differences in the relative productivity among the firms considered, it is found that at mean levels of input utilization the marginal value products of effort have approximately the same magnitude for all firm types, indicating resources on the average are efficiency utilized in the fishery.

A principal objective of this study was to test the usefulness of the economic survey data. We can conclude that while the survey may have been imperfect in many respects it provided data that bears up well under intensive econometric analysis. The production function estimated also should be useful for planning purposes. For example, the estimated value marginal products may be used as shadow prices when evaluating and designing fisheries development projects.

The study is not without its shortcomings, however. A major limitation is the short-run nature of the functions fitted, where the stocks of capital and fishery resources are assumed constant. Further analysis is required before we can obtain productivity measures of capital, and additional information must be generated before changes in the fish stocks can be adequately accounted for.

FOOTNOTES

[1]Note that the only difference between (1) and (2) is the way effort is defined. In (1) effort is decomposed into its separate component parts whereas in (2) effort is treated as a composite input.

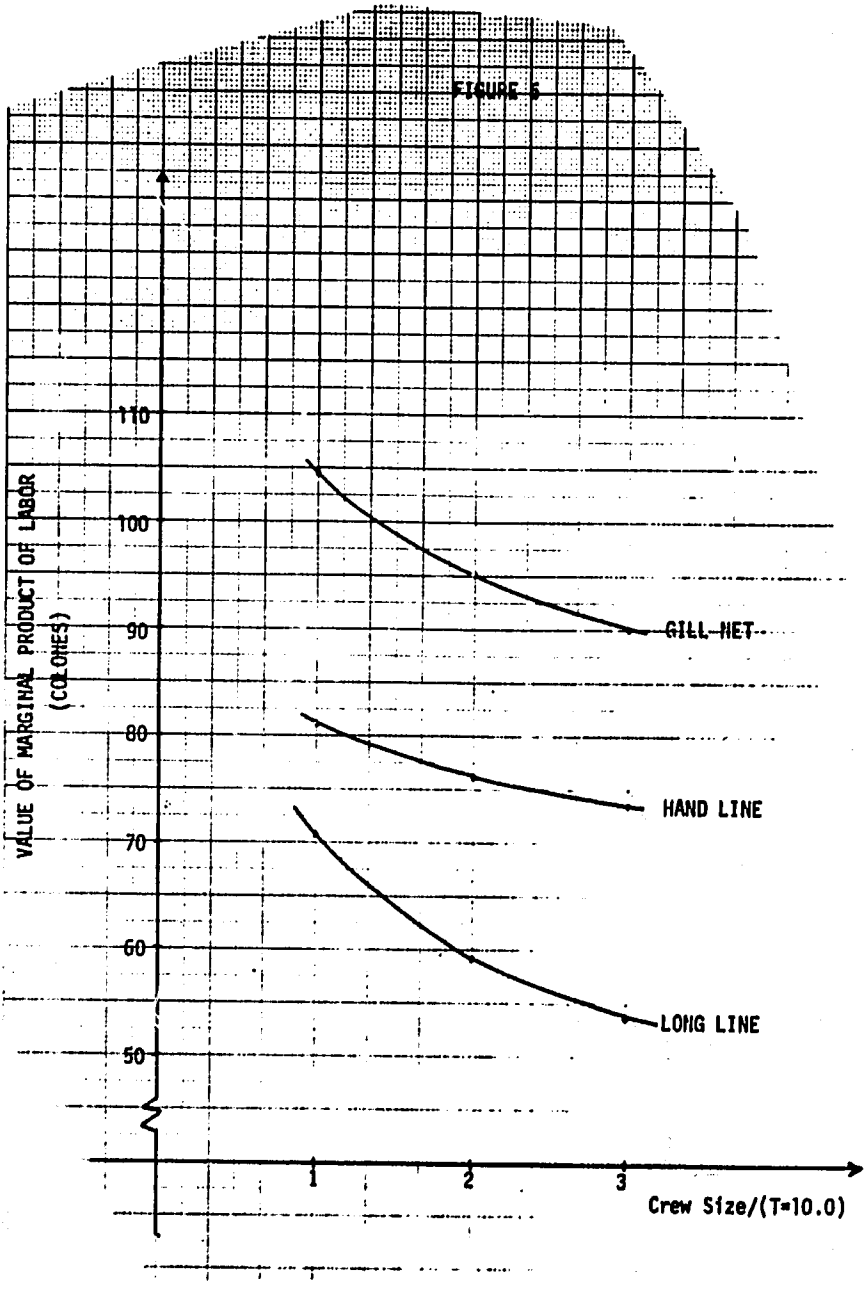


FIGURE 5
VALUE OF MARGINAL PRODUCT OF LABOR
(COLONES)
110
100
90
80
70
60
50
GILL NET
HAND LINE
LONG LINE
1
2
3
Crew Size/(T=10.0)

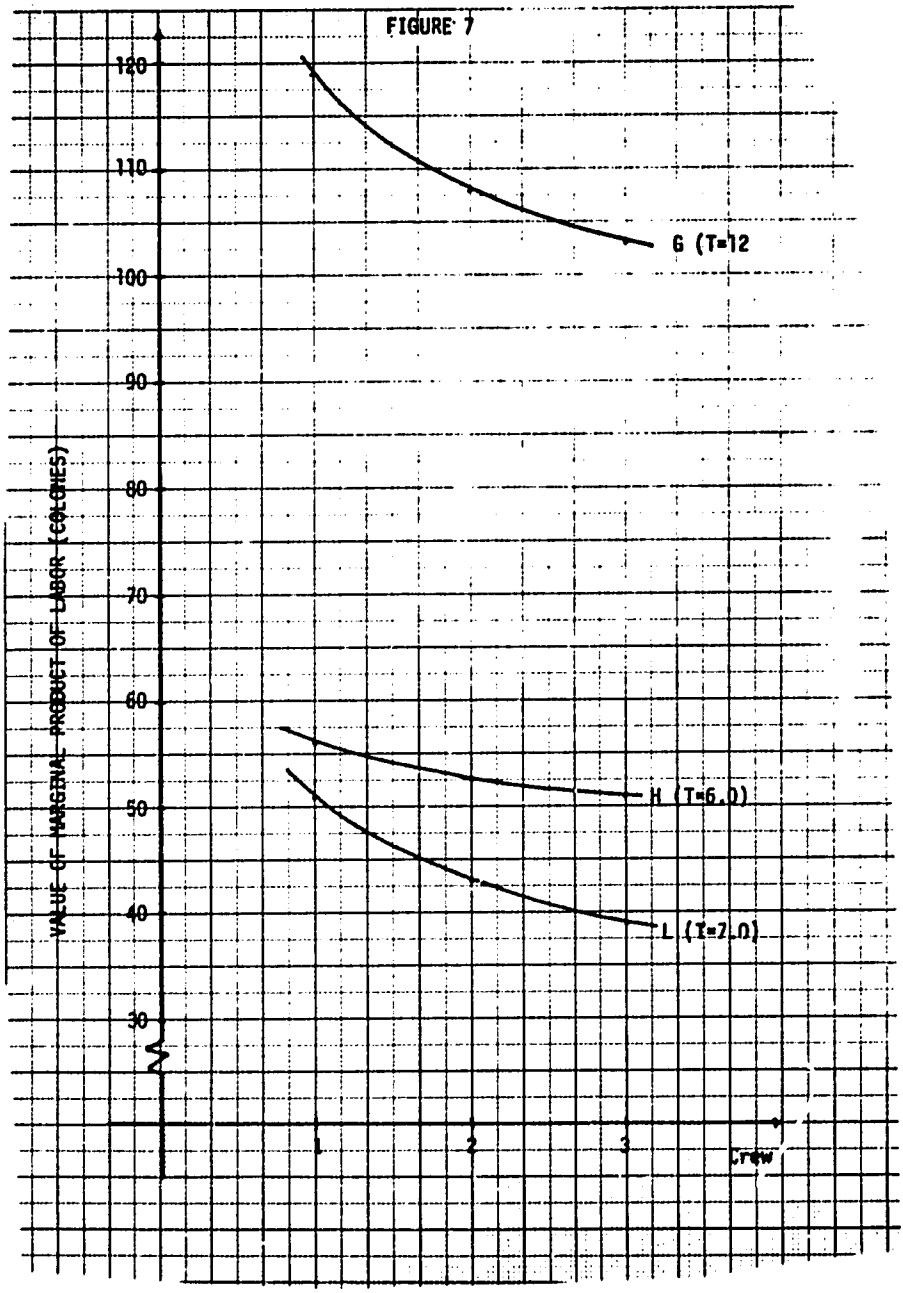


FIGURE 7
120
110
100
90
80
70
60
50
40
30
VALUE OF MARGINAL PRODUCT OF LABOR (COLONES)
G (T=12
H (T=6.0)
L (T=7.0)
1
2
3
Crew

[2]Let, $R = AL^{\alpha_1}T^{\alpha_2}$

when, R = Total Revenue

L = Crew size (labor)

T = Fishing time

$$f_R = \frac{\partial R}{\partial L} = A\alpha_1 L^{\alpha_1 - 1}T^{\alpha_2}$$

$$\partial(f_R/\partial T) = A\alpha_1\alpha_2 L^{\alpha_1 - 1}T^{\alpha_2 - 1}$$

Hence, partial elasticity of the value of marginal product of labor with respect to fishing time (T) will be:

$$\frac{\partial(F_R)}{\partial T} \cdot \frac{T}{f_R} = \frac{A\alpha_1\alpha_2 L^{\alpha_1 - 1}T^{\alpha_2 - 1}T}{A\alpha_1 L^{\alpha_1 - 1}T\alpha_2} = \alpha_2$$

[3]Using similar approach as in footnote 2,

$$\frac{\partial(F_R)}{\partial L} \cdot \frac{L}{f_r} = \frac{A\alpha_1(\alpha_1 - 1)L^{\alpha_1 - 2}T^{\alpha_2}L}{A\alpha_1 L^{\alpha_1 - 1}T^{\alpha_2}} = (\alpha_1 - 1)$$

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CHAPTER 13. THE ETHNOICTHYOLOGY OF SMALL-SCALE FISHERMEN OF PUNTARENAS, COSTA RICA: TAXONOMY

BY R.B. Pollnac

It is obvious that it is necessary to understand a given system if one wishes to effect desired changes within it. If human beings compose one of the units within the system, and if their actions are necessary to effect the desired changes, then it is essential to understand their perceptions of affected elements within the system. This is desirable for three reasons: first, it provides information which can be used to structure communications regarding proposed changes in terms of the concepts and structural features used by the target group; second, it permits comparison of target group and change agent perceptions of the target system, thereby enabling identification of potential conflict areas which could result in misunderstandings; third, the change agent's credibility is enhanced if he can relate to the system as it is understood by the target group.

With regard to changes in small-scale fisheries, it is important to note that local fishermen have usually been interacting with the sea for a long time. In their attempts to cope with the sea, they have made inferences from their observations and constructed taxonomies and theories concerning the marine environment and its flora and fauna. This folk science, or ethno-oceanography, is as real and important to the local fisherman as theories concerning ocean systems are to the academic oceanographer. Thus, attempts to communicate information concerning the ocean must take these folk scientific systems into account.

The purpose of this chapter is to present an account of selected aspects of the knowledge system that the small-scale fishermen of the Gulf of Nicoya, Costa Rica have developed concerning marine fish. The chapter examines the local fishermen's system of classifying fish and the criteria used in classification of members of important fish classes. This knowledge system will be referred to as the ethnoicthyology (ethno-local people; icthyology-science of fish) of the small-scale fishermen (Morrill, 1967).

I. Sample and Methods

Data for the study were collected from small-scale fishermen living in Barrio el Carmen, Puntarenas, Costa Rica.

Data for the taxonomy were elicited by requesting four knowledgeable informants to report all the different names of fish they knew. These lists were checked and expanded by ten additional informants. Four key informants were used to subcategorize the listed fish into taxa at different levels of inclusion (Frake, 1964).

Paired comparisons and triadic sorts were used to determine classificatory criteria and the structure of subsets of the domain (Pollnac, 1975a,b). Two knowledgeable small-scale fishermen participated in the paired comparison of types of corvina and shark. A sample of 50 small-scale fishermen responded to a triadic sort procedure involving a subsample of the most important types of corvina. In this procedure six of the most important types of corvina were arranged into all of the possible triadic combinations (20), and each informant was requested to select from each triad the type of corvina which he considered the most different and tell why it was the most different.

II. Analysis

Folk Taxonomy. The named fish types known to the small-scale fishermen of Puntarenas along with their folk taxonomic organization can be found in Figure

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1. The list includes 122 different categories of named fish which are further subcategorized into eight named categories and a residual large "other" category. The "other" category may be further subcategorizable, but further categories were not evident to the informants, and therefore, probably not very salient among this group of fishermen.

Several observations can be made concerning the folk taxonomy in Figure 1. First, although shark (tiburon) and rays do not have scales, the informants insisted that they were a type of pescado escama (scaled fish).[1] These same fishermen did not claim that a shark or ray has scales; thus, pescado escama is simply a name for the domain we are dealing with, not a descriptive name. Second, it will be noted that there are a relatively large number of different types of corvina, pargo (snapper), and tiburon (shark). These are important groups of fish among the fishermen in Puntarenas. Third, as can be seen in Figure 1, two different types of fish are referred to as corvina coliamarilla. One is the commonly caught large, yellow-tailed corvina (Cynoscion stolzmanni) and the other only grows up to one pound and has a big spine in the anal fin (tentatively identified as Bairdiella sp.). It is also interesting to note that one variety of corvina (Cynoscion albus) can be referred to by two different names--reina or chola--depending on the stage in the growth cycle. Chola is a large reina.

Dyadic Comparisons. Dyadic comparisons were conducted for two important categories of fish: corvina and shark. They were also conducted for three superordinate cateogries: corvina, pargo, and cuminate. Eleven of the fifteen named varieties of fish locally categorized as corvina were arranged into all possible dyadic combinations and the informants were asked how each member of each pair was different from the other member of the pair. The responses to the 55 possible dyadic combinations of the 11 types of corvina are summarized in Table 1.

Although the characteristics listed in Table 1 may not be used by biologists to classify the corvina, they are derived from responses made by Puntarenas small-scale fishermen and probably represent the key they use in identifying the various types of corvina. In other words, the characteristics are those which are salient to the local fishermen.

Size is rank ordered in Table 1. Scale thickness approached a rank ordering, but there was some disagreement. Thick scales, however, was noted by all as a salient characteristic of agria. In a true componential analysis, "large eyes" and "small eyes" would have been one component probably labeled "large eyes" with ojona (ojo = eye) given a "plus" and guavina a "minus" (Tyler, 1969). The same principle would probably apply to the "round head" and "flat head" characteristics. The characteristics were kept separate in this analysis, however, for clarity of presentation. The same type of comments apply to Table 2 which lists the defining characteristics of eleven types of shark. As in the previous discussion, these characteristics were derived from the responses to the 55 dyadic combinations of the eleven shark types.

The analysis of the dyadic comparisons between the superordinate categories corvina, pargo (snapper) and cuminate (catfish) indicate that in terms of maximum size of largest varieties caught out of Puntarenas and scale size, pargo is the largest, cuminate second, and corvina third. Comparing pargo and corvina, the informants note that the flavor is "different," pargo has harder meat, larger more open ribs, and a larger but thinner head. Concerning the pair corvina and cuminate, the meat of cuminate is reported as having less flavor. Cuminate are also reported as having harder and flatter heads, three big spines, and are very slippery. The responses to the cuminate-pargo dyad resulted, once again, in cuminate being ranked as less flavorful and more slippery. Pargo are noted as having a larger head and eyes than cuminate.

Triadic Sort. The triadic sort technique is used only on corvina. Basically the triadic sort is a technique used to determine the relative

PESCADO ESCAMA

- CORVINA
  - reina (chola)
  - collamarilla
  - china
  - cholesca
  - cinchada
  - zorra
  - guavina
  - agria
  - aguada
  - aguada ojona
  - picuda
  - rayada
  - nata
  - trompilla
  - colimarilla[2]
- PARGO
  - rojo
  - roquero
  - salmonete
  - estrella
  - seda
  - de la mancha
  - negro
  - blanco
  - jilguero
  - guacamayo
  - palmito
- TIBURON
  - torpedo
  - espada
  - gata
  - aleta negra
  - picudo
  - barroso
  - cornuda
  - martillo
  - bahia
  - mamon
  - tigre
  - sardo
  - paleta
  - amarilla
- RAYA
  - guitarra
  - raya
  - zopilota
  - gavilina
  - tembladera
  - manta
- CUMINATE
  - blanco
  - negro
  - volador
  - alguacil
  - colorado
  - bagre
  - gallina
- LISA
  - hedionda
  - real
  - palmera
- ANGUILA
  - anguila
  - cobra
  - morena
- JURELES
  - pampano
  - sierra
  - palometa
  - palometa de pluma
  - jurel
  - jurel ojon
  - bonito
  - bananito
  - platanillo
  - hojaran
  - come tierra
  - pinuelero
  - chopa
- OTHERS
  - mano de piedra
  - guataje
  - robalo
  - lulo
  - roncador
  - vieja
  - catecismo
  - salema
  - frijolillo
  - pez bandera
  - pez cotongo
  - pez chanco
  - pez hoja
  - pez lenguado
  - pez perro
  - congrio
  - gorrion
  - timboril
  - erizo
  - timboril chayota
  - hojaran
  - dorado
  - skipjack (barrilete)
  - macabi
  - sabalo
  - loro
  - mero
  - cabrilla
  - cabrilla profundidad
  - manta
  - cabro
  - merluza
  - palmito
  - macarela
  - berrugate
  - aguja
  - aguja palmera

OTHERS (Contd.)

- gallo
- guaju
- pez estrella
- remora
- calte
- pez jabon
- chupa piedra
- yorotei
- garrobo
- cinta
- machete
- vela
- merlin

Figure 1. Punateranas' Fishermen's Taxonomy of Marine Fish.

TABLE 1. Defining Characteristics of Eleven Varities of Corvina Abstracted from Dyadic Comparisons

	Type of Corvina										
Characteristic	Reina	Coliamarilla	Cholesca	Cinchada	Zorra	Guavina	Agria	Aguada	Picuda	Rayada	Ojona
Size*	8	7	1	3	3	3	6	5	4	3	2
Thick Scales							x				
Yellowish	x			x		x		x			
Silver								x	x	x	x
Golden							x				
Black			x		x						
3 Black Stripes Across				x							
Stripes Along Body										x	
Yellow Tail		x									
Chata** Mouth			x								
Small Downturned Mouth					x						
Pointed Jaw									x		
Elongated Jaw								x			
Large Eyes											x
Small Eyes						x					
Flat Head					x						
Round Head						x					
Wrinkled Head						x					
Round									x		
Two Barbs					x						
Soft								x			
From the Deep										x	

*Rank order ** "bonnet shaped"

TABLE 2. Defining Characteristics of Eleven Varieties of tiburon (Shark) Abstracted from Dyadic Comparisons

	Type of Shark										
Characteristic	Gata	Espada	Torpedo	Aleta Negra	Tigre	Mamón	Bahía	Martillo	Barrosa	Picudo	Cornuda
Dark Grey				x				x			
Grey					x				x	x	x
Very Light Grey			x								
Ash Colored Cenizo							x				
Yellowish Brown		x				x					
Cafe Claro (Light Coffee)	x										
Black Stripes					x						
Black Fin Tips				x							
Black Spot on Nose			x								
Yellow-Brown Tail	x										
Dark Meat								x			
White Meat											x
Rounded Hammerhead											x
Rectangular Hammerhead								x			
Round Head							x				
Pointed Nose			x			x				x	
Bonnet Nose (Ñato)					x		x		x		
Comb (Peine) Sawfish Bill		x									
Small Eyes	x							x			
Large Eyes		x									x
Small Mouth				x							
No Teeth						x					
Fine Teeth in Mouth	x	x		x							
Flattened Body (Aplastado)								x			x
Elongated Body					x	x					
Thick Skin	x										
From the Deep						x					
Size	3	7	2	2	8	1	4	6	4	2	5

*Rank order

similarity in meaning among the members of a set of terms. All possible triadic combinations of the set of terms are formed and the respondent is requested to select from each triad the term most different in meaning. The two remaining terms are the most similar in the triad. The total number of times each possible pair of terms is classified as the most alike is calculated, resulting in a measure of the relative similarity of the terms.

In this study, all possible triads were formed of six locally recognized corvina types, resulting in 20 triads. Corvina type similarity matrices were calculated for each individual, and reasons for the various sorts were content analyzed. The mean similarity matrix for the entire sample can be found in Table 3.

The similarity coefficients presented in Table 3 were scaled by dividing by a constant resulting in a figure which varies between zero and one, with one indicating a maximum similarity (equivalence) and zero a maximum distance. According to the results of the triadic sort technique, the local fishermen, on the average, perceive chola and zorra as the most unlike and agria and picuda as the most similar pairs within the set of six corvina types. An average link cluster analysis of the values in Table 2 provides a clearer representation of the perceived relationships between the six corvina types (see Figure 2).

Turning to rationales for the triadic sorts, the distribution of the various reasons provided for the 20 sorts can be found in Table 4.

The values presented in Table 4 indicate that weight/size and color are the most frequently mentioned rationales provided for the triadic sorts. There is a large gap between these two categories and taste, value, form, and scale size, the categories which come in next most frequently. The width/-thickness and class (marketing categories, first, second class, etc.) manifest relatively low frequencies. Categories mentioned but not entered in the table (e.g., soft, noise made, rot resistance) manifest very low frequencies and were used by only one individual each.

One thing that is evident in Table 4 is that there is a fair amount of variability with respect to the rationales used in the sorts. This type of variability in reasons for selecting the most different members of a triad can also result in variability in similarity matrices resulting from triad sorts. An examination of the standard deviations and maximum/minimum values for the cells in the corvina similarity matrix indicates that there is a fair amount of variability in individual similarity matrices also. It would be interesting and informative to determine the interrelationships between the variance in the similarity coefficients and the frequency of use of the various rationales for sorting. These two variable sets were intercorrelated using canonical correlation, and the results of the analysis can be found in Table 5.

In the analysis presented in Table 5, the triad sort rationale variable set (e.g., weight/size, color, etc.) is conceptualized as the independent variable, and the triad sort derived similarity coefficients as the dependent. The analysis indicates that there is a statistically significant relationship between the two variable sets. The first canonical variate is significant at better than the .001 level and the second at 0.03. The canonical correlations are .93 and .84 respectively.

The canonical variable loadings in Table 5 (the columns) can be interpreted as correlations with the canonical variate (Levine, 1977). For example, within the independent variable set, taste has the highest correlation with the first canonical variate. In turn, the canonical variates can be viewed as factors of the variable sets. Percent of trace for a given variable set is the sum of the squared elements of a column of canonical variable loadings divided by the number of variables in the set, and is therefore the proportion of a set's variance associated with each canonical variate (Levine, 1977). The redundancy coefficient is not symmetrical and is interpreted as the amount of variance in the dependent variable set trace

TABLE 3. Mean Similarity Matrix (Scaled) for *Corvina* Types

	Chola	Collamarilla	Aguada	Agria	Picuda	Zorra
Chola	1.00					
Collamarilla	.23	1.00				
Aguada	.25	.42	1.00			
Agria	.34	.27	.48	1.00		
Picuda	.19	.44	.97	.62	1.00	
Zorra	.17	.36	.61	.57	.54	1.00

N = 50

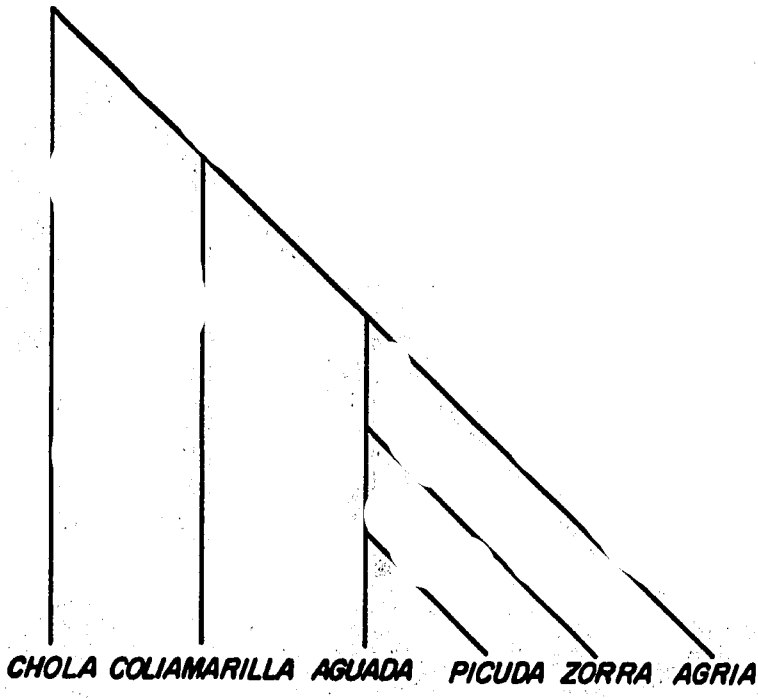

Figure 2. Average link cluster analysis of Corvina type similarity matrix.

TABLE 4. Distribution of Rationales for Triadic Sorts on *Corvina* Types

Categorized Rationale	Mean Number of Times Used	Standard Deviation	Maximum	Minimum
weight/size	9.1	5.4	19	0
color	8.2	5.6	19	0
form	1.7	2.5	12	0
width/thickness	0.4	0.7	3	0
taste	1.9	4.5	20	0
scale size	1.4	2.8	11	0
class	0.4	1.4	8	0
value	1.8	3.7	19	0

N = 50

TABLE 5. Canonical Analysis of Relationship Between Triad Sort Rationales and Similarity Coefficients

Variables	Canonical Variates I	Canonical Variates II
weight/size	-0.12	0.89
color	-0.64	-0.52
form	-0.15	-0.18
width/thickness	-0.14	0.19
taste	0.72	-0.17
scale size	-0.26	-0.08
class	0.20	-0.33
value	0.48	-0.07
Percent of trace	16.5	16.0
chola-coliamarilla	-0.16	-0.29
chola-aguada	-0.16	-0.46
chola-agria	-0.08	-0.51
chola-picuda	-0.21	-0.44
chola-zorra	0.48	-0.37
coliamarilla-aguada	-0.32	-0.20
coliamarilla-agria	0.14	-0.01
coliamarilla-picuda	-0.22	-0.09
coliamarilla-zorra	0.35	-0.36
aguada-agria	0.17	0.52
aguada-picuda	-0.60	0.60
aguada-zorra	-0.01	0.47
agria-picuda	0.08	0.12
agria-zorra	0.70	0.24
picuda-zorra	-0.09	0.36
Percent of trace	10.1	14.1
Redundancy coefficient	.087	.099
R_c	0.93	0.84
p	<.001	.03

N = 50

accounted for by the independent variable set canonical variate (Levine, 1977). Thus, in the analysis presented here, 8.7 percent of the variance in the dependent variable set trace (the similarity coefficients) can be accounted for by the independent variables' first canonical variate, and 9.9 percent by the second, for a total of 18.6 percent. This modest but respectable sum indicates that the criteria used in the sorts do, in fact, influence the similarity matrix derived from the sorts.

The two highest loading independent variables on the first canonical variate are color and taste, but one is high positive and the other high negative. This indicates that those who use color as criteria are less likely to use taste. Turning to the dependent variables (the similarity coefficients) we find that those who use taste as criteria (high positive on the first variate) and tend not to use color (high negative) make sorts that result in higher similarity coefficients for the chola-zorra and agria-zorra dyads. Those who use color, however, tend to make sorts that result in higher similarity coefficient for aguada-picuda (see Table 1; both are "silver"). The zero-order correlations bear out this analysis: the correlations between frequency of use of taste as criteria and the similarity coefficients for the chola-zorra, agria-zorra, and aguada-zorra dyads are 0.60, 0.36, and -0.52, respectively ($p < .01$). Frequency of use of color has a high negative correlation (-0.49; $p < .01$) with the agria-zorra similarity coefficient.

The highest loading independent variables on the second canonical variate are weight/size and color. Once again, the signs of the loadings are opposite indicating that those who use weight/size tend not to use color. Here we find that those who tend to use weight/size and not color make sorts that result in similarity coefficients which are lower for the chola-aguada, chola-agria, and and chola-picuda dyads and higher for the aguada-agria, aguada-picuda, and aguada-zorra dyads. The zero-order correlations also bear out the interpretation of the second canonical variate. Use of weight/size as criteria is negatively correlated with the similarity coefficients between the chola-aguada, chola-agria, and chola-picuda dyads ($r = -0.33$ ($p < .05$), -046 ($p < .01$), and -0.39 ($p < .01$), respectively) and positively correlated with the aguada-agria, aguada-picuda, and aguada-zorra dyads ($r = 0.44$, 0.55, and 0.38, respectively, $p < .01$).

The variance in triad sort data suggests that certain experiential variables may be influencing the perception of the various corvina types (Pollnac, 1975a,b). At this exploratory stage it might be revealing to examine the potential influence of age, education, and years fishing experience on the fishermen's perceptions of corvina. The intercorrelations between age, years of formal education, and years fishing experience and the triad sort variables can be found in Table 6.

The background variables used in the analysis presented in Table 6 are not strongly related to the triad sort variables. In brief, the analysis indicates that those with more fishing experience tend to perceive colimarilla and agria as less similar and picuda and zorra as more similar. Individuals with more education perceive colimarilla and picuda as more similar and see less of a similarity between zorra and both aguada and picuda. Finally, older fishermen perceive zorra as being more similar to both aguada and picuda than do younger fishermen. With respect to the categorized rationales for the triad sorts, Table 6 indicates that younger individuals and those with more education are more likely to use color as a rationale. Finally, those with less education manifest a tendency to use scale size as a triad sort criteria.

III. Summary and Conclusions

The various techniques used were successful in both developing a taxonomy of the fish known by the small-scale fishermen in Puntarenas and in determining the criteria used for classifying several important categories of fish.

TABLE 6. Correlations Between Triad Sort Variables and Background Variables

Triad Sort Variables	Background Variables		
	Age	Education	Fishing Experience
Similarity Coefficients			
chola-coliamarilla	-.20	.12	-.09
chola-aguada	.00	.23	.00
chola-agria	-.23	.01	-.15
chola-picuda	-.18	.09	-.22
chola-zorra	-.06	.05	-.12
coliamarilla-aguada	-.17	.08	-.15
coliamarilla-agria	-.09	.08	-.33*
coliamarilla-picuda	-.12	.27*	-.03
coliamarilla-zorra	.24	-.26	.14
aguada-agria	-.13	.03	-.03
aguada-picuda	-.09	.22	-.02
aguada-zorra	.33*	-.35*	.23
agria-picuda	.03	-.06	.04
agria-zorra	.23	-.09	.14
picuda-zorra	.30*	-.29*	.36*
Categorized Rationale			
weight/size	.08	.10	.00
color	-.38*	.29*	-.14
form	-.21	.15	-.10
width/thickness	.09	.05	.18
taste	.07	-.15	-.06
scale size	.25	-.27*	.16
class	.22	-.15	.25
value	.13	-.08	.07

N = 50 *p <.05

The triad sort technique was used to determine the relative importance of the various classificatory criteria along with the sociocultural correlates of this usage.

Overall, the analysis gives us some data pertinent to understanding what fish are significant to the small-scale fishermen of Puntarenas and how they organize these fish in their minds. One of the basic propositions underlying cognitive anthropology is that naming is one of the most important methods of ordering perception (Tyler, 1969); therefore, the analysis presented here should help us understand how the small-scale fishermen in the Gulf of Nicoya think about the fish in their environment. As pointed out in more detail in the introduction to this chapter, such an understanding is important in designing information systems and enhancing the interaction between the fishermen and others, such as fishery biologists and extension agents, who either interact with or are planning to interact with the small-scale fishermen. For example, if the full complexity and potential abiguity (e.g., two different fish with the same name or one fish with two different names at different sizes) of the local classification system is not understood, then information systems could produce erroneous data. In brief, the symbol systems used by both those who gather and use information and those who provide the information must be the same. The equivalence of such systems is an empirical question which can only be answered by research such as that presented above.

FOOTNOTES

[1]Technically, sharks do have scales (referred to as placoids), but they are quite different from what the non-biologist and the small-scale fishermen from Puntarenas would refer to as a scale (D. Stevenson, personal communication).

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CHAPTER 14. PERCEPTIONS OF THE OCCUPATION OF SMALL-SCALE FISHING
BY R.B. Pollnac and J.J. Poggie, Jr.

Planned development of any sector of an economy will be maximally effective if proposed changes are carried out with an understanding of the target population's attitudes, beliefs, and values towards the affected occupations. Such an understanding may help to explain resistance to change in some instances, and in others, it may facilitate development of programs which best fit the needs of the target group. For example, if development plans involve changes in personnel, knowledge of participant's perceptions of involved occupations can be used to construct relevant recruitment programs. Additionally, development of the industry can be formulated in such a manner that it will reduce perceived negative aspects while enhancing the positive. Finally, if changes involve restructuring certain aspects of the involved sector, worker's perceptions of these aspects can provide some indication of perceived functions which should be accounted for in developmental plans. The three studies in this chapter examine fishermen's perceptions of their occupation in the Gulf of Nicoya and Northwestern Costa Rica.

Study One Small-Scale Fishermen's Perceptions of the Occupation of Fishing in the Gulf of Nicoya, Costa Rica
By R.B. Pollnac

The purpose of this section of the chapter is to examine small-scale fishermen's perceptions of the occupation of fishing in the Gulf of Nicoya. Variance in perceptions of the occupation will be related to other sociocultural variables such as area of residence, ownership of productive equipment, age, years fishing experience, and years of formal education.

I. The Sample

Data for this study are based on interviews with 125 small-scale fishermen from the Gulf of Nicoya, Costa Rica. Part of the sample was drawn from Barrio el Carmen, Puntarenas, and a sample of 50 small-scale fishermen were interviewed at Costa de Pajaros.

Data concerning perceptions of the occupation of fishing were obtained by posing open-ended questions to fishermen concerning what they most and least like about their occupation, whether or not they would like their son to become a fisherman and why, and what they perceive as the qualities that make a good fisherman. Finally, other sociocultural variables such as age, education, years fishing, and area of residence were determined by answers to direct questions.

II. Analysis

Positive Attributes of Fishing. Categories of responses to the question concerning aspects of fishing that small-scale fishermen like most in comparison to other occupations can be found in Table 1.

The most frequent response category refers to the monetary reward of fishing. Many fishermen note that they can make more money by fishing than in any other job available to them. The next most frequent response category was the response that they like everything about fishing. Fishermen who made this response said that there was nothing that they liked best--that they liked everything equally well. The third most frequent response category includes responses referring to positive aspects of the environment such as "being in

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TABLE 1. Percent Distribution of Categorized Responses Reflecting Positive Aspects of the Occupation of Fishing

Category	Percent
Monetary Reward	30
Like Everything	24
Environment	15
Catching Many Fish	11
Peaceful Life	7
Independent	6
Easy Work	2
Other	3
Do Not Know	2

N = 125

the breeze," "away from the noise," "in the pure air," etc. Other response categories manifest relatively low frequencies.

The three most frequent response categories were examined in terms of their relationship to area of residence, vessel ownership, years fishing experience, age, and formal education. Turning first to area of residence, we find that rural fishermen (Costa de Pajaros) are more likely than urban (Puntarenas) to reply that they like most the monetary reward of fishing (40% versus 23%, respectively; $X^2 = 4.325$, $p < .05$). This finding can be explained by the fact that there is more occupational opportunity in the urban area. Additionally, urban fishermen are more involved in the cash economy (Pollnac, 1977); therefore, money is more salient to them. Area of residence is also related to the environmental category. Twenty-three percent of the urban fishermen refer to positive aspects of the environment in contrast to only 4 percent of the rural ($X^2 = 8.109$, $p < .01$). Perhaps, the crowding and noise in the urban environment increases the salience of the quiet and fresh air of the open sea. The other high frequency response category (like everything) is not related to area of residence.

Only one of the three high frequency response categories is significantly related to vessel ownership. Fishermen who own their own boat are more likely to make positive statements about the physical environment than are non-boat owners (21% versus 6%, respectively; $X^2 = 4.842$, $p < .05$). This is a difficult relationship to explain. One possibility is that it takes a relatively high degree of commitment to fishing to become a boat owner, and a positive feeling concerning the environment of fishing contributes to this commitment.

With regard to years fishing experience, age, and formal education, we once again find that of the high frequency categories, only the environmental category is significantly related to these variables. First, fishermen with less experience (less than 10 years: $\bar{X} = 12.2$ years) are more likely than those who have fished longer to respond that what they like most is the physical environment of fishing (26% versus 7%, respectively; $X^2 = 8.978$, $p < .01$). This suggests that the longer one is a fisherman, the more he takes the positive aspects of the environment for granted. This suggestion is somewhat supported by the fact that younger fishermen (less than 30 years of age; $\bar{X} = 30.6$) refer to the positive aspects of the environment more than older fishermen (23% versus 5%, respectively; $X^2 = 7.625$, $p < .01$). Finally, we find that fishermen with 4 or more years of education (sample mean = 3.6 years) are more likely to refer to environmental factors than those with less education (24% versus 5%, respectively; $X^2 = 8.441$, $p < .01$).

Negative Aspects of Fishing. Turning to negative aspects of the occupation of fishing, Table 2 indicates the percent distribution of categorized responses to the question concerning what fishermen like least about their occupation.

As can be seen in Table 2, the most frequently response was that there was nothing that the fishermen dislike about their occupation. The second most frequent response category referred to the lack or loss of fish. Twelve percent of the fishermen made complaints about environmental conditions such as a dislike for bad weather, getting wet, or being exposed to too much sun. Finally, 10 percent noted that what they dislike most about their job was staying up at night. For the most part, net fishermen stay out with their nets overnight. Other response categories manifested relatively low frequencies.

The four most frequent response categories were examined to determine their relationships with area of residence, years fishing experience, age, education, and vessel ownership. Overall, the relationships between these variables and perceptions of negative aspects of fishing were relatively weak. With regard to the most frequent response category, the response that there was nothing that the fisherman disliked about his occupation, we find that it appears to be associated only with vessel ownership. Vessel owners are less likely than non-owners to respond that there is nothing they dislike about

TABLE 2. Percent Distribution of Categorized Responses Reflecting Negative Aspects of the Occupation of Fishing

Category	Percent
Nothing	34
Specific Task	16
Lack of Fish	15
Environment (wind, rain, etc.)	12
Staying up all Night	10
Amount of Work	2
Problems with Equipment	2
Variance in Prices	2
Other	6
Dont' Know	1

N = 125

fishing (23% versus 40%, respectively; X^2 3.986, $p < .05$). It thus appears that boat owners are a little more critical of the occupation. The two next most frequent response categories (environmental factors and lack or loss of fish) manifest no significant relationships with the independent variables. Finally, reference to dislike of a specific task was significantly related only to area of residence. Thirty-six percent of the rural in contrast to three percent of the urban fishermen said that what they dislike about fishing is some specific task such as cleaning fish, bait fishing etc. ($X^2 = 24.802$, $p < .001$). This finding can probably be explained by the fact that in the rural area there is more kin involvement in fishing; e.g., crew members are more often kinsmen (Pollnac, this volume). In this situation, younger kinsmen are more likely to be assigned undesirable jobs than nonkinsmen; thus increasing the salience of these tasks. This suggestion is supported by the fact that individuals with fisherman fathers are more likely than other fishermen to complain about specific tasks (24% versus 7%, respectively; $X^2 = 7.068$, $p < .01$).

Attitude Toward Son Becoming Fisherman. Another question reflecting attitudes toward the occupation of fishing concerns whether or not a fisherman would want his son to become a fisherman. Forty-six percent of the fishermen respond that they would like it if their son became a fisherman. There is no relationship between this variable and age, education, and years of fishing dichotomized at their sample means ($X^2 = 0.839$, 0.040, and 1.939, respectively; $p > .05$). The lack of relationship between education and attitudes towards one's son becoming a fisherman is surprising in light of findings reported for Panama. There, small-scale fishermen who had more than the mean number of years of formal education were less likely to want their sons to become fishermen (Pollnac and Ruiz-Stout, 1977). Further, the hypothesis that individuals whose fathers were fishermen would be more likely to want their son to become a fisherman is not supported by the data ($X^2 = 0.001$, $p > .05$). The hypothesis that individuals who own the means of production (e.g., boat owners) would be more favorable towards having their sons follow in their footsteps is also rejected ($X^2 = 1.137$, $p > .05$). Both of these hypotheses were also rejected by research conducted among small-scale fishermen in Panama (Pollnac and Ruiz-Stout, 1977). Finally, we find that rural fishermen are more likely than urban fishermen to want their sons to become fishermen (64% versus 33%, respectively; $X^2 = 11.373$, $p < .001$). This finding probably reflects the relatively high salience of alternative occupational opportunities in the city, a finding similar to that reported for Panamanian small-scale fishermen (Pollnac and Ruiz-Stout, 1977).

Categorized positive and negative responses to this question can be found in Table 3.

The most frequent positive responses refer to monetary reward and job security. The next most frequent positive responses refer to the ease of the work. Other positive responses were idiosyncratic and are included in the "other" category. The most frequent negative response was that the fishermen would rather have his son study and learn another occupation. The next most frequent negative response category contains responses such as "it is a hard life," "one is poorly treated," "it is slave work," etc. Other negative responses refer to the unpredictability of the catch and the fact that the amount of fish being caught is decreasing.

Perception of Attributes of Good Fishermen. Fishermen's perceptions of the attributes of a good fisherman provide us with another perspective on their perceptions of the occupation of fishing. The responses to the question concerning the qualities of a good fisherman will give some indication of the small-scale fisherman's conceptualization of the body of knowledge and personal characteristics necessary to function effectively as a fisherman. The distribution of categorized responses to this question can be found in Table 4.

Table 4 reflects the percent of respondents who referred to a given

TABLE 3. Distribution of Rationales for Attitudes Toward Son's Becoming a Fisherman

Rationale		Percent
POSITIVE	Make more money	15
POSITIVE	Job security	13
POSITIVE	Ease of work	7
POSITIVE	Other	10
NEGATIVE	Rather have him study	22
NEGATIVE	It is a bad occupation	20
NEGATIVE	Unpredictable catch	6
NEGATIVE	Amount of fish decreasing	5
NEGATIVE	Other	2

N = 125

attribute in their first two responses. The most frequent response category concerns knowledge of the physical environment. Responses included in this category indicate that a good fisherman must know the tides, currents, winds, moons, weather, and the geography of the gulf. The second most frequent response was that a good fisherman must know where the fish are located. Know-ledge of use of fishing equipment was third highest in frequency. Ten percent of the respondents referred to personal characteristics of fishermen. These respondents suggest that a good fisherman must be strong, able, valorous, and observant. General knowledge about fishing was cited as important by 9 percent of the sample. It is interesting to note that only 4 percent of the fishermen suggest that luck was one of the attributes of a good fisherman. Attributing occupational success to possession of good equipment was also a relatively rare response.

The first, and therefore most salient, high frequency responses were cross-tabulated with area of residence, father's occupation, vessel ownership, years fishing experience, age, and education to determine the interrelationships between these variables and perceptions of the qualities of a good fisherman. The results of this analysis are presented in Table 5.

Tabular entries in Table 5 are Chi Square. Focussing our attention on variables manifesting significant relationships with perceived attributes of a good fisherman, we find that urban fishermen are more likely than rural to attribute fishing success to knowledge of fishing spots (29% versus 14%, respectively). At this time, we cannot provide an explanation for this finding. We also find that a greater percentage of fishermen whose fathers are also fishermen (23% versus 7%) note that knowing how to use equipment is an important quality of good fishermen. Once again, any attempt to explain this relationship would be speculative. Finally, boat owners are more likely than non-owners to emphasize the importance of knowing the physical environment (54% versus 34%, respectively). This finding can probably be explained by the fact that boat owners who also fish are usually captain of the vessel. As captain, the boat owner decides when to go out fishing and return, and knowledge of the tides, moons, weather, and currents is essential in making this decision; thus, environmental attributes are probably more salient to fishermen who are boat owners. Years fishing, age, and education appear to have no significant relationships with this variable.

III. Summary And Conclusions

We find that, in general, the small-scale fisherman of the Gulf of Nicoya has a rather positive attitude towards his occupation. Forty-six percent report that they would like it if their sons became fishermen, and approximately one-third stated that there was nothing they dislike about fishing. Most frequently mentioned positive attributes of fishing were the monetary reward and environmental features such as fresh air and silence. Almost one-fourth of the fishermen stated that they liked everything about fishing.

The fact that rural fishermen are more likely than urban to emphasize the monetary rewards of fishing and want their sons to become fishermen gives us some indication of the directions future changes may make in perceptions of the occupation. We predict that as the rural area becomes more like the urban in terms of occupational opportunity and engagement in the cash economy, the attitudes toward fishing in the rural areas will become more like those in the urban. This suggests that unless changes emphasizing perceived positive aspects of fishing are made in the industry, it will become more difficult to recruit new fishermen. As noted above, almost twice as many rural as urban fishermen would like it if their sons became fishermen.

In sum, we have examined small-scale fishermen's perceptions of various aspects of the occupation of fishing in the Gulf of Nicoya. Information provided can be of use in planning and implementing development programs which

TABLE 4. Percent Distribution of Categorized Attributes of Good Fishermen

Attribute	Percent*
Knowledge of physical environment	62
Knowledge of fishing spots	57
Know how to use fishing equipment	30
Personal characteristics (valor, strength, etc.)	10
General knowledge about fishing	9
Luck	4
Have good equipment	2
Like fishing	1
Other specific knowledge (not environmental)	6

N = 125

*Total exceeds 100% because entries reflect categorization of the first two responses to an open-ended question.

TABLE 5. Relationship (CHI SQUARE) Between Perceived Attributes of a Good Fisherman and Selected Sociocultural Variables

Sociocultural Variables	Attributes of a Good Fisherman		
	Knowledge of Physical Environment	Knowledge of Fishing Spots	Know how to Use Equipment
Rural/Urban	3.71	3.96**	2.99
Fisherman Father	0.04	0.96	6.15**
Boat Ownership	5.07**	1.87	0.13
Years Fishing*	1.25	0.91	1.07
Age*	2.95	0.72	0.07
Formal Education*	0.46	0.38	2.53

*Dichotomized at sample means. **$p < 0.05$ (Two-tailed test). N=125

will be maximally congruent with the fisherman's conceptualization of his occupation.

Study Two Variance in Perceptions of Fishing and Farming among Small-Scale Fishermen in the Gulf of Nicoya, Costa Rica

By R.B. Pollnac

Planned development of any sector of an economy will be maximally effective if proposed changes are carried out with an understanding of the target population's attitudes, beliefs, and values concerning affected occupations. For example, if changes result in displacement of individuals who must shift to alternative occupations, knowledge of attitudes towards the alternative occupations is essential to arrive at an understanding of the potential for either acceptance or rejection of proposed changes. If such knowledge is obtained in advance of proposed changes, programs can be structured to enhance the desirability of alternative occupations by focusing on positive attributes and attempting to change negative perceptions (Pollnac and Ruiz-Stout, 1977).

With respect to occupational perceptions, one area of potential importance involves comparing individual perceptions of present occupation with possible alternative occupations. Proceeding under the assumption that an individual's perception of self is related to that of his characterization of others involved in his occupation, we suggest that changes between occupations which are differentially characterized will result in like changes in self perception. For example, if ego characterizes others in his occupation in a positive manner, he is likely to have a positive perception of self. If he characterizes those in an alternative occupation negatively, he is likely to resist moving into that occupation because it would result in a more negative perception of self. It appears then, that an understanding of individual perceptions of participants in alternative occupations would be important in predicting possible resistance to occupational change due to perceived self-identity conflict.

The purpose of this study is to examine the sociocultural correlates of perceptions of farmers and fishermen by small-scale fishermen in the Gulf of Nicoya, Costa Rica. The alternative occupation of farming was selected because it was the most frequently mentioned alternative occupation in response to a question concerning what a fisherman would do if he could no longer fish in the Gulf of Nicoya.

1. The Sample

Data for this study are based on interviews with 80 small-scale fishermen from the Gulf of Nicoya, Costa Rica. Part of the sample (50) was drawn from Barrio el Carmen, Puntarenas, and a sample of 30 small-scale fishermen was interviewed at Costa de Pajaros.

Tests. The technique used here to investigate variability in perceptions of the occupations farmer and fisherman is the semantic differential. The semantic differential is based on the assumption that an individual's life experiences affect the connotative meaning of concepts (Osgood, Suci and Tannenbaum, 1957). In this paper we compare the connotative meaning of the concepts "fisherman" and "farmer" by having individual fishermen rank each concept on a set of six bipolar attributes (see Table 6).

Three of the bipolar attributes (GOOD - BAD, HAPPY - SAD, INTELLIGENT - STUPID) form an evaluation dimension, and the other three (STRONG - WEAK, FAST - SLOW, BRAVE - COWARDLY) a dynamism (potency-activity) dimension (Osgood, Suci, and Tannenbaum, 1957; Osgood, 1964). Each bipolar attribute was ranked on a seven-step scale with the emotively positive pole (e.g., GOOD) receiving

TABLE 6. Bipolar Attributes Used to Differentiate Farmers and Fishermen

1.	GOOD - BAD	BUENO - MALO
2.	HAPPY - SAD	FELIZ - TRISTE
3.	INTELLIGENT - STUPID	INTELIGENTE - ESTUPIDO
4.	STRONG - WEAK	FUERTE - DEBIL
5.	FAST - SLOW	RAPIDO - LENTO
6.	BRAVE - COWARDLY	VALIENTE - COBARDE

a value of seven, and the negative (e.g., BAD) a value of one.

The four independent variables (age, education, years fishing, and rural/urban residence) were determined with the use of direct questions.

II. Analysis

The mean values on each bipolar attribute and the dynamism and evaluation dimensions can be found in Table 7. Overall Table 7 indicates that small-scale fishermen tend to characterize farmer more negatively than fisherman. In Figure 1, the mean values for fisherman and farmer are plotted on the evaluation and dynamism connotative meaning dimensions. This figure makes it clear that the vector leading from fisherman to farmer in connotative meaning space is almost equally emotively negative on both dimensions.

The next step in the analysis was to determine if differences in conceptualization of farmer and fishermen are related to other socioeconomical variables. Distance between fisherman and farmer (FFD) was calculated for each connotative meaning dimension by summing the value for fisherman minus the value for farmer on each attribute within each dimension. This resulted in an FFD on both the dynamism and evaluation dimensions for each individual within the sample. Dynamism and evaluation FFD's were intercorrelated with age, education, years fishing experience, and area of residence (dummy variable; rural = 1, urban = 2). The results of this analysis can be found in Table 8.

Table 8 indicates that both years fishing experience and area of residence are related to FFD. It appears that the longer one has been fishing, the greater the FFD on both dimensions. Area of residence is significantly related only to the evaluative dimension. Here the data suggest that evaluative dimension FFD is greater for the urban than the rural fishermen. Table 9 provides mean values for the rural and urban samples on both dimensions, and Table 10 provides these values for the sample dichotomized at modal years fishing experience (mode = 13 years). Figures 2 and 3 graphically display the relationship between these two independent variables and perceptions of farmer and fisherman.

Figures 2 and 3 clearly indicate the relationship between the independent variables and FFD on both dimensions. In Figure 3, the distance between farmer and fisherman on the evaluative dimension is clearly greater for the urban fishermen than the rural fishermen. Differencea between the concepts on the dynamism dimension are approximately the same for both samples. Nevertheless, we can see that the urban sample, in contrast to the rural sample, consistently ranks both farmer and fisherman higher on the evaluative dimension. In Figure 3 we find that individuals who fished less than the modal number of years (13 years) tend to characterize fisherman and farmer closer together on both dimensions than those who have fished 13 years or more. Further, Figure 3 indicates that those who have fished longest have the most negative perception of farmers.

Finally, since both years fishing and area of residence were significantly related to evaluative FFD, the combined effects of these two variables were examined. The multiple correlation between these two variables and evaluative FFD is 0.30 ($p < .05$) indicating that together they explain nine percent of the variance in the dependent variable, a modest but respectable sum.

III. Discussion and Conclusions

Part of a person's self-identity is obtained from membership and roles in groups. Some is ascribed (e.g., sexual identity), and some is achieved. According to some authors, occupation forms a significant aspect of achieved

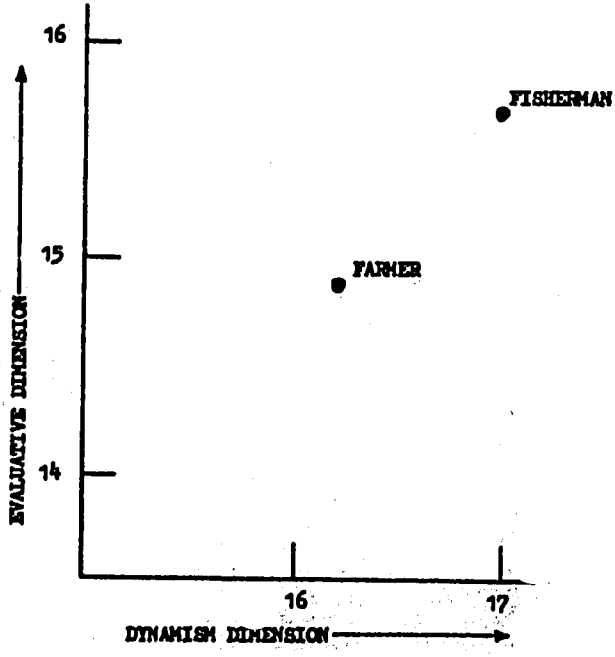

Figure 1. Location of FISHERMAN and FARMER in Connotative Meaning Space.

TABLE 7. Mean Values on Bipolar Attributes and Semantic Differential Dimensions for the Concepts Fisherman and Farmer

Attribute or Dimension	Fisherman	Farmer
STRONG-WEAK	5.23	5.23
GOOD-BAD	5.39	5.40
HAPPY-SAD	4.93	4.44
INTELLIGENT-STUPID	5.36	5.04
FAST-SLOW	5.58	5.00
BRAVE-COWARD	6.20	6.00
EVALUATIVE DIMENSION	15.68	14.88
DYNAMISM DIMENSION	17.00	16.22

TABLE 8. Correlations between Independent Variables and FFD on Evaluative and Dynamism Dimensions

Independent Variable	Dynamism FFD	Evaluative FFD
1. Age	.06	.06
2. Education	-.06	-.06
3. Years Fishing	.22*	.22*
4. Area of Residence	.03	-.23*

N = 80 *p < .05

TABLE 9. Rural/Urban Differences in Mean Values on Semantic Differential Dimensions for Farmer and Fisherman

Concept/Dimension	Urban	Rural	F Ratio	p
Fisherman/Dynamism	17.7	15.8	17.68	<.001
Fisherman/Evaluative	16.0	15.1	4.05	<.05
Farmer/Dynamism	17.0	14.9	10.88	<.01
Farmer/Evaluative	14.7	15.1	0.33	>.05
N	50	30		

TABLE 10. The Effects of Years Fishing on Evaluation of Fisherman and Farmer on Semantic Differential Dimensions

Concept/Dimension	Years Fishing*			
	<13	≥13	F Ratio	p
Fisherman/Dynamism	16.8	17.2	0.67	> .05
Fisherman/Evaluative	15.9	15.4	1.58	> .05
Farmer/Dynamism	16.4	16.0	0.34	> .05
Farmer/Evaluative	15.6	14.1	6.43	< .05
N	42	38	*Mode = 13	

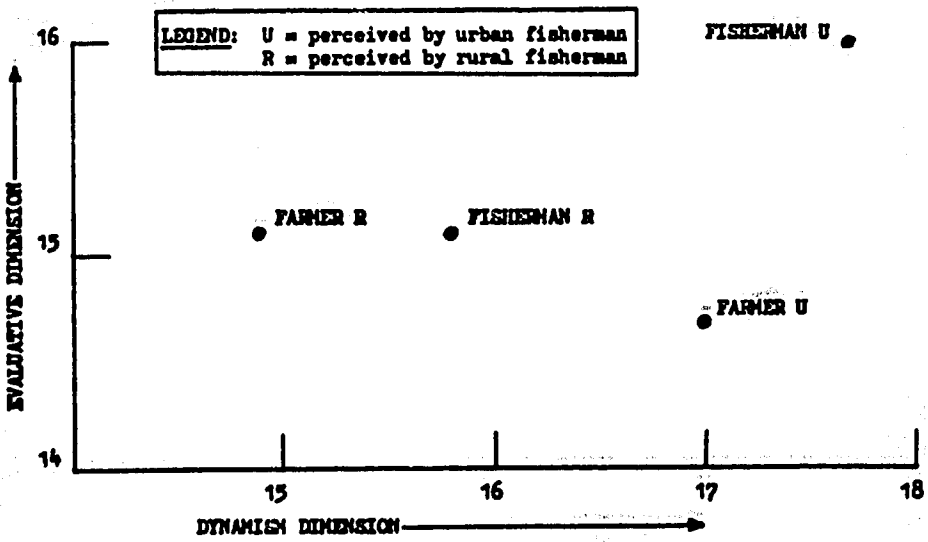

Figure 2. Rural-Urban Differences in Location of FARMER and FISHERMAN in Connotative Meaning Space.

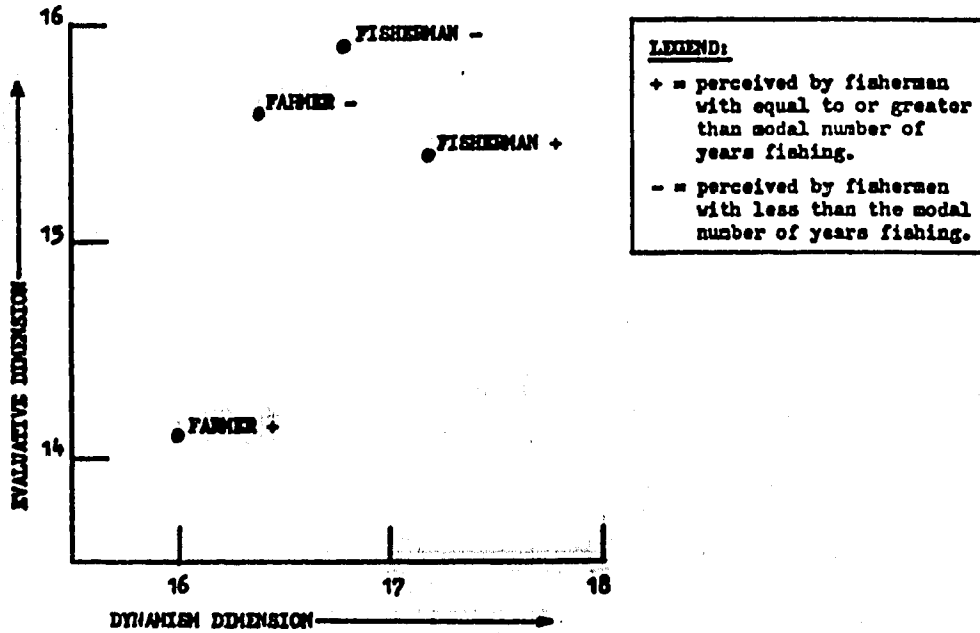

Figure 3. Effects of Years Fishing on Location of Fisherman and Farmer in Connotative Meaning Space.

identity (McKee, 1974), and participation in low-status occupations can result in disesteemed self-identities. Our findings indicate that small-scale fishermen in the Gulf of Nicoya perceive farmers (their primary alternative occupation) more negatively than fishermen. This suggests that they will perceive a shift from fishing to farming as possibly resulting in a loss of self-esteem. It is therefore predicted that if access to the fishery is restricted, fishermen who will be forced into farming will resist primarily because they conceptualize farmers more negatively than fishermen in connotative meaning space. Further, if they go into farming, it is possible that loss of self-esteem will result in social problems until the system stabilizes through means such as formation of alternative social groupings to enhance achieved identity and self-esteem. Although this generalization holds for all fishermen, it is especially true for urban fishermen and those who have fished longer. Urban fishermen, however, have more alternative occupational opportunities than rural fishermen; thus suggesting that the impact will be less in the urban area. This, however, is an empirical question which depends on the fishermen's perceptions of other alternative occupations relative to fishing.

If access to the fishery is to be restricted, resulting in some fishermen being dislocated, it is suggested that programs be implemented in advance to either improve conceptualization of alternative occupations or increase occupational opportunity in desirable occupations. This presupposes a research program structured to determine the relative desirability of various occupations. Further, formation or support of community groups as a means of providing alternative sources for achieved identity may also help reduce the impact of such a change.

In sum, we have seen that, in general, small-scale fishermen in the Gulf of Nicoya perceive farmers more negatively than they perceive fishermen. Further, the degree of this negative perception is positively related to both urban residence and years fishing experience. Finally, suggestions were made concerning programs to reduce impact of any changes which would result in the occupational dislocation of fishermen.

Study Three Small-Scale Fishermen's Perceptions of the Occupation: Northwestern Costa Rica
By J.J. Poggie, Jr.

This study deals with an analysis of socio-cultural aspects of small-scale fishermen from northwestern Costa Rica. The purpose of the analysis is to describe perceptions of the occupation and to compare these with fishermen from the Gulf of Nicoya to the south. Because the northwest coast is a more exposed environment than the Gulf of Nicoya, it will be possible to suggest what effect this macro-environmental feature has on the perceptions of occupation of otherwise fairly similar small-scale fishermen.

Knowledge of fishermen's perceptions of their occupation and how these perceptions may be influenced by environmental factors (protected gulf versus open ocean) can be useful in designing change programs, particularly if these require fishermen to utilize ecological niches to which they are unaccustomed.

1. The Sample

The sample employed in this analysis consists of 70 fishermen from four communities in the Gulf of Papagayo region of northwestern Costa Rica. All available fishermen encountered at landing sites were interviewed in Playa del Coco, Cuajiniquil, Jobo and Puerto Soley, Guanacaste. It has been estimated that there are some 200 fishermen in the northwestern region, thus approximately 35 percent of the total were interviewed.

Fishermen in this region have small-scale operations, using mainly outboard-powered skiffs and small boats (up to about 30'). Gill netting of fish is the most common form of capture, but some diving, various combinations of gill net and line-fishing also take place. Of our sample of 70 fishermen and crew members, 30 used monofilament gill net, 27 used multifilament gill net, 7 were divers and the remaining 6 used various combinations of line and gill nets.

Tests. Fishermen were asked open-ended questions concerning qualities of good fishermen as well as what they most like and dislike about fishing. From these projective-like questions, perceptions of occupation may be derived. Other socio-cultural variables such as age, years fishing, boat ownership, education and father's occupation were measured by means of direct questioning.

II. Analysis

Qualities of a Good Fisherman. Categories of first response concerning perceived qualities of a good fisherman are presented in Table 11. The most frequent first response to this question is that one has to like fishing in order to be a good fisherman. Thirty-nine percent of the sample mentioned this idea. The next most frequent response was that a person needed to know how to use equipment in order to be good at fishing. Thirty-one percent responded in this way. Together, these two responses account for 70 percent of the responses. Personal characteristics of fishermen were believed to contribute to being a good fisherman in the view of 9 percent of the respondents. As seen in Table 11, a variety of other responses make up the remaining 21 percent of first responses, but none by itself accounts for a large percentage.

The two most frequent responses were considered as they relate to the independent variables of age, years fishing, boat ownership, education, father fisherman and father farmer. Age was not significantly related to the dependent variables, but years fishing was related ($X^2 = 7.75$ $p < .01$) to whether one emphasized "liking fishing" as a condition for being a good fisherman. Those with less experience (below mean) emphasized liking fishing more than those with more years of experience. This seems to indicate that fishing serves more as a form of enjoyment to those who first enter the occupation than those who have been in the occupation for some time. There was a corresponding tendency (44%) for respondents with fishermen fathers (versus 33% for those with non-fishing fathers) to consider liking fishing as a requirement for being a good fisherman. Respondents socialized in fishing households tend to emphasize the need to enjoy fishing, perhaps as an outgrowth of their learning the "costs" of fishing from association with their fishermen fathers.

Positive Aspects of Fishing. Turning to what fisherman most like about fishing, we see in Table 12 the categories and percentages of responses. The most frequently mentioned response had to do with some specific type of fishing such as gill netting, diving, etc. Thirty-seven percent of the responses were in this category. The second msot frequent response "catching many fish" amounted to 16 percent of the responses, while "independence" and some specific aspect of the job (e.g., pulling net) tied for third most frequent with 11 percent each. As seen in Table 12, a variety of other responses make up the remaining total.

These responses were also analyzed as they related to age, years fishing, boat ownership, education and father's occupation. It was found that none of these independent variables was related to perceptions of what respondents most like about fishing.

Negative Aspects of Fishing. Responses to the question of what fishermen like least about fishing are shown in Table 13. We note here that negative

TABLE 11. Qualities of a Good Fisherman

Category	(f)	Percent
Like fishing	27	39
Know how to use equipment	22	31
Personal characteristics	6	9
Know fishing spots	4	6
General knowledge about fishing	3	4
Luck	3	4
N/A	3	4
Have good equipment	1	1
Know tides, weather, etc.	1	1

N = 70

TABLE 12. Most Like About Fishing

Category	(f)	Percent
Specific type of fishing	26	37
Catching many fish	11	16
Independence	8	11
Specific attribute of job	8	11
Monetary reward	5	7
Environment	4	6
Like everything	3	4
Easy work	2	3
Peaceful life	1	1
D/K, N/A	2	3

N = 70

TABLE 13. Like Least About Fishing

Category	(f)	Percent
Environment (wind, bad weather, etc.)	19	27
Nothing	15	21
Specific task	11	16
Problem with equipment	9	13
Lack of fish	7	10
Other	4	6
Prices	3	4
Amount of work	1	1
D/K	1	1

N = 70

aspects of the environment (wind, bad weather, etc.) form the most frequent (27%) category of response. The category "nothing" is second most common (21%), while some specific task (e.g., mending nets) is third. The fact that negative environmental features are emphasized is of interest, as these fishermen exploit an exposed section of coastline.

When these responses were analyzed in terms of the independent variables of age, years fishing, boat ownership, education, and father's occupation, only one significant relationship emerged. This, too, had to do with negative aspects of the environment. It was found that the more educated (above and below the mean, 35 versus 13 percent, respectively) emphasized negative environmental featurea as what they disliked most about fishing ($X^2 = 3.96$ $p < .05$, $\phi = .24$). Thus in some way education contributes to a greater concern with environment as a negative aspect of the occupation.

Open Ocean vs. Gulf of Nicoya. Small-scale fishermen's perceptions of the occupation in the protected Gulf of Nicoya region have been discussed by Pollnac. In this section we will compare responses from the northwestern open ocean region with those from the protected gulf in an effort to see how this macro-environmental difference appears to effect perceptions of occupation.

Pollnac used the same tests to determine fishermen's perceptions of qualities of a good fisherman and positive and negative aspects of the occupation. His sample of 125 was drawn from Gulf of Nicoya fishermen in Puntarenas and Costa de Pajaros. His result are directly comparable to those from the north.

Turning first to a comparison of the four most frequent responses to the question of what makes a good fisherman, we note clear differences between the regions (Table 14).

It is most frequent responses of knowledge of the physical environment and liking fishing that most differentiate the two regions. It would seem that knowledge of aspects of the physical environment (particularly tides and currents) is more important in the geographically constricted gulf than it is in the more open northwest region. It is not clear why liking fishing would be so important in the northwest. One suggestion is that open ocean fishing is more "intensive fishing," requiring greater time and greater removal from land and landbound society and thus cannot be carried out effectively well unless one likes it. As noted earlier, northwest fishermen often are 40 to 50 miles from land, while Gulf of Nicoya fishermen are never out of view of land because of distance.

Looking at the comparison of what fishermen from the two areas like about their occupation, we again note marked differences (Table 15).

It is interesting that northwest fishermen rank aspects of the job itself first, while Gulf fishermen rank the monetary reward of work as first. This suggests that there is more non-economic reward involved in the work of northwest fishermen from those in the south. This finding supports the ecological interpretation that one has to like fishing in order to carry it out well in the more open high energy physical environment of the north.

Finally, turning to the negative aspects of fishing in the two areas we present the four highest ranking of negative aspects in Table 16.

The rankings of negative aspects of fishing also seem to reflect the difference in ecological conditions between the two zones. Fishermen in the northwest emphasize environmental difficulties as those which they dislike the most. It is also interesting to note that "lack of fish" appears in the Gulf fishermen's list of greatest concern and "problems of equipment" is that of the northwest fishermen. Both of these concerns appear to be ecologically based. The more heavily fished Gulf is subject to more depletion of stock than the less intensely fished northwest. Problems with equipment is of greater concern to offshore fishermen than those who are not so distant from shore.

TABLE 14. Ranked, Categorized Responses: Attribute of Good Fishermen

Rank	Gulf of Nicoya	Rank	Northwest Region
1	Knowledge of physical environment	1	Like fishing
2	Knowledge of fishing spots	2	Know how to use fishing equipment
3	Know how to use fishing equipment	3	Personal characteristics
4	Personal characteristics	4	Know fishing spots

TABLE 15. Ranked Categorized Responses:
Most Like About Fishing

Rank	Gulf of Nicoya	Rank	Northwest Region
1	Monetary reward	1	Specific type of fishing
2	Everything	2	Catching many fish
3	Environment	3.5	Independence
4	Catching many fish	3.5	Specific attribute of job

TABLE 16. Ranked Categorized Responses:
Like Least About Fishing

Rank	Gulf of Nicoya	Rank	Northwest Region
1	Nothing	1	Environment
2	Specific task	2	Nothing
3	Lack of fish	3	Specific task
4	Environment	4	Problem with equipment

III. Summary and Conclusions

Overall the fishermen of the northwest appear to be fairly positive about their occupation but with clear preferences for specific types of fishing and with the view that one must like fishing to be good at it. This suggests that development programs that require fishermen to change their mode of fishing or require added labor may involve resistance and recruitment problems. Changes in mode of fishing could conflict with their preferences for specific types of fishing, while recruitment would potentially bring in individuals who do not have the psychocultural predisposition to the occupation.

Also suggested by the data is that environmental factors (inshore vs. offshore) play a role in the occupational subculture that evolves within small-scale fisheries. For this reason too, planners should not assume that all small-scale fishermen are equally amenable to different types of fishing. Studies to determine the sociocultural potential for change among fishermen targeted for change programs should be carried out before decisions of direction of change are made.

GENERAL CONCLUSIONS

The studies found that, overall, small-scale fishermen from the Gulf of Nicoya and Northwest Costa Rica have rather positive perceptions of their occupation. In the Gulf of Nicoya almost one-half report that they would like it if their son became a fisherman and about one-third stated that there was nothing they disliked about fishing. Fishermen from the Gulf of Nocoya also perceived farming--their most likely alternative occupation--more negatively than fishing. This negative perception was positively correlated with both urban residence and years fishing experience. Finally, in the northwest, fishermen made it clear that one must like fishing to be good at it. As detailed in the studies, these findings can be of use in planning and implementing developmental programs which will be maximally congruent with the fishermen's conceptualizations of their occupation.

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CHAPTER 15. KINSHIP LINKS AMONG SMALL-SCALE FISHERMEN IN THE GULF OF NICOYA, COSTA RICA

BY R.B. Pollnac

When changes are proposed at the productive level of any sector of the economy it is important to understand existing social relations between individual workers at the level involved. Work groups with which individuals are personally identified provide a degree of psychological security and satisfaction, and innovations perceived as threatening the structure of these groups often meet resistance (Foster, 1973). Among small-scale fishermen, changes in the nature or size of technology can result in drastic changes in work group composition. Additionally, changes restricting access to resources can result in denial of access to some group members who would normally enter the occupation (Gersuny and Poggie, 1973). These individuals would be dispossessed of what they normally considered a right, and resistance to the new regulations would probably develop. An understanding of these potential problems will facilitate development of policy and plans which will minimize social dislocations and increase the probability that proposed changes will succeed.

Kinship plays an important and varied role in the structure of the occupation of fishing in many parts of the world. The importance of kinship in fishermen's work groups has been extensively cited in the literature from regions as widely separated as Ghana (Quinn, 1971), Peru (Sabella, 1974), Micronesia (Knudson, 1970), the Faroe Islands (Biehr, 1963), Ulithi (Lessa, 1966), and the West Indies (Aronoff, 1967). The need for harmony on a vessel is essential for success at sea, and kinship ties may enhance co-operativeness within the work group. Other factors may also increase the tendency toward kin based crews. For example, Gladwin (1970) notes that among the Mfante of Ghana, boat crews with family cores are more stable than non-kin linked crews. On Moala kinship ties are related to the sharing and loaning of capital equipment such as boats (Sahlins, 1962), while on Tikopia canoes are nominally owned by heads of kin groups, but actually by the kin group as a whole (Firth, 1965). Sabella (1974) suggests that the use of kin in the crew among small-scale fishermen from Peru is often related to keeping boat production within the family.

Among some fishing people, however, we find that kinship plays little or no role in crew composition. Glacken (1955) notes that family members fish from different vessels on Okinawa. This is done to minimize loss to individual families if a fatal accident occurs. Further, neither Taiwanese (Diamond, 1969) nor Malay (Firth, 1966) fishing crews are primarily based on kin ties. Norr (1972) reports a similar situation in South India and suggests that the skilled nature of the occupation of fishing results in worker recruitment on the basis of skill and interpersonal ability rather than social ties.

It also appears that recruitment to the occupation of fishing takes place along kinship lines in many societies. For example, in societies cited above wherein crew composition is based on kinship links, kinship doubtless plays a role in recruitment. Data from the Atlantic Coast of North America also indicates a great deal of kinship ties between fishermen (Liguori, 1968; Proskie and Adams, 1969; Gersuny and Poggie, 1973).

In this chapter kinship links between fishermen in the Gulf of Nicoya, Costa Rica will be examined. Specifically, the chapter provides a description of the role of kinship in crew structure and recruitment to the industry. The chapter also examines variance in the role of kinship among different age and residential groups.

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I. The Sample

Data for this study are based on interviews with 125 small-scale fishermen from the Gulf of Nicoya, Costa Rica. Part of the sample was drawn from Barrio el Carmen, Puntarenas, and a sample of 50 small-scale fishermen were interviewed at Costa de Pajaros, a concentration of fishermen in a rural region approximately 21 air-kilometers northwest of Puntarenas on the coast of the Gulf of Nicoya. In both areas most small-scale fishermen fish from motorized wooden plank or dugout vessels from 15 to 30 feet in length using handlines and/or nets. Some still use sail or oars. Fishing crews usually consist of three men. Sometimes unskilled individuals are taken along as helpers. Fishermen report that crews are selected primarily on the basis of fishing skill. Reported characteristics of undesirable crew members (i.e., bad character, liar, thief, etc.) suggest that social skills are also important. Fishermen report that catches are usually divided fifty-fifty, with one-half going to the vessel and one-half being divided among the crew members. If an unskilled helper is present, he gets a much reduced share which is determined by the crew. In some cases trip costs are removed before division of catch, and in others, costs are deducted from the vessel share. Although this reported system is the most frequent, a random sampling of landings over a five-month period has thus far identified some 25 systems (Sutinen, personal communication). It is important to note for purposes of this paper that variance in catch distribution often occurs when kin fish together. Sometimes the entire catch is pooled, and proceeds go to the domestic group as a whole.

Data were obtained from questions included in a larger sociocultural questionnaire. Interviews were conducted in Spanish.

II. Analysis

Turning first to the relationship between kinship and crew membership we find that for the total sample, a slight majority (52%) of the fishermen do not fish with kin. Thirty-four percent of the fishermen fish with at least one relative, 10 percent with two, while only 4 percent fish with three or more kinsmen.

As can be seen in Table 1, however, the rural and urban areas differ significantly with regard to the role that kinship plays in crew membership. Sixty-six percent of the rural as contrasted with 36 percent of the urban fishermen fish with relatives. This difference is statistically significant ($X^2 = 10.817$, $p < .01$).

Table 2 indicates kin types that fish with respondents in both the rural and urban area. Tabular entries refer to number of respondents reporting designated relative as a crew member.

The rural column in Table 2 sums to more than 50 because some rural fishermen fish with more than one kin type. Overall, the greatest difference between the rural and urban area with respect to crew membership is the higher proportion of brothers who fish together in the rural area. In the rural area we find that 38 percent of the fishermen fish with a sibling in contrast to only 8 percent in the urban area ($X^2 = 16.875$, $p < .001$). Age is not related to inclusion of relatives in crew. The mean age of the sample is 30.7 years. Forty-eight percent of those less than 30, and 48 percent of those 30 years of age and older fish with relatives.

Turning to familial involvement in fishing, Table 3 reflects number of relatives of each respondent in the rural and urban areas who are involved in fishing. Tabular entries refer to the number of respondents who report having the indicated number of relatives involved in fishing.

For the total sample the mean number of relatives involved in fishing is 4.12. If we dichotomize the entries in Table 3 at the sample mean we find that only 13 percent of the urban fishermen have 5 or more relatives who fish

TABLE 1. Number of Relatives in Crew

Number	Urban	Rural
4	1	3
3	0	1
2	6	7
1	20	22
0	48	17
Total	75	50

TABLE 2. Relationships Between Respondents and Crewmembers

Relationship	Urban	Rural
Father	6	5
Brother	6	19
Son	5	4
Father's Brother	2	3
Mother's Brother	0	1
Nephew	2	1
Spouse	2	0
Cousin	2	5
Wife's Brother	2	2
Non-relative	48	17

TABLE 3. Number of Relatives Involved in Fishing

Number of Relatives Fishing	Frequency	
	Urban	Rural
20	0	1
16	0	1
13	0	4
12	0	3
11	1	5
10	0	3
9	0	3
8	0	4
7	0	2
6	3	3
5	6	3
4	7	2
3	9	8
2	13	4
1	19	1
0	17	3
Total	75	50

in contrast to 64 percent of the rural fishermen, a statistically significant difference ($X^2 = 34.519$, $p < .001$).

Table 4 provides a breakdown of the various kin types involved in fishing. Tabular entries refer to the number of respondents who report having one or more of the indicated kin type involved in fishing.

Confining our remarks to kin types reported by at least 20 percent of the sample, we find that the rural sample reports a significantly greater proportion of fathers, father's brothers, and brothers involved in fishing ($X^2 = 7.726$, $p < .01$; $X^2 = 22.367$, $p < .001$; $X^2 = 8.078$, $p < .01$, respectively).

The preponderance of kinship links between fishermen in the rural area is also indicated by the distribution of family names. If we limit our examination to family names shared by at least five fishermen, we find that in the rural area out of a sample of 50, one family name is shared by 19 fishermen, another by 8, and four others by 5 fishermen each. In the urban area out of a sample of 75, three family names are shared by more than 5 fishermen each, and in each case only 6 fishermen share the name.

Turning to occupational succession, we have already seen that a larger proportion of rural fishermen have fathers who were fishermen. This suggests that in the rural area expectations are high that a fisherman's son will become a fisherman. This suggestion is supported by the fact that in the rural area more fishermen report that they would like it if their son became a fisherman than in the urban area (64% versus 33%, $X^2 = 11.373$, $p < .001$). Further, individuals who fish with relatives are more likely to want their sons to become fishermen than those who do not (61% versus 37%, respectively, $X^2 = 7.541$, $p < .01$). Finally, as can be seen in Table 5, rural fishermen are more likely than urban to be introduced into fishing by relatives. Seventy-two percent of the rural fishermen were taught to fish by relatives as opposed to only 31 percent of the urban. This difference is statistically significant ($X^2 = 20.565$, $p < .001$).

III. Discussion

Overall, kinship appears to play an important role in crew structure and occupational succession among small-scale fishermen in the Gulf of Nicoya. The large number of fishermen who have relatives who fish clearly indicates the salience of kinship links in this occupation. It is important to note that these links are primarily agnatic (i.e., through the male line) as would be expected in an occupation which is composed principally of males (all except one of the fishermen interviewed were males). For the most part, these kinship links are more salient in the rural area than in the urban area.

These interrelationships between kinship and small-scale fishing in the Gulf of Nicoya have several implications for research and development in this sector of the economy. (1) Changes in technology which would affect work group structure (i.e., by creating highly specialized jobs or radically increasing or decreasing crew size) should be examined to determine the effect they would have on the role of kinship in crew structure. Attitudes toward these potential effects should be adjusted to desired work group structure. (2) Changes such as limiting entry to the occupation need to be more carefully conducted in areas where occupational succession follows kinship lines. Alternative occupational opportunities need to be provided to take the place of the occupation that individuals had normally considered their birthright. To be most successful, these alternative occupational opportunities should provide the same degree of satisfaction as small-scale fishing. As a means of achieving this goal, we need to understand the fishermen's perceptions of his occupation in comparison with other occupations. (3) Finally, economic studies involving fishermen's income should be aware of the degree of kinship involvement in crew structure. Individual income may appear to be low in some

TABLE 4. Kin Types Involved in Fishing

Relationship	Frequency Urban	Frequency Rural
Father	32	34
Brother	38	38
Son	8	4
Father's Brother	6	22
Mother's Brother	4	8
Nephew	2	1
Spouse	2	0
Cousin	10	7

TABLE 5. Distribution of Individuals Who Taught Respondent to Fish, Classified by Kin Type

Relationship	Frequency Urban	Frequency Rural
Grandfather	0	1
Mother's Brother	1	1
Brother	3	6
Father and Cousin	1	0
Father	18	28
Non-relative	52	14
Total	75	50

cases, but if kinship involvement is high and if the proceeds of the catch are pooled for household use, household income may be higher than individual income would suggest.

In sum, we have examined the extent of kinship involvement in small-scale fishing in the Gulf of Nicoya, Costa Rica, and have found that it is relatively more extensive in the rural than in the urban area. Implications of kinship links in crew structure and occupational succession were discussed and considered of sufficient importance to warrant their consideration in any program of planned change which would affect the structure or recruitment of work groups among these small-scale fishermen.

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CHAPTER 16. FUTURE ORIENTATION AMONG SMALL-SCALE FISHERMEN

BY R.B. Pollnac, M.C. Robbins and L. Robbins

An important component to be considered in any situation of proposed techno-economic change is the temporal perspective of the population involved. It is clear that participation in change programs will be enhanced if the participants are oriented toward the future as opposed to the present or the past. This is true because most development schemes do not pay off immediately--there is usually a delay between the acquisition of new technology and increased income or production. This delay after investment of time, effort, and capital is often perceived as risky, and in situations where the outlook for the future is uncertain or negative, individuals are less likely to defer gratification (Thompson, 1975; Pollnac and Poggie, 1978). Where the perceptions of the future are rather unfavorable, an orientation towards the present and/or the past develops, and change programs oriented toward the future are unlikey to succeed unless they include some means of influencing this temporal perspective. The studies in this chapter examine both attitudes concerning future goal attainment and future investment orientations among small-scale fishermen in Costa Rica.

Study One — Investment Orientations among Small-Scale Fishermen in the Gulf of Nicoya, Costa Rica

By R.B. Pollnac

Development programs which include technological change often depend, in part, on the entrepreneurial orientations of individuals in the affected sector. In developing countries this is especially true with respect to small-scale fishermen, many of whom are already entrepreneurs as a result of the nature of their occupation and productive equipment involved (Pollnac, Gersuny and Poggie, 1975; Pollnac and Poggie, 1978; Poggie, 1977; Aronoff, 1967). Although the cost of small-scale fishing equipment is not negligible, it is still within means of a hard working fisherman who wisely invests his earnings. Nevertheless, rampant inflation in many parts of the world coupled with the perceived need for more sophisticated productive equipment has led to increased costs for the independent small-scale fisherman; thus making it more difficult to initiate and sustain development in a sector of the economy which is becoming increasingly important in regions suffering from protein shortages. Even in situations where initial development of the small-scale fishery is produced by injection of funds from outside sources, there is still a need to sustain development through investment of reasonable amounts of profit to provide for equipment maintenance and replacement. The marine environment is especially hard on equipment (Pollnac, 1976), and if such provisions are not made, the initial investment may be lost due to destruction or breakdown of productive equipment. Given these conditions, it is therefore essential that we understand factors associated with investment orientations among small-scale fishermen in areas where development programs are anticipated.

Investment orientations cannot be considered without taking into account theories concerning gratification behavior. Some individuals, under certain conditions, defer gratification; that is they postpone immediate desires to obtain more substantial rewards in the future. Others immediately gratify their desires. Investment in productive equipment can be considered deferred gratification behavior; therefore, investment orientations are related to the larger body of theory dealing with gratification orientations.

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A great deal of research has related gratification orientations to a host of sociocultural variables. Variability in gratification orientations has been related to modernization and acculturation. Some researchers report a positive relationship (e.g., Doob, 1960, Graves, 1967; Rogers, 1969; Inkles, 1969), others find no relationship (Sexton and Woods, 1977), while one study reports a non-linear relationship with a tendency for deferred gratification behavior to increase, level off, then decrease slightly as the degree of modernization increases (Pollnac and Robbins, 1972).

Studies relating age to deferred gratification have reported negative (Mischel and Metzner, 1962; Lessing, 1968; Pollnac and Robbins, 1972; Levy, 1976), positive (Pollnac and Poggie, 1978), inconsistent, and no relationship (Doob, 1971; Robbins and Thompson, 1974; Pollnac, Gersuny, and Poggie, 1975). Socioeconomic status has been reported as having both a negative (Thompson, 1975; Levy, 1976) and a positive relationship (Graves, 1967; Wober and Musoke-Mutanda, 1971) with deferred gratification. Findings have also been inconsistent with regard to urbanization. Gold (1967) reports a positive relationship between degree of urbanization and deferred gratification, while several other studies report a negative relationship (Robbins and Thompson, 1974; Thompson, 1975). Economic predictability and security (Rodgers, 1967; Meade, 1971; Robbins and Thompson, 1974; Thompson, 1975; Margolis, 1977; Sexton and Woods, 1977; Pollnac and Poggie, 1978), community level of economic development and industrialization (Turner, 1971; Rosen, 1971), education (Doob, 1960; Armer and Youtz, 1971), periodicity of income (Pollnac, Gersuny and Poggie, 1975), efficacy and optimism (Pollnac, Gersuny and Poggie, 1975; Thompson, 1975; Pollnac and Poggie, 1978) are all reported as having positive relationships with deferred gratification. Finally, several researchers report a negative relationship between deferred gratification and reward salience (Mischel, Ebbesen, and Zeiss, 1972; Robbins and Thompson, 1974; Thompson, 1975).

The large number and complexity of the variables related to gratification orientations may be responsible for some of the inconsistent findings cited above. Situational differences in the directions of relationships between independent variables account for some of the inconsistencies (Pollnac and Poggie, 1978). Thompson's (1975) research also supports the proposition that situational constraints must be carefully controlled. It is therefore important to control for situational factors, as well as the variables cited above, in studies concerning variance in investment orientations. The purpose of this chapter is to examine investment orientations and their sociocultural correlates among small-scale fishermen in the Gulf of Nicoya, Costa Rica.

I. Methods

Sample. Data for this report are based on interviews with 125 small-scale fishermen from the Gulf of Nicoya, Costa Rica. A sample of 75 was drawn from Barrio el Carmen, Puntarenas and a sample of 50 small-scale fishermen were interviewed at Costa de Pajaros.

Several imporant situational factors distinguish the rural and urban areas. Individuals in the rural area are much less tied into the cash economy than those in the urban area. In the rural area many small-scale fishermen have subsistence plots and domestic animals (usually pigs and chickens). Additionally, food can be bought or bartered from family, friends, or local farmers at much lower prices than in the city. In the urban area fishermen are locked into the cash economy. There is much less space for subsistence plots and domestic animals; thus, almost all non-fish food is purchased from local shopkeepers. Finally, electricity is available in Puntarenas but not at Costa de Pajaros. Consequently, numerous shops in Puntarenas are stocked with luxury goods such as stereos, televisions, blenders and refrigerators which depend upon electricity, thus increasing the salience of expensive, non-

productive goods among the urban fishermen.

Tests. Investment orientations were determined with the use of several questions: 1) if you were to receive 1,500 Colones (approximately 8.5 Colones equals one U.S. Dollar) as a gift or inheritance, what would you do with it? (2) if you were to receive 8,500 Colones as a gift or inheritance what would you do with it? (3) Under what conditions would you invest in more fishing equipment? (4) What would you invest in? Responses to all questions were content analyzed. Responses to the first two questions were further classified and coded as deferred if the response reflected an investment for future gain (e.g., purchase fishing equipment, put in bank, buy a business, etc.) or immediate if lacking an investment factor (e.g., buy things for the house, clothing, etc.). The immediate category was assigned a value of zero, and the deferred a value of one. Values assigned to each of the two questions were summed for each fisherman resulting in a scale having a range of from zero to two. This scale is referred to as the EGOCOMP Scale.

Turning to the independent variables, self-evaluation of socioeconomic position, perceived socioeconomic progress, optimism, and efficacy were determined with the use of the ladder of life test (Cantril, 1963). The ladder of life test consisted of showing the respondent a ladder diagram with ten rungs. He was told that the top rung represented the best possible life and the bottom, the worst. He was then requested to tell us where he felt he stood on the ladder at the present time (T_0), five years in the past (T_{-5}), and five years in the future (T_{+5}).

Another potential indicator of occupational optimism used in this study was the response to a question concerning whether or not an individual would like it if his son became a fisherman. It is assumed that individuals who are pessimistic about the future of fishing would prefer their sons to enter other occupations.

Material culture was measured with the use of a check list containing seven material items: 1) indoor plumbing; 2) indoor toilet; 3) electricity; 4) radio; 5) television; 6) refrigerator; 7) sewing machine. Each item was assigned a score of one if present and zero if absent. The scores for all eight items were summed forming a scale of material items. Item total correlations were calculated and all were high (ranging from 0.48 to 0.82) except for radio ownership. Radio ownership was eliminated from the scale, and item-total correlations were re-calculated. All item-totals were high (ranging from 0.46 to 0.87; $p < 0.01$). The resultant scale, composed of six items, is referred to as the Material Cultural Scale.

Another aspect of material culture measured was fishing technology. Fishing technologies were ranked from one to seven in terms of relative complexity, with the higher numbers referring to the least complex equipment. The rankings were as follows: 1-long line and net; 2-net and hand line; 3-net; 4-long line and hand line; 5-long line; 6-hand line; 7-hand (shellfish collecting).

Exposure to mass media was measured by asking fishermen how many days per week they listen to the radio, read newspapers, watch television, read magazines, and go to the cinema. Frequencies for the five mass media were summed forming a scale with a potential range of from 0 to 35. Item total correlations were calculated and were found to range from 0.41 to 0.60, all significant at better than the 0.01 level. This scale is referred to as the mass media exposure scale.

Income was measured by responses to questions concerning total annual income in the past year, income in the past month, and income in maximum and minimum months. Periodicity of income was calculated by dividing the difference between the maximum and minimum months by the maximum, resulting in a figure that varies between zero (no periodicity) and one (indicating maximum periodicity).

Age, father's occupation, and years of formal education were determined from answers to direct questions. Finally, ownership of means of production

was considered as a potential indicator of economic security. This variable was measured by determining if the individual fisherman owned the boat from which he fished.

II. Analysis

Investment Orientation. Turning first to the dependent variables, we will examine the range of responses to the four investment orientation questions. Categorized responses to the question concerning conditions which would lead to investment in additional equipment can be found in Table 1.

As can be seen in Table 1, the majority of fishermen said that they would invest in additional equipment if more fish were available for capture. Only 32 percent provide other conditions; the most frequent of which was more financing. In general, the small-scale fishermen feel that there has been a drop in the number of fish available for capture over the years. In response to a question concerning perceived changes in production, 73 percent responded that less fish were being caught at the present time. Twenty-one percent said that the same amount were available, and 6 percent said more. Fifty-nine percent of the fishermen attributed lowered production to the existence of more fishermen, boats, and nets. Ten percent, however, suggested that less fish are available because shrimp boats have been killing the small fish and their food. Overall, it appears the small-scale fishermen feel that there are fewer fish available and that they would invest in more equipment if they were sure they could catch more fish.

The types of equipment that fishermen said they would invest in can be found in Table 2. Most fishermen said they would invest in more nets. Two of those who would invest in nets noted that they would buy nets with a smaller mesh than the ones they presently use. The next most frequently response category concerned the purchase of a launcha. A launcha is a dugout or plank vessel from 18 to 36 feet in length with a small cabin and an inboard diesel engine. Fifteen percent of the fishermen said they would invest in more line for long line fishing. Other response categories are of relatively low frequency.

Turning next to the question concerning what individual fishermen would do with a windfall of 1500 or 8500 colones, we find that 66 percent would invest the larger amount into some type of fishing equipment while 48 percent would do the same with the smaller amount. Types of equipment, as specified in responses, can be found in Table 3.

Only a small percentage of the fishermen indicated that they would invest in ventures other than fishing. What is interesting is the fact that, with respect to the 8500 colone question, only about one-fourth of the fishermen made responses lacking an investment factor. A larger percentage made non-deferred responses to the 1500 colone question, noting that it was an amount unworthy of investment. These findings are in keeping with Pollnac, Gersuny and Poggie (1975) Pollnac and Poggie (1978) and Poggie (1979) who suggest that a deferred orientation is an adaptive characteristic among small-scale fishermen.

Description of Sample Characteristics on Independent Variables. The distribution of the independent variables within the total sample and the rural and urban subsamples can be found in Table 4.

The F-Ratios in Table 4 refer to differences between the rural and urban samples. As can be seen in Table 4, differences between the two subsamples are quite extensive. The urban sample is older than the rural, uses more complex fishing gear, is composed of fewer boat owners, and is less likely to look favorably upon one's son becoming a fisherman. With regard to self-evaluation of socioeconomic position, the urban fishermen are higher both five years in the past and the future. Overall, however, the urban fishermen feel that they are worse off today than five years in the past, thus

TABLE 1. Percent Distribution of Preconditions for Investment in Additional Fishing Equipment

Condition	Percent
More fish	68
More financing	21
Nothing	5
Better prices	3
Pay off present debts	1
Need for spare equipment	1
Loss of present equipment	1

N = 80

TABLE 2. Percent Distribution of Equipment Types Mentioned as Possible Investments

Equipment Type	Percent
Net (trasmallo)	46
Launcha (vessel)	29
Line	15
Nothing	5
Motor	3
Boté (small boat)	1
Whatever I lose	1

N = 80

TABLE 3. Percent Distribution of Consumption Aspiration Responses

Response	8500 Colones Percent	1500 Colones Percent
Fishing equipment (general)	44	39
Launcha	9	0
Equipment for vessel	6	2
Boté	3	4
Motor	3	1
Down payment on equipment	0	2
Agricultural equipment and seed	1	0
Study	0	1
Buy fish to sell	0	2
Buy animal to fatten	0	2
Put in bank	4	3
Save (bank not mentioned)	3	6
Non-investment responses (e.g., clothes, household items, etc.)	26	38

N = 125

TABLE 4. Distributions of Independent Variables

Variable	Total Sample	Urban Sample	Rural Sample	F-Ratio	d.f.	p
Age	30.7	32.7	27.6	5.15	1 123	<.05
Education	3.6	3.9	3.2	1.97	1 123	>.05
Years Fishing Experience	12.3	12.6	11.8	0.23	1 123	>.05
Own Boat (%)	.38	.31	.50	4.85	1 123	<.05
Fishing Gear (scale)	3.7	3.3	4.3	14.61	1 123	<.001
Ladder T_0	4.4	4.5	4.1	0.77	1 123	>.05
Ladder T_{-5}	4.4	5.1	3.2	16.31	1 123	<.001
Ladder T_{+5}	7.2	7.8	6.4	5.13	1 83*	<.05
Ladder $T_0 - T_{-5}$	0.0	-0.6	0.9	6.81	1 123	<.05
Ladder $T_{+5} - T_0$	2.6	2.9	2.3	1.15	1 83*	>.05
Like Son to Become Fisherman	.46	.33	.64	12.31	1 123	<.001
Watch TV (days/week)	2.7	2.8	2.7	0.06	1 123	>.05
Listen to Radio (days/week).	5.2	4.7	6.1	7.52	1 123	<.01
Read Newspaper (days/week)	1.8	2.8	0.3	26.71	1 123	<.001
Read Magazine (days/week)	0.9	1.2	0.5	3.50	1 123	>.05
Go to Cinema (days/week)	1.2	1.9	0.1	22.96	1 123	<.001
Mass Media Exposure Scale	11.9	13.4	9.7	7.63	1 123	<.01
Running Water (%)	.52	.83	.06	159.86	1 123	<.001
Electricity (%)	.49	.81	.02	187.79	1 123	<.001
Radio (%)	.82	.79	.86	1.07	1 123	>.05
TV (%)	.34	.56	.02	56.43	1 123	<.001
Refrigerator (%)	.13	.21	.00	13.34	1 123	<.001
Sewing Machine (%)	.30	.33	.24	1.25	1 123	>.05
Toilet Indoors (%)	.35	.57	.02	58.46	1 123	<.001
Material Culture Scale	2.2	3.3	0.4	125.68	1 123	<.001
Income (maximum month) Colones	1988	2414	1416	9.53	1 115*	<.01
Income (minimum month) Colones	463	623	248	19.60	1 115*	<.001
Income (past year) Colones	11,153	13,711	6838	5.18	1 41*	<.05
Income (past month) Colones	670	824	432	7.73	1 100*	<.01
Farmer Father (%)	.25	.23	.28	0.45	1 123	>.05
Fisherman Father (%)	.53	.43	.68	8.10	1 123	<.01
Income Periodicity	.74	.71	.78	4.72	1 115*	<.05

*d.f. varies due to missing data on income and ladder questions.

contrasting with the rural who report that they are in a more favorable position. As would be expected, urban fishermen are more exposed to the mass media and score higher on the material culture scale. This is a direct result of the ready availability of electricity, city water, and mass media in the urban setting. Urban fishermen's incomes are also significantly higher than the rural. Income periodicity, however, is greater in the rural area. Finally, a larger percentage of rural fishermen have fathers who are also fishermen.

Interrelationships between Independent and Dependent Variables. turning first to gratification orientations, the correlations between most of the independent variables and the EGOCOMP Scale can be found in Table 5.

Ladder T_{+5} (response) in Table 5 refers to whether or not the respondent refused to guess where he would be on the ladder of life test five years in the future. This variable was created because a significant proportion of the sample refused to hazard a guess concerning the future. It is suggested that refusal to respond to the future component of the ladder test indicates a feeling of lack of control over the future (a non-efficacious feeling). This variable was therefore dichotomized with individuals who give a response receiving a value of one, and those who refuse to respond a value of zero.

Overall, the results are relatively weak. As can be seen in Table 5, only fishing gear complexity and minimum month income are significantly related to the EGOCOMP Scale in both the total sample and the urban subsample. The material culture scale is significantly related to the EGOCOMP Scale only for the total sample.

The results are especially surprising with regard to income periodicity. We have earlier argued and presented strong findings indicating that income periodicity is positively related to a deferred orientation (Pollnac, Gersuny, and Poggie, 1975; Pollnac and Poggie, 1978). On retrospect however it seems possible that there might be a non-linear relationship between periodicity and the EGOCOMP Scale. Periodicity, up to a certain level, may stimulate a deferred orientation as has been argued in previous papers (Pollnac, Gersuny and Poggie, 1975; Pollnac and Poggie, 1978). Nevertheless, it could be argued that a very high level of periodicity may result in a situation of insecurity and instability which could have just the opposite effect. Examination of a scattergram of the two variables suggested that this is, in fact, the case.

Second order polynomial regressions were calculated between the dependent variable and periodicity for the total sample and each subsample. This analysis indicated that the relationships are not statistically significant for either the total sample or the rural sample ($R = 0.20$ and $R = 0.07$, respectively; $p > .05$). The results are, however, statistically significant for the urban subsample ($R = 0.33$; $p < .05$).

Finally, despite extensive differences between the two subsamples with respect to variables found to be related to economic gratification orientations in other studies, we find that the rural and urban subsamples are not significantly different with respect to mean EGOCOMP Scale scores (1.44 versus 1.29, respectively; F-Ratio = 1.136, d.f. = 1 123, $p > .05$).

As a means of determining combined effects of independent variables on economic gratification orientations, a stepwise multiple regression procedure was used to further analyze the data. In this procedure all independent variables are intercorrelated with the dependent variable, and the independent variable which explains the most variance is entered into the equation first. The next variable entered is the one which explains the most variance with the first controlled. This procedure is continued until all variables are entered or a previously set criterion is reached. In the analysis presented here, entry into the regression equation was restricted to variables which add at least 2 percent to the total amount of variance explained. The rural subsample was not independently analyzed since it manifests no significant relationships between the independent and dependent variables. The results of this anlaysis with respect to the total sample can be found in Table 6.

TABLE 5. Correlations between EGOCOMP Scale and Independent Variables for Total Sample and Subsamples

Variable	Total Sample	Rural Sample	Urban Sample
Age	-.09	-.09	-.06
Education	-.01	-.01	.01
Years Fishing Experience	.09	.00	.14
Own Boat	.03	.00	.01
Fishing Gear Complexity	.18*	-.12	.30*
Ladder T_0	-.16	-.22	-.11
Ladder T_{-5}	-.03	-.07	.05
Ladder T_{+5} (response)	.16	.23	.10
$T_0 - T_{-5}$	-.10	-.13	-.13
Like Son to become Fisherman	.15	.06	.17
Mass Media Exposure Scale	-.08	-.02	-.06
Material Culture Scale	-.19*	-.17	-.18
Maximum Month Income	-.16	.06	-.22
Minimum Month Income	-.22*	.01	-.26*
Father Farmer	-.14	-.21	-.11
Father Fisherman	.17	.20	.13
Income Periodicity	.13	-.07	.23
N	117	50	67

*$p < .05$

Table 6 indicates that three independent variables--minimum monthly income, father farmer, and material culture--explain 9 percent of the variance in the dependent variable. This multiple correlation is statistically significant at each step, but the total amount of variance explained by these three variables is disappointingly small.

Turning next to the urban subsample, the second order polynomial regression between periodicity and the EGOCOMP Scale was forced into the equation first. This procedure was justified by the fact that the curvilinear correlation between periodicity and the dependent variable was higher than that between the EGOCOMP Scale and all other independent variables. The stepwise procedure was initiated following the entry of periodicity. The results of this analysis can be found in Table 7.

With regard to the urban subsample, the first five independent variables entered explain a total of 26 percent of the variance in the dependent variable. This modest, but respectable, amount is statistically significant at the .01 level.

Turning to the question concerning small-scale fishermen's preconditions for further investment in fishing equipment, high frequency categorized responses were cross tabulated with age and education dichotomized at their sample means (30.6 and 3.6 years, respectively), years fishing experience dichotomized at ten and ten or more years, area of residence and net fishing (in any combination with or without line fishing) versus long or hand line fishing only. The results of this analysis can be found in Table 8.

As can be seen in Table 8, only age and education are significantly related to the dependent variables. First, we find that older fishermen are more likely than younger fishermen to suggest that more financing is an important precondition for investment in additional equipment (32 versus 12 percent, respectively; $X^2 = 5.143$, $p < .05$). Next, we see that fishermen with more than the sample mean years of education are more likely to use "more fish" (78 versus 53 percent; $X^2 = 5.713$, $p < .02$) and less likely to use "more financing" (13 versus 32 percent; $X^2 = 4.355$ $p < .05$) as preconditions for investment in additional equipment.

Equipment types mentioned as possible investments were cross tabulated with the same independent variables, and the results of this analysis can be found in Table 9.

Table 9 indicates that only area of residence and use of net are related to possible investments in fishing equipment. First, 56 percent of the urban fishermen, in contrast to only 30 percent of the rural said that they would invest in a fishing net ($X^2 = 5.098$, $p < .05$). Finally, net fishermen are more likely to make further investments in nets (65 versus 21 percent; $X^2 = 15.663$, $p < .001$) and less likely than non-net fishermen to make further investment in a launcha (20 versus 41 percent, respectively; $X^2 = 4.457$, $p < .05$) or long lines (7 versus 26 percent, respectively; $X^2 = 6.102$, $p < .02$). Figure 1 graphically displays the investment orientations of the different types of fishermen.

III. Discussion and Conclusions

Turning first to preconditions for further investment in capital equipment, we have seen that older fishermen and those with less education are those most likely to note that they would invest in more fishing equipment if more financing were available. Fishermen with more than the sample mean years of education, however, are more likely to argue that they would like to see an increase in fish available for capture before they make further investments in equipment. This finding makes sense in light of the fact that 8[illegible] percent of the fishermen with four or more years of education in contrast to only 59 percent of those with less than four years, indicated that the amount of fish available for capture has decreased over the years ($X^2 = 5.547$, $p < .02$).

TABLE 6. Stepwise Multiple Regression between EGOCOMP Scale and Independent Variables for Total Sample

Variable Entered and Controlled	Partial to Enter	Multiple Regression with EGOCOMP Scale
Minimum Monthly Income	-.22	.22*
Father Farmer	-.16	.27*
Material Culture Scale	-.15	.30*

N = 117 *p < .05

TABLE 7. Stepwise Multiple Regression between Independent Variables and the EGOCOMP Scale for the Urban Subsample

Variable Entered and Controlled	Partial to Enter	Multiple Regression with EGOCOMP Scale
Periodicity (2nd order polynomial)	.33	.33*
Fishing Gear Complexity	.25	.41**
Like Son to be Fisherman	.21	.45**
Father Farmer	-.20	.48**
Material Culture Scale	-.19	.51**

N = 67 *p <.05 **p <.01

TABLE 8. Correlations (Phi) between Preconditions for Investment in Additional Fishing Equipment and Selected Independent Variables

Independent Variables	Precondition	
	More Fish	More Financing
Age	-.16	.25*
Education	.27**	-.23*
Fishing Experience	-.16	.07
Area of Residence	.12	.10
Use of Net	.05	.01

N = 80 *p <.05 **p <.02

TABLE 9. Correlations (Phi) between Equipment Types Mentioned as Possible Investments and Selected Independent Variables

Independent Variables	Equipment Type		
	Net	Launcha	Long Line
Age	-.11	.13	.03
Education	.09	-.07	-.06
Fishing Experience	-.10	.00	-.12
Area of Residence	.25*	.02	.11
Use of Net	.44***	-.24*	-.28**

N = 80 *p <.05 **p <.02 ***p <.001

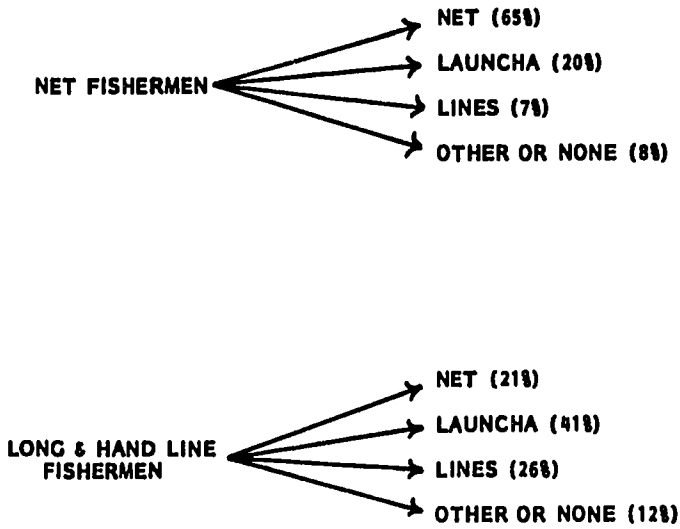

Figure 1.--Investment Orientations of Long and Hand Line and Net Fishermen.

In general, most fishermen agree that average catches are decreasing, but the more educated are less likely to view increased financing of equipment as a solution to the problem.

With regard to fishing equipment as possible investments, it can be seen that, in general, fishermen have a tendency to reinvest in the same general type of equipment that they are already using. The positive relationship between urban residence and orientation toward investment in nets can be explained by the fact that there is a greater percentage of net fishermen in the urban area, and net fishermen tend to say that they would invest in more nets.

Turning to the correlates of gratification orientations, we found strong rural/urban differences. As a matter of fact, the significant zero order correlations for the total sample probably result from the significant correlations between the dependent and independent variables within the urban sample. We will therefore focus our discussion on the urban sample.

The analysis indicates that there is a tendency for deferred economic gratification orientations to increase, level off, then decrease as the degree of income periodicity increases in the urban subsample. It is interesting to note that although the rural subgroup manifests a higher degree of income periodicity than the urban subsample there is no significant difference in economic gratification orientations between the two areas. This suggests that situational factors might be affecting the relationships between the two variables.

As periodicity of income increases, skillful management becomes essential for survival. A future orientation must be maintained to preserve and allocate income to support one's self and family during periods of little or no production (Pollnac, Gersuny and Poggie, 1975; Pollnac and Poggie, 1978). It was suggested above, however, that after periodicity of income increases to a certain point, economic insecurity may result. Several investigations have related economic predictibility and security to gratification orientations (Rodgers, 1967; Meade, 1971; Robbins and Thompson, 1974; Thompson, 1975; Pollnac and Poggie, 1978; Margolis, 1977). At this higher level of income periodiity, with its concomitant economic insecurity, the individual is living from day-to-day, probably in debt to friends, family, shopkeepers, and middlemen. If he does not spend what he receives, it may soon be claimed by his creditors. Several situational factors may account for the differential existence of these phenomena in the rural and urban subsamples.

It was noted above that individuals in the rural area are much less tied into the cash economy than those in the urban area. In the rural area many small-scale fishermen have subsistence plots and domestic animals (usually pigs and chickens) to help them through less productive periods. Additionally, food can be bought or bartered from family, friends, or local farmers at much lower prices than in the city. Thus a high level of fishing income periodicity probably does not generate insecurity in the rural area since other resources are available. Further, subsistence plots and domestic animals probably assist in leveling out overall periodicity.

In the urban area fishermen are locked into the cash economy. There is much less space for subsistence plots and domestic animals; thus, almost all non-fish food is purchased from local shopkeepers. Electricity and luxury goods such as televisions and refrigerators are readily available. Televisions are extremely expensive in Costa Rica, yet over 50 percent of the urban fishermen report that they own one (only one fisherman in the rural sample owned one along with a generator which was necessary for its operation). The urban small-scale fishermen obtain these luxury goods on credit, thus locking themselves into monthly payments for both utilities and the items themselves. Thus, for the urban fisherman, increases in periodicity demand a deferred orientation in order to pay bills and purchase food. When periodicity of income goes beyond a certain point, however, the urban fisherman, in contrast to the rural, goes further into debt and has little opportunity to invest in

the future. His funds become committed to past purchases and present existence.

This same type of explanation holds for the significant negative zero-order correlation between minimum monthly income and gratification orientations in the urban area. This correlation indicates that the lower the minimum monthly income, the more deferred the individual fisherman. Once again, this is adaptive in the urban context where fishermen are locked into the cash economy. The smaller the minimum monthly income, the more one needs a deferred orientation to put aside money earned in more productive months for support in lean months. In the rural area, as described above, lesser involvement with the cash economy and alternative food sources reduces the effects of small minimum monthly fishing incomes.

The strong positive relationship between the fishing gear complexity scale and the EGOCOMP Scale indicates that as gear complexity increases, the deferred orientation decreases. Since most responses coded as deferred are fishing equipment, it appears that those who already use complex equipment are less likely to say that they would use a sudden windfall of money for more equipment. Apparently the need for additional gear is not very salient among fishermen who are adequately equipped. The alternative explanation that those with more complex equipment have lower periodicity and higher minimum monthly incomes thus reducing the need to defer was rejected because correlations between these income variables and gear complexity were -.12 and -.22, respectively, within the urban sample ($N = 67$, $p > .05$).

Once again we find important situational constraints affecting the relationships between economic gratification orientations and other variables. In this case, economic gratification orientations are related to income periodicity and minimum monthly income only in the urban area where small-scale fishermen are committed to the cash economy and often in debt due to the credit structure. Further, income periodicity and minimum monthly income are related to economic gratification orientations only where the effects of these variables are not leveled out by less obvious incomes such as produce from subsistence plots and small domestic animals. The importance of this variable in contexts of planned change suggests that the situational determinants of economic gratification orientations are of utmost significance, and development schemes should be involved with creating environments favorable to deferred orientations if they are to succeed.

Study Two — Income Periodicity and Expectations of Goal Attainment among Small-Scale Fishermen in the Gulf of Nicoya, Costa Rica

By M. Robbins, R. Pollnac and L. Robbins[1]

There is a large and growing literature in the behavioral sciences which shows that peoples' subjective perceptions and evaluations of their life situations and their expectations and plans for the future are essential ingredients in any research paradigm which seeks to explain a sizeable proportion of their behavior.[2]

Important to this perspective is the notion that people inhabit and adapt to "meaningful environments" as well as objective sets of circumstances. That is, people simultaneously exist in multiple environments, both subjective and objective, and the degree of congruence between them is at best problematic. Accordingly, a group of individuals living in ostensibly similar objective situations may, or may not, all be in the same subjective "psychological situation." The obverse of course is also true. Assuming this enables us conceptually to cope with the fact that people in similar objective situations, say social locations (e.g., social classes, occupations, marital and legal statuses, residences, etc.) need not *a priori* be expected to all think and feel the same way, nor engage in the same behavior (e.g., remain in these locations for the same duration; follow similar alternative courses of action;

respond the same to the same stimuli, etc.). This is because at least some of the variation in people's mental and outward behavior (especially optative as opposed to coerced behavior), can be presumed to be governed by their available knowledge, evaluations of their situations and perceived opportunities and expectations concerning the future. In other words, because part of their behavior is determined by their subjective environment.

An important consequence of this perspective is that it allows research aimed at assessing the "psychological situation" to achieve parity with research aimed at assessing "ecological," "demographic," "economic" and "sociological" situations because variables and data drawn from all these approaches (and perhaps others) are normally required to complete a full understanding of human behavior in any given instance. It also forces us to realize that the "definition of a situation" imparted to it by "analysts," "development-agents" and "applied behavioral scientists" may be at odds with the definition of the situation imparted to it by the target populations themselves. Finally, it makes the search for the nature and correlates of subjective psychological dispositions of fundamental concern.

I. The Hypotheses

With the above thoughts in mind we intend to examine the relationship between objective economic conditions existing among small-scale fishermen in Costa Rica and their subjective expectations of life-goal attainment. Our definition of "expectations" follows Inkeles, who has described them as expressions of "...the subjective probability that events, including some that are aspired to, will actually occur" (1976, p. 25).

Although fishing as a way of life has many desirable qualities associated with it, Alexander (1977, p. 235) has observed correctly that "fishing is everywhere regarded as an industry of great risk and uncertainty" (cf. Poggie, Pollnac, and Gersuny, 1976; Pollnac, 1976). Among other things, yields fluctuate drastically and market conditions are unstable. Investments in equipment are high and subject to severe damage, loss and depreciation. Replacement and recurring costs are considerable and subject to inflation. And personal safety is often jeopardized to some extent.

However, within this framework of risk there is some degree of variation in the extent to which all fishermen experience these conditions. Some for example, for a variety of reasons, simply manage to be more consistently successful than others (Poggie, 1977, 1979). So, while there are undoubtedly many demonstrable similarities among all fishermen, when compared to other occupational groups (Aronoff, 1967; Poggie and Gersuny, 1974) there is also some variation among fishermen themselves; and not all of them can be expected to perceive their situations in exactly the same way nor shar the same expectations about the future.

Since fishing is primarily an economic venture, we believe it is reasonable to assume that periodicity of income received from fishing should be a critical factor shaping the lives and outlooks of fishermen (Pollnac, Gersuny, and Poggie, 1975). In particular we shall concentrate on exploring the relation between income periodicity and expectations of most desired life-goal attainment.

Heuristically, one way to examine the nature of this relationship is in terms of economic security. Other things being equal (e.g., total income earned) one can assume that fishermen who experience relatively low income periodicity will feel more secure and thus be relatively more optimistic about attaining the goals they aspire to than fishermen experiencing higher income periodicity. According to this view, people adjust their expectations to what they know they will objectively get and value what they have more than what they do not have (Inkeles, 1976; Bluhm, 1975). Economic security and predictability are thus conceived as potentiating factors which enable them to

achieve these ends, especially if these ends involve or depend upon economic resources.

While on the surface this view seems quite reasonable, and is certainly worthy of consideration, closer inspection of the matter allows us to frame an alternative proposition. If we start by assuming that peoples' expectations are only loosely tied to reality and involve desires for improving their existence and attaining things not presently possessed, as well as simply retaining present satisfactions, the picture changes. From this angle, fishermen with low income periodicity might not necessarily be expected to be particularly optimistic. In fact, they might be expected to be rather "inertial." That is, they may feel rather secure in thinking they will remain about where they are but not be particularly optimistic about attaining goals they presently do not possess. In fact, if they perceive their relatively "fixed-income" as a "bind" they might feel rather pessimistic about attaining them at all.

On the other hand, those experiencing high income periodicity might be less "intertial" and either more optimistic or pessimistic. That is, their fluctating income could mean either opportunity or failure. A directional prediction is difficult to make. However, since fishing in general is an occupation of considerable risk, being optimistic would seem to be the most likely adaptive psychological strategy. In fact optimism could be considered a rationalization and affirmation of persistence in the face of known vicissitudes. Hence, we would predict that, under conditions of high income periodicity, fishermen will tend to be more optimistic than pessimistic. To feel otherwise would be "cognitively dissonant" (Festinger, 1957) and probably lead them to leave fishing and turn to other jobs.

With this as background, two alternative hypotheses were formulated. Namely that, within the limits of random error and overall income being roughly equal.

Hypothesis I: Fishermen experiencing relatively low income periodicity will display comparatively more optimism in their expectations of most desired life-goal attainment than fishermen experiencing high income periodicity.

Hypothesis II: Fishermen experiencing relatively high income periodicity will display comparatively more optimism in their expectations of most desired life-goal attainment than fishermen with low income periodicity.

II. The Evidence

Data for this paper are based on interviews conducted in Spanish with 125 small-scale fishermen from the Gulf of Nicoya, Costa Rica. A sample of 75 was drawn from Barrio el Carmen, Puntarenas, and a sample of 50 small-scale fishermen was interviewed at Costa de Pajaros.

Income Periodicity. Periodicity of income (IP) was measured by asking individual fishermen how much income they earned from fishing in both maximum and minimum months and dividing the difference by the maximum or

$$IP = \frac{x - y}{x}$$

where x is the maximum and y is the minimum. This ratio varies between zero (no periodicity) and one (maximum periodicity). For purposes of analysis the sample was divided at the mean producing two subgroups: (1) High Periodicity Group--hereafter HPG--with an income periodicity $\geq .75$ (n = 60); and (2) Low Periodicity Group--hereafter LPG--with a periodicity ratio $< .75$ (n = 57).

Table 10 contains income information on these two groups. First, there is

no significant difference between their (a) annual fishing income, (b) annual income from other sources, (c) total income (a + b combined) and (d) income from the month immediately preceding the interview. Second they do differ significantly in (a) maximum months income from fishing (HPG higher) and (b) minimum months income (LPG higher). Third, they differ significantly, as expected, in periodicity of income (HPG higher). In sum, while overall income and fishing income is about the same, HPG have higher maximum months of earnings from fishing but also lower minimums. The opposite is true of LPG.

Table 11 compares these two groups on other variables which might be conceived as potentially affecting expectations of goal attainment. Table 11 indicates that the two groups differ with respect to material style of life. Surprisingly, those with the lowest periodicity (and the lowest income) manifest a more elaborate material style of life. This can probably be explained by the fact that a steady income is more conducive to the purchase of large scale household items on credit. There is no significant difference between the two groups with respect to age, years fishing experience, number of dependents, years of formal education, or exposure to mass media.

Expectations of Goal Attainment. This variable was measured with the Ladder of Life Test (Cantril, 1963). This test consists of showing a respondent a ladder diagram with ten rungs. At the top (10) he is to imagine the best possible life and at the botton (1) the worst possible life. He is then asked to indicate where he is on the ladder at present, where he was five years ago, and where he expects to be five years in the future. In the present study "optimism" is defined as expecting to be on a higher rung in the future than at present. "Pessimism" is defined as expecting to be on a lower rung than at present and "Inetria" is defined as expecting to remain in the same position in the future as one is at present (more on this below). This test is considered useful for comparative purposes because it is "self-anchoring" that is, a respondent determines for himself what is the "best" and "worst" possible life and positions himself accordingly at each time period.

As a means of providing some cultural content to ladder diagram responses, perceptions of the best possible life were determined by asking each fisherman to describe the best thing that could happen in the future. Categorized responses to this question can be found in Table 12. Overall, the majority of responses concern economic factors including attainment of things not presently possessed.

Further information which may be of value in interpreting responses to the ladder question can be found in Table 13 which provides categorized response frequencies to a question concerning fishermen's perceptions of factors influencing their attainment of goals (i.e., where the fisherman expects to be on the ladder of life five years in the future). As can be seen in Table 13, the two highest frequency responses categories refer to factors which are basically under control of the individual fisherman, and the third highest, the attainment of the tools of production to build toward and maintain life goals.

During the interview 15 respondents or 25 percent of the HPG refused to guess their position five years in the future and 20 respondents or 35 percent of LGP also refused. This difference is not statistically significant (X^2 = 1.42, p > .05). This reduced the size of the HPG subsample to 45 and the LPG subsample to 37. The HPG is 51.1 percent rural and the LPG is 40.5 percent rural. This difference is also not statistically significant (X^2 = .91, p > .05).

In Table 14 we present the mean ladder positions of both of these groups at each time period and the difference of means between the future and the present and the present and past for both groups. In each instance there is no significant difference between them.

TABLE 12. Fishermen's Perceptions of the Best Thing that Could Happen in Their Future

Response	Percent Distribution
More or better fishing equipment	34
Own home or property	15
Better, more happy, comfortable life	14
Have enough money to buy what I want	13
Be healthy	06
Be in another occupation	04
Have work	03
Other	10

TABLE 13. Fishermen's Perceptions of Factors Influencing Goal Attainment

Response	Percent Distribution
Work hard	27
Save	19
Fishing equipment	18
Things (fishing) getting worse	09
Find help (partner, etc.)	08
As it is, it is good	08
Other	12

TABLE 14. Mean Ladder of Life Comparisons

Ladder Position	HPG	LPG	F	df*	P
Present (time t)	4.39	4.57	.13	1/115	>.05
Past (time t-1)	4.26	4.63	.482	1/115	>.05
Future (time t+1)	7.02	7.28	.164	1/80	>.05
Future - Present	2.19	2.76	1.112	1/80	>.05
Present - Past	0.131	-0.054	.091	1/115	>.05

*df varies because of refusal to guess t + 1.

TABLE 10. Mean Incomes of Costa Rican Fishermen

Income	HPG	LPG	F	df*	P
Total**	137.74	116.53	0.379	1/38	>.05
Fishing**	118.7	108.74	0.101	1/40	>.05
Other**	15.73	10.78	0.466	1/90	>.05
Maximum Month***	231.64	162.95	4.414	1/115	<.05
Minimum Month***	26.97	67.32	23.863	1/115	<.001
Previous Month***	65.94	69.68	0.067	1/99	>.05
Periodicity	0.59	0.872	226.95	1/115	<.001

*df varies due to missing income data.

**measured in 100's of Colones (one U.S. Dollar equals approximately 8.5 Colones).

***measured in 10's of Colones.

TABLE 11. Comparison of High and Low Periodicity Fishermen on Selected Variables

Variable	LPG	HPG	F	df	P
Age	30.9	30.2	0.090	1/115	>.05
Years Fishing	11.5	12.7	0.496	1/115	>.05
Dependents	3.3	3.5	0.134	1/115	>.05
Formal Education	4.0	3.5	0.942	1/115	>.05
Mass Media Exposure*	12.7	11.2	1.263	1/115	>.05
Material Style of Life**	3.4	2.5	5.800	1/115	<.05

*Scale formed by summing number of days per week exposed to television, radio, newspapers, magazines, and cinema. Item total correlations for each scale item ranged between 0.41 and 0.63 (p <.01).

**Scale formed by determining total number of items from the set (running water, electricity, radio, television, refrigerator, sewing machine, indoor toilet) present in household. Item total correlations range between 0.21 and 0.82 (p <.05).

III. Analysis

A Stochastic Process Model. We shall use a stochastic process model to examine the relative predictive efficacy of the two alternative propositions. In so doing we shall conceptualize expectations of life goal attainment (or responses to the ladder of life test) as a probabilistic temporal process. "...in a processual model or atochastic process a phenomenon is represented as a set of states that are maintained over time or are altered in accordance with a set of transition probabilities" (White, 1973, p. 373). A major advantage in doing so is that this does not restrict comparisons of perceived and expected degree of goal attainment to a single point in time. Since the propositions themselves call for a comparison of tendencies toward a change (optimism--expected ascent on the ladder, and pessimism--expected descent on the ladder) or stability (inertia--no expected change on the ladder) over time in expected goal attainment between HPG and LPG this method may reveal differences that would not otherwise be apparent if only single time periods were considered (Robbins, Robbins, and Pollnac, 1977).

Several conditions make this mode of analysis appropriate for the present study. (1) The number of positions (or "states" in the language of stochastic processes) on the Ladder of Life Test is finite. This is given by the nature of the choice task. (2) Observations of respondent's perceptions of their positions at more than one, equally spaced time interval (5 year period) are available. This is given by the nature of the "synthetic" panel design. (3) A transition probability matrix can be constructed from the proportion of respondents expecting to be in a specific position, or state on the Ladder of Life Test, at one time period (e.g., future) according to their perceived position, or state, at another (e.g., present). And (4) the mathematical machinery of Markov chains can be employed to model the process of expected life-goal attainment (Kemeny and Snell, 1960). The Markov model assumes that (a) the number of positions, or "states" is finite, (b) observations are available at more than one time interval, (c) a respondent's state at time $t + 1$ depends at most upon his state at time t, and (d) transition probabilities among states remain constant over time. Assumptions (c) and (d) are of course subject to doubt and normally require empirical verification. In the present study, however, this matters little since we do not intend to use the actual longitudinal projections extrapolated from the model. Rather, we are interested in detecting certain consequences that would result *if* transitions among states, determined by a matrix of transition probabilities, governed an infinite period. These ultimate consequences are interpreted as tendencies implicit in the nature of the transition matrices of expected goal attainment. In other words, the utility of the model is not contingent upon whether or not the empirical patterns "fit" a Markov Chain process, but rather on its value as a frame of reference for analyzing the cross-sectional data and for comparing the structure of potential shifts between the two groups.[3]

We shall use this model to examine differences between the HPG and LPG groups, and test the two alternative propositions in three interrelated ways: (1) Compare the structure and content of the transition probability matrices to determine which group is proportionately more optimistic, pessimistic and inertial. (2) Extrapolate and compare the relative distance: (a) each group as a whole is from ultimately attaining its life-goals, (b) and individuals in each group are from attaining their life-goals according to their present position. And (3) Compare the velocity of the process of goal attainment of each group.

Results. In Table 15 we present probability vectors of LPG and HPG at time t (present) time $t - 1$ (past or 5 years ago) and time $t + 1$ (future or 5 years in the future). The components of three vectors specify the proportion of respondents in each ladder position (or state) at the three time periods.[4] A two-sample Kolmogorov-Smirnov test (Siegel, 1956) revealed no significant differences (at .05 level) between the LPG and HPG at each

separate time period. These results are similar to those reported in Table 14 which showed no significant differences between these groups in mean ladder positions at each time period. Focusing on each time period separately then few differences are apparent.

Table 16 displays the transition probability matrices from present to future for each group. Each p_{ij} element in the matrices indicates the proportion of the sample who expect to be in a specific state in the future (t + 1) according to where they perceive themselves to be at present (t). For example, consider the top row of the LPG transition matrix. The proportion of LPG at position 1 (S_1) at present who expected to remain at position 1 (S_1) in the future is .375. The proportion of LPG at position 1 (S_1) at present who expect to be at position 2 (S_2) in the future is .00, at position 3 (S_3) and 4 (S_4) in the future .25, at position 5 (S_5) .125 and so on. Since all rows in the matrices sum to 1 these proportions are mathematically equivalent to probabilities. Each matrix then specifies the probabilities of the five possible transitions from state to state over one five-year interval. Hence, it is called a "transition probability matrix." With the data transformed into these arrays it is possible to begin our comparison of the relative degree of optimism, pessimism and intertia of each group. For example, the proportions of each sample above, below, and on the main diagonal provide an approximate, but convenient, index of the relative amount of optimism, pessimism, and intertia respectively between the two groups. These figures are provided in Table 17.

Two different techniques were used to calculate the values in Table 17. At the top are the percentages with those remaining in S_1 and S_5 included in the measure of inertia. Below are found the same figures but with those remaining in S_5 included in the measure of optimism and those remaining in S_1 included in the measure of pessimism. This latter measure is perhaps more reasonable since S_5 is the highest step on the ladder and confidence in remaining there five years into the future should indicate some optimism. Likewise expecting to remain on the bottom should indicate some pessimism. These results tend to show some differences between the two groups. While for the most part both groups are predominantly optimistic, viewed either way, there is a greatertendency for HPG to display significantly more optimism and less pessimism and inertia with regard to attaining their most desired life-goals than LPG. Using a chi-square test the groups differ significantly on the first measure (X^2 = 6.68, df 2, $p < .05$) and the second (X^2 = 6.43, df 2, $p < .05$). These findings support Hypothesis II.

Some further comparisons can also be made. In the transition probability matrices of both groups S_5 (element p_{55}) is a terminal, or absorbing, state which once entered is never left (i.e., the probability of remaining in S_5 is 1.00). Since it is possible to reach this state from every other state (though not necessarily in one transition or five-year interval) we are dealing with absorbing (as opposed to regular) Markov chains (Kemeny and Snell, 1960, pp. 35-39). This guarantees an important consequence--the probability that the groups will eventually be absorbed is 1. That is, if the process of life goal attainment were to continue as it started, then everyone in both groups will eventually reach their highest or more desired life goal or state (S_5) and remain in it.[5] The procedure for demonstrating this is straightforward and can be accomplished using a little matrix algebra. If p is a row vector, the components of which specify the proportion of the population in each state at the present time 1 (see Table 15), and P is the matrix of transition probabilities from time t (present to t + 1 (future) (see Table 16), then

$$p^{(t+1)} = p^{(t)}P \qquad (1)$$

where $p^{(t+1)}$ is the future vector the components of which specify the proportion of the population in each of the states at t + 1 (5 years in the

TABLE 15. Probability Vectors at Ladder Positions at Each Time Period*

	S_1	S_2	S_3	S_4	S_5
Past					
HPG	.422 (19)	.156 (7)	.178 (8)	.133 (6)	.111 (5)
LPG	.243 (9)	.189 (7)	.298 (11)	.135 (5)	.135 (5)
Present					
HPG	.288 (13)	.267 (12)	.20 (9)	.178 (8)	.067 (3)
LPG	.216 (8)	.135 (5)	.324 (12)	.19 (7)	.135 (5)
Future					
HPG	.06, (3)	.111 (5)	.222 (10)	.156 (7)	.444 (20)
LPG	.108 (4)	.082 (3)	.135 (5)	.243 (9)	.432 (16)

*numbers in parentheses.

TABLE 16. Transition Probability Matrices from Present to Future

Hi Periodicity Group

To: Future

From: Present

	S_1	S_2	S_3	S_4	S_5
S_1	.231	.231	.231	.154	.154
S_2	.00	.083	.417	.00	.50
S_3	.00	.00	.00	.556	.444
S_4	.00	.125	.25	.00	.625
S_5	.00	.00	.00	.00	1.00

Lo Periodicity Group

To: Future

From: Present

	S_1	S_2	S_3	S_4	S_5
S_1	.375	.00	.25	.25	.125
S_2	.20	.60	.00	.20	.00
S_3	.00	.00	.25	.417	.333
S_4	.00	.00	.00	.143	.857
S_5	.00	.00	.00	.00	1.00

TABLE 17. Matrix Index of Optimism
Present to Future*

	Optimistic	Inertial	Pessimistic
Measure I			
HPG	.778 (35)	.156 (7)	.067 (3)
LPG	.568 (21)	.405 (15)	.027 (1)
Measure II			
HPG	.844 (38)	.022 (1)	.133 (6)
LPG	.703 (26)	.189 (7)	.108 (4)

*number in parentheses.

future) (see Table 15). It can also be shown recursively that

$$\underline{p}(\underline{t} + n) = \underline{p}(\underline{t})\underline{p}n \qquad (2)$$

that is, by raising $\underline{P}$ to the $\underline{n}^{th}$ power and then premultiplying by $\underline{p}(\underline{t})$ one obtains the proportion in each state at time $\underline{n}$. For example, to extrapolate the proportion of the population in each of the states at time $\underline{t}$ + 2 (10 years into the future) we use the equation

$$\underline{p}(\underline{t} + 2) = \underline{p}(\underline{t})\underline{p}2 \qquad (3)$$

To determine if the process will eventually terminate in an absorbing state and, the number of time intervals this will take, we can simply estimate, by successive exponentiation of the matrices in Table 16, the time intervals in the future (or powers of $\underline{P}$) where each column has the same values to one significant digit (see Table 18). In the case of LPG this occurs at the 14th power of $\underline{P}$ (or $\underline{P}^{14}$)--all the elements of the first 4 columns of $\underline{P}^{14}$ are .000, and all the elements of the fifth column are 1.000 (see Table 18). Thus, in accordance with the absorbing nature of the transition matrix, everyone in the LPG sample can be expected to reach the most desired life goal (or state S_5) and remain there after 14 time intervals. For the HPG this occurs at the 8th power of $\underline{P}$ or ($\underline{P}^8$). We can conclude from this, therefore, that the entire HPG will attain their most desired life state before (or faster) than the entire LPG. These results also support Hypothesis II.

To compare (1) average individual distances of members of each group from their most desired life-goals according to their position at present and (2) the expected number of time-intervals (5 year periods) they will spend in other positions before they reach this state, we compute $\underline{N}$ the fundamental equation of an absorbing Markov chain (Kemeny and Snell, 1960, pp 45-58)

$$\underline{N} = (\underline{I} - \underline{Q})^{-1} \qquad (4)$$

where $\underline{I}$ is an identity matrix with 1's in the main diagonal and 0's elsewhere and $\underline{Q}$ is the matrix of transition probabilities among the nonabsorbing states (S_1, S_2, S_3, S_4; see Table 16). Thus the quantity $(\underline{I} - \underline{Q})^{-1}$ is the inverse of the difference of ($\underline{I}$ - $\underline{Q}$). The $\underline{N}$ matrices of both groups are displayed in Table 19.

The $\underline{n}_{ij}$ elements in Table 19 display the expected number of time-intervals a person will remain in each position before reaching S_5 (the absorbing state) according to their starting state, or position on the ladder at present. Each row sum ($\sum_{j=1}^{4} n_{ij}$) specifies the expected total number of time-intervals it will take for a person to reach S_5 depending on their starting state. For example, consider the top row of the LPG $\underline{N}$ matrix. On the average a fisherman who perceives himself to be in S_1 at present on the ladder of life can be expected to spend 1.6 time-intervals at that state, 0 time intervals at S_2, .532 intervals at S_3 and .728 intervals at S_4 in the future before reaching S_5, the most desired life state. The sum of these elements = 2.86 and gives the average number of time-intervals it will take for that person to reach S_5 (i.e., 2.86 x 5 = 14.3 years). Comparing the LPG and HPG $\underline{N}$ matrices we see that they are quite similar. However there is (with the exception of S_4) a tendency for the average time to S_5 to be shorter for the HPG. In fact, taking the sum of all the elements of each matrix ($\sum_{i=1}^{n} \sum_{j=1}^{m} \underline{n}_{ij}$) and comparing them shows that the total number of time-intervals for LPG before reaching S_5 is 10.526 whereas for HPG this sum is 8.345. This shows that on the average HPG individuals are less distant from

TABLE 18. Absorbing State Matrix

$$\lim_{n \to \infty} \underline{P}^{(n)} = \begin{array}{c} \\ S_1 \\ S_2 \\ S_3 \\ S_4 \\ S_5 \end{array} \begin{array}{c} \begin{array}{ccccc} S_1 & S_2 & S_3 & S_4 & S_5 \end{array} \\ \begin{bmatrix} .00 & .00 & .00 & .00 & 1.00 \\ .00 & .00 & .00 & .00 & 1.00 \\ .00 & .00 & .00 & .00 & 1.00 \\ .00 & .00 & .00 & .00 & 1.00 \\ .00 & .00 & .00 & .00 & 1.00 \end{bmatrix} \end{array}$$

TABLE 19. Fundamental Matrices for Present to Future Absorbing Chains

--------- Hi Periodicity Group ---------

		S_1	S_2	S_3	S_4	Row Sums
	S_1	1.3	.41	.469	.614	2.793
	S_2	0	1.14	.475	.352	1.967
$\underline{N}$ =	S_3	0	.105	1.044	.775	1.924
	S_4	0	.189	.079	1.393	1.661
						8.345

--------- Lo Periodicity Group ---------

		S_1	S_2	S_3	S_4	Row Sums
	S_1	1.6	0	.532	.728	2.86
	S_2	.8	2.5	.266	.95	4.516
$\underline{N}$ =	S_3	0	0	1.33	.65	1.98
	S_4	0	0	0	1.17	1.17
						10.526

their most desired life than LPG individuals. We interpret this as further evidence in favor of Hypothesis II.

Let us now summarize the results of this analysis. So far we have shown that:

1) At each separate time-period--past, present and future--there is no significant difference in the proportional distribution of each group in the state-set vectors (Table 15).

2) Constructing a transition probability matrix for each group (by classifying individuals in a state they expect to be in the future according to where they perceive themselves to be at present) reveals that significantly more HPG expect to be in higher states than LPG who in turn expect to be more in either the same or lower states (Table 17). The "matrix index of optimism" therefore allows us to infer that HPG are more optimistic than LPG. This supports Hypothesis II).

3) Since the transition probability matrices of both groups can be defined as an absorbing Markov chain, both groups can be expected to eventually reach their most desired life-goals if the process continues as it began. Using equation (2) we can further extrapolate that all HPG can be expected to attain their most desired life-goals, or S_5, faster (after 8 five-year time intervals) than LPG (after 14 five-year time intervals). These results also support Hypothesis II because HPG are more optimistic about attaining their life-goals faster than LPG expect to attain theirs.

4) Finally we have used equation (3) to compute an average individual goal distance measure. Comparing the measures of both groups again shows that with the exception of S_4, the distance to S_5 is somewhat shorter for HPG than LPG (Table 19). This also supports Hypothesis II. In sum, the results of the stochastic process analysis of the period from present to future reveals that HPG are more optimistic than LPG.

We now briefy turn to an analysis of the positions of the groups in the past and present. Here we shall examine the way in which fishermen retrospectively compare their past positions on the ladder (5 years ago) with their present positions. Since we now suspect that HPG are more optimistic than LPG about expecting to attain their most deaired life-goals in the future it should prove interesting to see how they perceive their past in relation to their present. As we will see, this should also serve to enlarge our perspective of their relative degree optimism about the future.

We can construct another pair of transition probability matrices by classifying individuals in the present according to where they were in the past (5 years ago). These appear in Table 20. Using the entries in these arrays we can again derive another "index of optimism." This appears in Table 21. Of interest is the fact that both groups are quite similar on both measures. Chi-square tests reveal no significant differences between them on the first ($\underline{X}^2 = 2.597$, $\underline{df}$ 2, $\underline{p} > .05$) or second measure $\underline{X}^2 = 3.397$, $\underline{df}$ 2, $\underline{p} > .05$).

Examining the nature of the transition matrices reveals that both can be defined as <u>regular</u> Markov chains. That is, a Markov chain whereby some power of the transition matrix has all positive, non-zero elements (Kemeny and Snell, 1960, p. 69). This indicates that there is always some probability of going from any state to any other state at any transition (i.e., after any 5 year interval elapses) and this includes the highest state S_5. This means that although there is always some probability of attaining (and remaining in) S_5, the most desired life state, there is also always an associated probability of leaving it. Because this is a <u>regular</u> (as opposed to an absorbing) chain, it further guarantees the fact that at no time will all individuals attain and remain in the highest Ladder of Life state. Instead, if the transition probabilities remain the same, a fixed point or equilibrium vector ($\underline{p}^e$), will be reached wherein some proportion of the sample will always be distributed in other states as well. These proportions will always remain invariant when further multiplied by the transition matrix[6] or

TABLE 20. Transition Probability Matrices From Past to Present

- - - - - - - - - Hi Periodicity Group - - - - - - - - -

	S_1	S_2	S_3	S_4	S_5
S_1	.369	.263	.158	.105	.105
S_2	.286	.286	.286	.142	.00
S_3	.25	.375	.25	.125	.00
S_4	.333	.333	.167	.167	.00
S_5	.00	.00	.20	.60	.20

- - - - - - - - - Lo Periodicity Group - - - - - - - - -

	S_1	S_2	S_3	S_4	S_5
S_1	.556	.222	.111	.111	.00
S_2	.00	.143	.571	.143	.143
S_3	.091	.091	.454	.273	.091
S_4	.00	.20	.20	.40	.20
S_5	.40	.00	.20	.00	.40

$$\underline{p}^e = \underline{p}^e\underline{P} \qquad (5)$$

These are presented for the LPG and HPG in Table 22. These equilibrium vectors abstract the ultimate fate of the transition matrices and process of goal attainment of each group. A two sample Komolgorov-Simirnov test revealed no significant difference between them. Thus far then, both groups appear to display rather similar retrospective comparisons of their past and present positions on the Ladder of Life.

In order to compare their distance from their most desired life goals (S_5) another quantity was deduced from the regular Markov chain model. This is $\underline{M}$ the "Mean First Passage Time" and is derived from $\underline{Z}$ the fundamental equation of regular Markov chains (Kemeny and Snell, 1960, pp. 75-82).[7] Mean First Passage Time estimates specify the average number of transitions (time-intervals) it will take to reach a state for the first time from any other state. The diagonal entries specify the mean first-return times. Table 23 presents $\underline{M}$ matrices for each group. For example consider the top row of the mean first passage times for the HPG. The $\underline{m}_{15}$ element 27.21 indicates it will take a person who was in S_1 in the past an average of 27.21 time intervals to first reach S_5, the most desired life state. The $\underline{m}_{11}$ element 3.35 specifies the expected number of time intervals it will take a person who is in S_1 to again be in S_1. The $\underline{M}$ matrices thus provide a useful comparative measure of distance from expected goal-attainment when dealing with a regular chain. If we compare the $\underline{M}$ matrices of each group it is apparent that, particularly with respect to the initial distance to S_5 (see column 5), the LPG are on the average about three times closer to first attainment of their most desired goals than HPG. And they are for the most part somewhat further from the bottom (S_1). This suggests that although the groups are similar in their ultimate state-set distribution specified by the equilibrium vectors $\underline{p}^e$ (see Table 22), LPG individuals appear to be less distant from their most desired goals than HPG. This further suggests that LPG perceive less disparity between their past and present than do HPG. Coupled with what we now know about the present to future transition probabilities this indicates that overall LPG see relatively more continuity, or stability, between their past, present and future than HPG, who in turn probably see themselves as having come a long way from past to present, and who expect to go a long way in the future.

Thus we may further hypothesize that the velocity of change in goal attainment is slower for LPG than HPG. If this is so we will then have a further piece of evidence that HPG are more optimistic than LPG. One way to test this directly is to compute and compare the ratio $\underline{R}$. Beauchamp (1966) has suggested that we take the ratio of the sum of the elements of the matrix $\underline{N}$ for an earlier period to the sum of the elements of a matrix $\underline{N}$ for a later period (designated $\underline{N}'$) to arrive at an overall measure of the rate of change of an absorbing Markov chain process, $\underline{R} = \underline{N}/\underline{N}'$ (i.e., a ratio of the total of the average times to absorption from all nonabsorbing states for each time period). If $\underline{N} = \underline{N}'$ then the ratio $\underline{R} = 1$ indicates no change between periods. If $\underline{N}$ is greater than $\underline{N}'$ then the ratio $\underline{R} > 1$ indicates that the process is accelerating. If $\underline{N}$ is less than $\underline{N}'$ then the ratio $\underline{R} < 1$ indicates that the rate of change is decelerating. Since we have already computed $\underline{N}'$ for the period from present to future for both groups (see Table 19) all that remains is to compute $\underline{N}$ for the period past to present. Here we confront a problem. Since the matrix for the past to present period is regular we cannot directly compute $\underline{N}$ which is the fundamental matrix for absorbing matrices. If, however, we are willing to confine our interest simply to the initial attainment of S_5, and forget for the moment the corresponding probabilities of leaving S_5 once it is attained, we may fruitfully apply absorbing chain theory to regular chains and compute $\underline{N}$ (Kemeny and Snell, 1960, p. 196). To do this all we need do is convert S_5 in the matrices in Table 20 to absorbing states by making the $\underline{p}_{55}$ elements 1.00 and all other elements in

TABLE 21. Matrix Index of Optimism
Past to Present*

	Optimism	Inertia	Pessimism
Measure I			
HPG	.356 (16)	.289 (13)	.356 (16)
LPG	.405 (15)	.405 (15)	.189 (7)
Measure II			
HPG	.378 (17)	.111 (5)	.511 (23)
LPG	.459 (17)	.216 (8)	.324 (12)

*Number in parentheses.

TABLE 22. Equilibrium Vectors Past to Present

	S_1	S_2	S_3	S_4	S_5
HPG	.299	.294	.219	.149	.039
LPG	.198	.133	.311	.210	.149

TABLE 23. Mean First Passage Time Past to Present

- - - - - - - - HI Periodicity Group - - - - - - - -

$$M = \begin{array}{c} \\ S_1 \\ S_2 \\ S_3 \\ S_4 \\ S_5 \end{array} \begin{array}{c} \begin{array}{ccccc} S_1 & S_2 & S_3 & S_4 & S_5 \end{array} \\ \begin{bmatrix} 3.35 & 3.65 & 5.1 & 6.72 & 27.21 \\ 3.53 & 3.4 & 4.44 & 6.91 & 30.73 \\ 3.65 & 3.1 & 4.57 & 7.03 & 30.86 \\ 3.34 & 3.28 & 5.02 & 6.71 & 30.55 \\ 4.67 & 4.48 & 5.01 & 3.01 & 25.5 \end{bmatrix} \end{array}$$

- - - - - - - - Lo Periodicity Group - - - - - - - -

$$M = \begin{array}{c} \\ S_1 \\ S_2 \\ S_3 \\ S_4 \\ S_5 \end{array} \begin{array}{c} \begin{array}{ccccc} S_1 & S_2 & S_3 & S_4 & S_5 \end{array} \\ \begin{bmatrix} 5.06 & 5.89 & 4.61 & 6.51 & 10.11 \\ 9.3 & 7.51 & 2.65 & 5.92 & 7.95 \\ 8.75 & 7.63 & 3.22 & 5.19 & 8.4 \\ 9.21 & 6.92 & 4.13 & 4.77 & 7.12 \\ 4.58 & 8.14 & 4.74 & 7.74 & 6.72 \end{bmatrix} \end{array}$$

the fifth rows .00 (i.e., $\underline{P}51$, $\underline{P}52$, $\underline{P}53$, $\underline{P}54$). Table 24 contains these quantities calculated from equation (4). The sum of the elements in the LPG matrix $\underline{N}$ is 33.78. The sum of the elements in the HPG matrix $\underline{N}$ is 119.37. Recalling that $\underline{N}'$ for the LPG and HPG (present to future) was 10.53 and 8.345, respectively, we can compute $\underline{R} = \underline{N}/\underline{N}'$ for both groups and compare them to see which group's process is changing at a faster rate. For the LPG $\underline{R}$ = 33.78/10.53 = 3.29. For the HPG $\underline{R}$ = 119.37/8.345 = 14.3. These results rather clearly support our hypothesis that the process of expected goal attainment is changing faster for the HPG. Thus, the HPG manifests a much sharper discontinuity between the periods past to present, and present to future, than the LPG. These results allow us to infer that they see themselves as having come a longer way from past to present in goal attainment than HPG. And, as our earlier results show, they are more optimistic about attaining their most desired life goals in the future at a faster rate.

IV. Summary and Conclusions

We began this paper by recognizing the importance of studying people's perceptions of their life-situation and expectations concerning the future. In particular, we have been concerned with fishermen's subjective evaluations of their chances of attaining their most desired life-goals. Our focus has been on economic factors which may shape their relative degree of optimism, pessimism, or inertia. Given the precarious and uncertain nature of fishing we postulated that a prime factor which should influence fishermen's goal expectations is income periodicity. Two alternative hypotheses were advanced: 1) that low-income periodicity would be related to optimism; and 2) that high-income periodicity is related to economic security which in turn conditions fishermen to be optimistic about goal-attainment. Hypothesis II is based on the assumption that economic opportunity is related to high income periodicity and those with more income periodicity will be more optimistic. The alternative possibility that high periodicity could also be associated with failure and therefore pessimism was ruled out on the grounds it would probably produce too much cognitive dissonance.

To examine the relative value of these hypotheses a sample of fishermen from Costa Rica was subdivided into two groups--a low periodicity group (LPG) and a high periodicity group (HPG)--on the basis of the periodicity of their income from fishing. Data and analysis revealed they did not differ in their overall annual income, income from fishing nor income during the month preceding the interview. The HPG, however, did have higher maximum months and lower minimums than LPG. Using Cantril's Ladder of Life Test to measure optimism about expectations of most desired life-goal attainment, and a stochastic process model, it was found that:

1) There is no significant difference between LPG and HPG in their ladder positions in the past, present and future. That is, they are proportionately distributed in similar ways in ladder positions at each time period.

2) HPG are significantly more optimistic about being in higher positions (closer to their goals) in the future, according to their present position than LPG.

3) HPG as a group expect to attain their goals faster than LPG.

4) Individual HPG fishermen are closer to attaining their goals than individual LPG fishermen.

5) HPG have come a longer way from past to present than LPG toward attaining their goals and expect to go further in the future.

TABLE 24. Fundamental Matrices for Past to Present Absorbing Chain Conversions

- - - - - - - - - Hi Periodicity Group - - - - - - - - -

$$\underline{N} = \begin{array}{c} \\ S_1 \\ S_2 \\ S_3 \\ S_4 \end{array} \begin{array}{c} \begin{array}{cccc} S_1 & S_2 & S_3 & S_4 \end{array} \\ \begin{bmatrix} 9.52 & 8.26 & 5.93 & 3.5 \\ 9.52 & 10.37 & 6.85 & 4 \\ 9.52 & 9.5 & 7.85 & 4 \\ 9.52 & 9.35 & 6.68 & 5 \end{bmatrix} \end{array} \begin{array}{c} \underline{\text{Row Sums}} \\ 27.21 \\ 30.74 \\ 30.87 \\ 30.55 \\ \hline 119.37 \end{array}$$

- - - - - - - - - Lo Periodicity Group - - - - - - - - -

$$\underline{N} = \begin{array}{c} \\ S_1 \\ S_2 \\ S_3 \\ S_4 \end{array} \begin{array}{c} \begin{array}{cccc} S_1 & S_2 & S_3 & S_4 \end{array} \\ \begin{bmatrix} 2.9 & 1.6 & 3.18 & 2.38 \\ .64 & 2.4 & 3.12 & 2.05 \\ .84 & 1.19 & 4.08 & 2.29 \\ .49 & 1.11 & 2.4 & 3.11 \end{bmatrix} \end{array} \begin{array}{c} \underline{\text{Row Sums}} \\ 10.06 \\ 8.21 \\ 8.4 \\ 7.11 \\ \hline 33.78 \end{array}$$

In sum, the results favor Hypothesis II over Hypothesis I. These results are obviously tentative, however, pending on more research with larger samples and more replications. They nonetheless suggest, at the very least, that high-income periodicity is not inimical to maintaining optimistic expectations about life-goal attainment. On the other hand we are not in a position to conclude that low-income periodicity is inimical to optimism. After all, the results show both groups to be predominantly optimistic. What we have discovered is some degree of difference.

We are likewise not in a position to delineate the underlying casual dynamics. Income periodicity can be postulated to be an antecedent factor contributing to degree of optimism but the reverse is also tenable. That is, degree of optimism could also be antecedent to income periodicity. For example, we could argue that optimistic fishermen are more likely to manifest more exploratory behavior and search out new fishing areas. This strategy could result in either very large catches (exploiting previously untouched stocks) or failure to find any fish at all; hence, resulting in greater periodicity of income than a strategy that concentrates on known stocks of reliable but lower productivity. In either case, numerous other variables could be postulated to intervene and modulate these relationships.

We do believe the results are interesting and should be followed up. Income periodicity, expectations of life-goal attainment, and stochastic process models for analysis, all show promise for further study. Actual longitudinal, panel studies, where groups are observed over time, would be a logical next step.

We would also suggest that the results of this study support the position that peoples' life-goals are probably only loosely tied to reality and for the most part involve attainment of things not presently possessed (cf. Table 12). Optimism about attaining these goals seems to be more related to economic opportunity, as indicated by higher income periodicity, than to economic security, as indicated by lower income periodicity. In this regard it should be re-emphasized however, that this generalization can only be claimed to apply to situation where overall income is roughly similar. Clearly if high-periodicity of income were associated with low overall income different results might obtain. An important goal of future research will be to explore the relationship of overall income differences to degree of optimism about life goal attainment and then compare the effects of periodicity. Finally, we would urge others to investigate the correlates and consequences of other aspects of the "psychological situation" for as W.I. Thomas has said of "definitions of the situation" in his famous dictum: "If men define situations as real, they are real in their consequences" (1928, p. 572).

FOOTNOTES

[1]We want to thank Andy Walker and Craig Sturdevant for their help with the computer analysis of these data. Computer facilities of both the University of Missouri and the University of Rhode Island were used.

[2]No effort will be made to review this literature here. Readers are referred to Burgers (1975) and Bennett (1976), for representative theoretical statements, to Graves (1973), Graves and Van Arsdale (1966), Johnson (1974), Fliegel et al. (1968) and Bluhm (1975) for representative empirical applications and to Spradley (1972) and Jessor and Jessor (1973) for both.

[3]Fuguitt (1965) has employed Markov chain models in a similar way to study demographic trends in small towns. He observes this is analogous to using the "net reproduction rate" as a descriptive measure of fertility at a single point in time even though it is couched in longitudinal terms.

[4]The 10-step ladder was collapsed to 5 steps: 1 + 2 = 1, 3 + 4 = 2, 5 + 6 = 3, 7 + 8 = 4, 9 + 10 = 5. This was done so that the number of matrix entries would not be inoperatively small. No appreciable difference between the two groups resulted from this.

[5]A major theorem of absorbing Markov chains is that the probability that the process will eventually be absorbed is 1. Kemeny and Snell (1960, pp. 43-65) provide a proof of this theorem.

[6]The equilibrium vector ($\underline{p}^e$) can be discovered by solving a system of linear equations. Since $\underline{P}$ is regular we know it has a unique fixed-vector $\underline{p}^e$ associated with it, the components of which are all positive. Further, the values of the components of $\underline{p}^e$ will not change when multiplied by any power of $\underline{P}$ or $\underline{p}^e\underline{P}$ (equation 5). Therefore the following matrix equation will hold:

$$[x_1, x_2 \ldots x_n]^e \begin{matrix} p_{11} & p_{12} & \cdot & \cdot & \cdot & p_{1n} \\ p_{21} & p_{22} & \cdot & \cdot & \cdot & p_{2n} \\ \cdot & \cdot & & & & \cdot \\ \cdot & \cdot & & & & \cdot \\ \cdot & \cdot & & & & \cdot \\ p_{n1} & p_{n2} & & & & p_{nn} \end{matrix} = [x_1, x_2 \ldots x_n]^e$$

Let $\underline{P}$ = the LPG matrix in Table 20. Then the following system of linear equations can be derived.

$$\begin{aligned}
x_1 + x_2 + x_3 + x_4 + x_5 &= 1 \\
.55x_1 + 0x_2 + .091x_3 + 0x_4 + .4x_5 &= x_1 \\
.222x_1 + .143x_2 + .091x_3 + .2x_4 + 0x_5 &= x_2 \\
.111x_1 + .571x_2 + .454x_3 + .2x_4 + .2x_5 &= x_3 \\
.111x_2 + .143x_2 + .273x_3 + .4x_4 + 0x_5 &= x_4 \\
0x_2 + .143x_2 + .091x_3 + .2x_4 + .4x_5 &= x_5
\end{aligned}$$

from which we compute

$\underline{p}^e$ = (.198, .133, .311, .21, 149)

[7]The fundamental equation of a regular Markov chain is

$$\underline{Z} = (\underline{I} - \underline{P} + \underline{A})^{-1} \qquad (6)$$

where $\underline{I}$ is an identity matrix, $\underline{P}$ is the transition probability matrix and $\underline{A}$ is a fixed-state matrix with each row equal to $\underline{p}^e$ as defined by equation (5). The Mean First Passage Time is given by

$$\underline{M} = (\underline{I} - \underline{Z} + \underline{EZ}_{dg})\underline{D} \qquad (7)$$

where $\underline{I}$ is again an identity matrix, $\underline{Z}$ is defined in equation (6), $\underline{E}$ is a matrix with all entries 1, $\underline{Z}_{dg}$ is a diagonal matrix with $\underline{j}$-th entry as in $\underline{Z}$ and zero's elsewhere and $\underline{D}$ is a diagonal matrix with $\underline{j}$-th entry $1/a_j$ (the reciprocals of the diagonal elements of $\underline{A}$).

Study Three Future Orientation among the Small-Scale Fishermen of the Northwest Coast of Costa Rica

By R.B. Pollnac

The purpose of this paper is to examine the temporal perspective and future investment orientations of small-scale fishermen on the Northwest coast of Costa Rica. A great deal of research has related investment orientations (or economic gratification orientations) to a host of variables such as age, modernization, socio-economic status, success, efficacy, optimism, income variability, and occupaton.[1] Likewise, there is an increasing amount of studies which relate behavior to subjective evaluation of life situation and future expectations.[2] This paper will examine the interrelationships between these two variables and a range of sociocultural variables including age, years fishing experience, kin involvement in fishing, number of dependents, ownership of productive equipment, years formal education, income variability, father's occupation, and relative success at fishing.

1. The Sample

A sample of 70 small-scale fishermen was interviewed at four locations on the northwest coast of Costa Rica between Playa del Coco and the Nicaraguan border. Thirty-nine were interviewed at Playa del Coco, a relatively popular resort area located in Bahia el Coco in the Gulf of Papagayo. Approximately 40 kilometers of black-top, all weather road links Playa del Coco with Liberia, the closest population center (population approximately 11,000), which is on the interamerican Highway 216 kilometers from San Jose. Twenty-three fishermen were interviewed at Cuajiniquil located on Bahia de Cuajiniquil approximately 50 air-kilometers northwest of Liberia. An all-weather road linking Cuajiniquil with the interamerican Highway was undergoing construction at the time the research was conducted. Finally, 8 fishermen were interviewed at Jobo on the Gulf of Santa Elena and Puerto Soley in Bahia de Salinas approximately 5 kilometers from the Nicaraguan Border.

Most of the small-scale fishermen in the sample (77%) fish from open dugout vessels, approximately 18 to 24 feet long, powered by outboard motors. Others use vessels (primarily dugout but two large fiberglass vessels were in the sample) from 24 to 30 feet in length with inboard motors and cabins (launchas). Type of gear used was principally the gill net. Monofilament gill nets are the most frequently used type at Playa del Coco (used by 77% of the fishermen), while further north 94 percent of the fishermen interviewed use multifilament nets either alone or in combination with long or hand lines. Only one fisherman interviewed at Cuajiniquil used a monofilament gill net. Finally, 7 of the fishermen were divers (6 at Playa del Coco and one at Cuajiniquil) who captured various shellfish including the spiney lobster.

Overall, the fishermen at Playa del Coco have much more contact with modern Costa Rican society because of their relatively easy access to Liberia and the quantity of Costa Rican and other tourists who frequent the area. Manifestations of the impact of this contact among the small-scale fishermen can be found in differences in level of technology (the high frequency of use of the relatively modern monofilament gill net at Playa del Coco) and levels of formal education (a mean of 6 years at Playa del Coco as opposed to 4 years

among the fishermen further north). In the analysis section the sample of fishermen from north of Playa del Coco will be referred to as the "North Sample."

II. Tests

Self-evaluation of socio-economic position, perceived socio-economic progress, and perceptions of future position were determined with the use of the ladder of life test (Cantril, 1963). The ladder of life test consisted of showing the respondent a ladder diagram with ten rungs. He was told that the top rung represented the best possible life, and the bottom the worst. He was then requested to tell where he felt he stood on the ladder at the present time (T_0), five years in the past (T-5) and five years in the future (T+5). The respondent was also requested to tell what he would do to arrive at the T+5 position.

Three items were used to determine future investment orientations (FIO). The first item involved the question concerning what the fisherman felt he must do to arrive at the state he projected for T+5. The responses were content analyzed, and those manifesting a plan to save or invest were assigned a value of one and all others a value of zero. The other two items were derived from two questions: 1) If you were to receive 1500 colones as a gift or inheritance what would you do with it?, and 2) If you were to recieve 8500 colones as a gift or inheritance what would you do with it?[3] Responses to these two questions were content analyzed and classified as deferred if the responses reflected an investment for future gain (e.g., purchase fishing equipment, put in a bank, etc.) or immediate if lacking an investment factor (e.g., buy clothing, alcohol, etc.). The immediate category was assigned a value of zero and the deferred a value of one. The values assigned to these three items were then summed, resulting in a scale which varied between zero and three, with zero indicating a lack of future investment orientation and three a maximum future investment orientation.

Independent variables such as age, years fishing experience, and education, were determined by responses to direct questions. Income variability was determined by subtracting the minimum monthly income from the maximum and dividing by the maximum. This result in index which varies between zero and one, with one indicating maximum variability and zero no variability. Success rank was determined by requesting key informants (middlemen who had been buying fish from the fishermen for years) to rank each fisherman as being a very good, good, or average fisherman. These evaluations were assigned values of three, two, and one, respectively.

III. Analysis

The distribution of responses to the questions concerning use of an unexpected inheritance or gift can be found in Table 25. By far, the largest percentage of responses to both the 8500 and 1500 colones questions make reference to investment in some sort of fishing equipment. Other studies (e.g., Pollnac and Poggie, 1978) have noted a similar tendency among small-scale fishermen. Overall, only 13 percent of the fishermen provided non-investment oriented responses to the 8500 colones question. This percentage increased to 24 percent with respect to the 1500 colones question reflecting the fact that the smaller amount is less likely to be perceived in terms of investment potential.

The distribution of responses to the self anchoring ladder scale can be found in Figure 2. As can be seen in Figure 2, the level of the modal response increases steadily from T-5 to T+5, indicating that the population is overall optimistic about the future. Further analysis of this scale will only

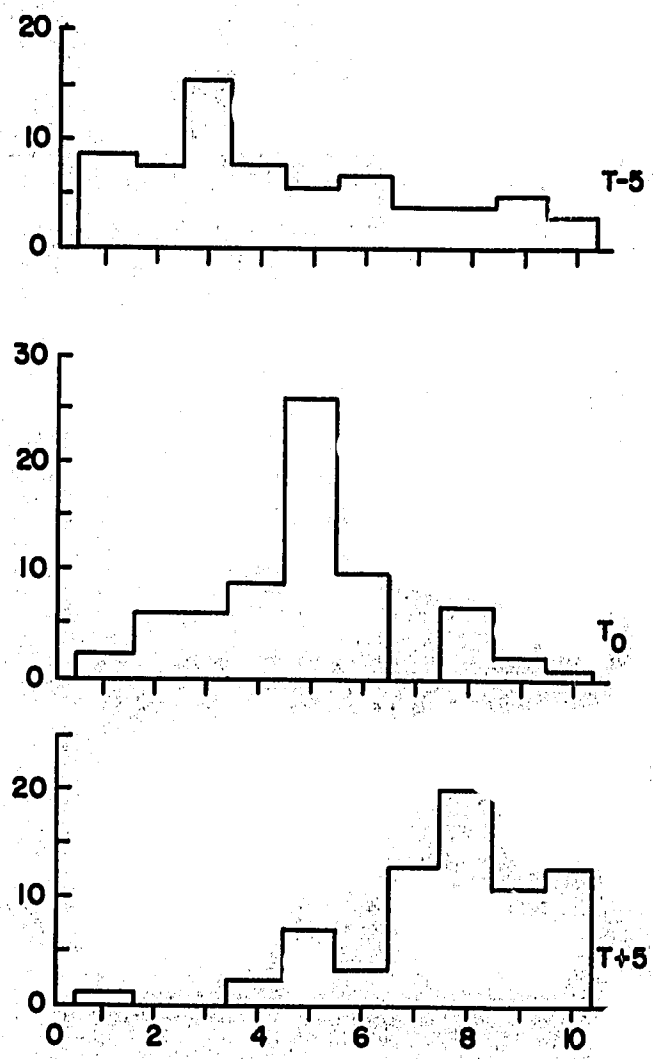

Figure 2. Distrubution of Responses to Ladder of Life Test.

TABLE 25. Percent Distribution of Responses to Questions Concerning Use of an Unexpected Inheritance or Gift

Categorized Response*	8500 Colones Question	1500 Colones Question
Invest in fishing equipment	54	36
Purchase boat	16	00
Purchase boat with motor	09	00
Purchase motor	01	03
Purchase net	00	03
Repair equipment	00	01
Non-fishing investment (business, etc.)	03	06
Save (bank)	04	26
Non-investment response	13	24

*Responses also include downpayment for item noted. N=70

TABLE 26. Distribution of Fishermen's Perceptions of Factors Influencing Goal Attainment

Response	Percent
Work and save	37
Work hard	30
Have equipment	11
Save	10
Other (luck, find help, etc.)	09
Things getting worse	03

N=70

involve a consideration of individual differences in position across time (e.g., T_0 - T-5).

Fishermen's perceptions of factors influencing attainment of projected T+5 level emphasize work, saving, and possession of adequate equipment. The distribution of categorized responses can be found in Table 26. These responses manifest a marked similarity to the distribution of responses to an identical question posed to small-scale fishermen in the Gulf of Nicoya, Costa Rica (Study One, this chapter).

The distribution of the independent and dependent variables used in further correlation analyses can be found in Table 27.

Table 27 indicates that Playa del Coco is significantly different from the North on several of the independent variables. The analysis indicates that there is less kin involvement in fishing and that fishermen have less fishing experience in the northern region. Fishermen in the North also manifest less years of formal education, probably as a result of their relative isolation. Finally, income variability is greater in the North.

Zero order correlations between the independent and dependent variables for the total sample and the two subsamples can be found in Tables 28-30.

Tables 28-30 indicate that the independent variables are related to Future Investment Orientation (FIO) only in the North Sample, and that only one variable, number of kin fishing, is significantly related to this variable. Perceived changes in socio-economic position and perceptions of future position are significantly related to several of the independent variables in all samples. In the Total Sample, both T+5-T_0 and T+5-T-5 are positively correlated with number of dependents, and income from fishing during the past month is positively related to T_0-T-5 and T+5-T-5. Both fisherman father and number of dependents are positively related to T+5-T_0 in Playa del Coco. Finally, in the North Sample, success rank is positively and years of formal education negatively related to perceived progress (T_0-T-5).

As a next step in the analysis, a step-wise multiple regression of the independent variables on the dependent was applied in cases where Tables 28-30 indicate that the dependent variables had at least one statistically significant correlation with an independent variable. In this procedure, the independent variable which accounts for the most variance in the dependent variable is entered first. The next variable entered is the one that manifests the largest partial correlation with previously entered variables controlled. This procedure is continued until all variables are entered or until some previously set criterion is reached. Here the criteria was set at an F-ratio of at least 2.0 for the variable to be entered. The results of these analyses can be found in Table 31-33.

The analyses presented in Tables 31-33 indicate that for the total sample the independent variables account for only a small proportion of the variance in the socio-economic progress variables. In Playa del Coco, two of the independent variables account for 19 percent of the variance in perceived progress from T_0 to T+5--almost twice the amount of variance that was accounted for in the same dependent variable for the total sample. The strongest relationships are found in the North Sample. There, four variables account for 55 percent of the variance in perceived progress from T-5 to T_0, and five independent variables account for 44 percent of the variance in FIO. The two subsamples are apparently quite different in terms of the correlates of the dependent variables.

IV. Discussion and Conclusions

Overall, we have seen that the small-scale fishermen are positively oriented toward the future and manifest a relatively high degree of future investment orientation. An examination of the socio-cultural correlates of these variables resulted in some relatively interesting findings. Turning

TABLE 27. Distribution of Independent and Dependent Variables

Variable	Total Sample	Playa del Coco	North	X^2	t-value	p
Age ($\bar{X}$)	28.1	27.6	28.7	----	-0.49	> .05
Years fishing ($\bar{X}$)	9.3	11.9	6.0	----	2.97	< .01
Fishermen kin ($\bar{X}$)	3.8	4.9	2.4	----	2.48	< .02
Own boat (%)	39	33	45	1.02	----	> .05
Dependents ($\bar{X}$)	4.3	3.7	5.1	----	-1.80	> .05
Years Education ($\bar{X}$)	5.4	6.2	4.4	----	2.64	< .02
Farmer father (%)	49	41	58	2.01	----	> .05
Fisherman father (%)	20	28	10	3.71	----	< .10
Success rank ($\bar{X}$)	2.0	1.9	2.1	----	-0.97	> .05
Income variability ($\bar{X}$)	.83	.79	.87	----	-2.63	< .02
Income past month* ($\bar{X}$)	21.6	18.6	25.3	----	-1.38	> .05
FIO ($\bar{X}$)	2.10	2.02	2.19	----	-0.80	> .05
T_0 - T-5 ($\bar{X}$)	.50	.23	.84	----	-0.90	> .05
T+5 - T_0 ($\bar{X}$)	2.77	2.49	3.13	----	-1.19	> .05
T+5 - T-5 ($\bar{X}$)	3.27	2.72	3.97	----	-1.69	> .05

*100's of Colones. N=70

TABLE 28. Zero-Order Correlations between Independent and Dependent Variables for the Total Sample

Independent Variables	FIO	T_0 - T-5	T+5 - T_0	T+5 - T-5
Age	.01	.06	.09	.12
Years fishing experience	.14	-.09	.01	-.08
Number of family fishing	.00	.05	.05	.08
Boat ownership	.15	.09	.11	.17
Number of dependents	.08	.07	.24*	.24*
Years formal education	.04	-.14	.00	-.12
Farmer father	.09	.17	-.10	.08
Fisherman Father	.03	-.05	.22	.11
Success rank	-.07	.28*	-.11	.17
Income variability	.09	.12	.11	.19
Last month fishing income	---	.24*	.04	.24*

*p <.05 N=70

TABLE 29. Zero-Order Correlations between Independent and Dependent Variables for Playa del Coco

Independent Variables	FIO	T_0 - T-5	T+5 - T_0	T+5 - T-5
Age	.05	-.06	.13	.05
Years fishing experience	.18	-.07	.08	.00
Number of family fishing	-.12	.09	.08	.16
Boat ownership	.05	.02	.13	.12
Number of dependents	.08	-.04	.36*	.27
Years formal education	.08	.25	-.14	.12
Farmer father	.17	.01	-.19	-.16
Fisherman father	-.02	-.08	.34*	.21
Success rank	-.03	.18	-.18	.02
Income variability	.22	.09	.11	.18
Last month fishing income	---	.12	.03	.14

*p <.05 N=39

TABLE 30. Zero-Order Correlations between Independent and Dependent Variables for North

Independent Variables	FIO	T_0 - T-5	T+5 - T_0	T+5 - T-5
Age	-.07	.22	.01	.20
Years fishing experience	.23	-.05	.03	-.02
Number of Family Fishing	.41*	.11	.17	.20
Boat Ownership	.24	.14	.07	.16
Number of Dependents	.03	.14	.01	.13
Years formal education	.08	-.42*	.26	-.21
Farmer father	-.04	.31	-.04	.25
Fisherman father	.17	.05	.13	.13
Success rank	-.15	.38*	-.06	.30
Income variability	-.13	.10	.03	.11
Last month fishing income	---	.29	.00	.26

*p <.05 N=31

TABLE 31. Stepwise Multiple Regression of Independent Variables on Dependent Variables for the Total Sample

Dependent Variable	Variable Entered	Partial To Enter	R	F-Ratio To Enter
T_0 - T-5	Success rank	---	.28[a]	5.64
" "	Last month fishing income	.20	.34[a]	2.72
T+5 - T_0	Number of dependents	---	.24[a]	4.16
" "	Fisharman father	.22	.32[a]	3.38
T+5 - T-5*	Last month fishing income	---	.24[a]	4.26

N=70 *No variable to enter had an F-Ratio greater than 2.0

a = p < .05

TABLE 32. Stepwise Multiple Regression of Independent Variables on Dependent Variables for Playa del Coco

Dependent Variable	Variable Entered	Partial To Enter	R	F-Ratio To Enter
T+5 - T_0	Number of dependents	---	.36[a]	5.50
" "	Fisherman father	.27	.44[a]	2.75

N=39 a = p <.05

TABLE 33. Stepwise Multiple Regression of Independent Variables on Dependent Variables for North

Dependent Variable	Variable Entered	Partial To Enter	R	F-Ratio To Enter
T_0 - T-5	Years formal education	---	.42[a]	6.12
" "	Success rank	.44	.58[b]	6.79
" "	Fisherman father	.42	.67[b]	5.86
" "	Boat ownership	.40	.74[b]	4.88
FIO	Number of kin fishing	---	.41[a]	5.91
"	Boat ownership	.30	.49[a]	2.71
"	Years fishing experience	.30	.56[a]	2.75
"	Success rank	-.32	.62[b]	3.02
"	T+5 - T-5	.29	.66[b]	2.23

N=31 a = p <.05 b = p <.01

first to perceived socio-economic progress over the past 5 years (T_0-T-5), the analysis indicates that for the Total Sample, success rank and income from fishing during the past month are the strongest predictors of this variable. Success rank is also an important predictor of perceived progress in the North Sample. The explanation of this finding is quite clear. Those who have higher incomes and are relatively successful as fishermen are probably more likely to state that their condition has improved over the past five years. In the North Sample, it was found that in addition to success rank, years formal education, fisherman father, and boat ownership contribute to the perception of progress. Boat ownership is important to the positive self perception of a fisherman which probably contributes to his perception of progress over the past five years. Further, those with fishermen fathers are probably more aware of how extremely isolated the northwestern aector was in the recent past with respect to transporting fresh fish products. Today, however, construction of the all-weather road to Cuajiniquil provides the fishermen with better access to markets and thus enhances their view of progress over the past five years. The strong negative correlation between years of formal education and perception of progress is probably the result of disillusionment--a young man living in an area where the education level is relatively low who obtains an education higher than many others and finds that he still must fish for a living would probably feel rather negative about his present position. This does not occur in Playa del Coco because the fishermen there have more contact with modern Costa Rican society and have a more realistic perception of the levels of education necessary for alternative occupations.

In both the Total Sample and Playa del Coco number of dependents and fishermen father are relatively strong predictors of projected socio-economic progress (T+5-T_0). Several alternative explanations can be suggested to explain the positive relationship between number of dependents and T+5-T_0. First, one could argue that the more optimistic one is concerning the future, the more likely one would be to acquire more dependents. Concerns about their future maintenance or place in the world would be minimized. Second, it can be suggested that number of dependents increases future security, assuming that those who depend on you today will contribute to your welfare in the future. Thus, number of dependents can be either the cause or result of optimistic preceptions of the future. In reality, there is probably reciprocal interaction between the two variables.

The other correlate of T+5-T_0, having a father who was also a fisherman, can probably be explained by the fact that fishing has improved greatly (in terms of access to the market) in the northern Pacific coast of Costa Rica in the recent past, and these changes result in those with a history of involvement in fishing becoming even more optimistic concerning the near future.

Finally, turning to Future Investment Orientations (FIO), the only statistically significant correlations with this variable were found in the North Sample. The only independent variable manifesting a significant zero-order correlation with FIO is number of kin fishing. This relationship can probably be explained by the fact that individuals with more family fishing are probably better adapted to the occupation through the socialization process of growing up in a fishing family context. If, as has been suggested elsewhere (Poggie, 1978; Pollnac and Poggie, 1978), a deferred orientation is an adaptive characteristic among fishermen, then those more thoroughly adapted through familial involvement would be expected to manifest a greater degree of FIO. This explanation, however, contradicts earlier findinga which show a relatively strong negative correlation between fisherman father and gratification orientations (Pollnac and Poggie, 1978). This contradictory explanation, however, is in keeping with the inconsistent nature of relationships between gratification orientations and other variables reported in the literature and argues strongly for further research to delineate the situational

constraints which affect these relationships (Pollnac and Poggie, 1978).

Boat ownership, as one of the predictors of FIO, can be explained by the fact that one must have a deferred orientation to obtain a boat and to keep it running. The boat owner must have a future orientation to take the time to perform the preventative maintenance which, after all, only reduces the chance of a need for major repairs in the future. He also needs a future orientation to put money aside for the periodic repairs which require parts if he wants the least amount of interruption in his future production. The restriction of this correlation to the North Sample can probably be explained by the fact that a lower percentage of fishermen in the north have fathers who were fishermen; thus, there was less of a chance for equipment to be inherited and more of a need for an initially deferred orientation to obtain the equipment (Pollnac and Poggie, 1978).

Years fishing experience, as a predictor of FIO, makes sense in light of the adaptive hypothesis cited above. If a future orientation is an adaptive characteristic for fishermen, the longer one fishes, the more they would be expected to manifest an FIO. The negative partial correlation between success rank and FIO is the opposite of what would be expected on the basis of Poggie's (1978) findings that a deferred orientation is positively related to success as a fishermen. In this case it could be suggested that those who are already successful do not need to defer since they have already achieved their major goals. It must be noted, however, that although the multiple correlation coefficient is statistically significant, the negative partial correlation between success rank and FIO, with previously entered variables controlled, is not statistically significant at the .05 level.

In sum, the findings presented here indicate, once again, the existence of a relatively strong situational component influencing differential patterning of determinants of future investment orientations. The importance of situational constraints with respect to the determinants of gratification orientations have been emphasized in several studies (Pollnac and Poggie, 1978; Thompson, 1975; Robbins and Thompson, 1974). The results presented here indicate that we cannot assume that individuals from one area or occupational subculture will respond to increased wealth in the same manner as those from other regions or occupational subcultures. If development funds are invested in a region with the goal of sustained development through reinvestment of reasonable amounts of profit, then the situational determinants of future investment orientations are of utmost significance. Part of the development scheme should be involved with creating an environment which would facilitate optimistic perceptions of the future and, hence, a climate favorable to investment.

FOOTNOTES

[1]This literature will not be reviewed here. Readers are referred to Pollnac and Poggie (1978), Poggie (1978), Pollnac (1977), and Thompson (1975) for reviews of the gratification orientation literature and empirical applications.

[2]Several recent studies include references to this literature (Robbins, Pollnac and Robbins, this volume; Robbins, Robbins and Pollnac, 1977).

[3]One U.S. Dollar was worth approximately 8.5 Colones when the research was conducted.

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CHAPTER 17 SOCIOCULTURAL ASPECTS OF COOPERATIVE FORMATION AMONG SMALL-SCALE FISHERMEN

BY J.J. Poggie, Jr.

Cooperatives are often perceived by change agents as ideal modes of organizing small-scale fishermen into more efficient and productive groupings. Many attempts have been made to form small-scale fishermen's cooperatives in both developed and developing regions, but there has been considerable variation in the success of these attempts. Some cooperatives are successful (FAO, 1971), while most have failed dismally (UNRISD, 1975). It has become clear that the positive perception of cooperatives on the part of change agents is based more on faith than on any clear understanding of this multi-functioning institution.

Nevertheless, small-scale fishermen's cooperatives--when successful--can serve very beneficial economic and social functions such as providing a more favorable economic return to producer and an organizational linkage for otherwise relatively unarticulated individual fishermen. Effective cooperatives reduce uncertainty for their members by providing important buffering, leveling, and anticipating functions in the socioeconomic environment (Gersuny and Poggie, 1974). Also, as an institutional link between producers and the redistribution system, they are important loci of attempts to reduce post-harvest loss by making preservation techniques more widely available. Better understanding of cooperatives and how to institute them may also lead to improved catch and effort statistics and could enhance fishery biologists' efforts to more accurately assess fishery stocks.

The two studies in this chapter examine different, but related aspects of fishermen's cooperatives. The first study focuses on the relationship between psychocultural characteristics of small-scale fishermen and cooperative formation, and the second on the interrelationships between beliefs about cooperatives and their planning and development.

Study One Cooperative Formation and Small-Scale Fishermen's Psychocultural Characteristics

By J.J. Poggie, Jr.

A fundamental assumption of the human ecology paradigm is that psychocultural characteristics may often be explained as adaptions to the contingencies faced by individuals in their total environments. Recent empirical studies applying this paradigm to small-scale fishermen have been quite productive in generating a middle-range theory of maritime adaptations. The areas of psychocultural life among small-scale fishermen where this paradigm has been productively applied are quite varied. They range from perception (Pollnac, 1977b); to ritual behavior (Poggie, Pollnac and Gersuny, 1976; Poggie and Gersuny, 1974; Poggie 1978); to gratification orientation (Pollnac, Gersuny and Poggie, 1975; Pollnac, 1977a; Pollnac and Poggie, 1978; Poggie, 1978); to level of psychological functioning (Aronoff, 1965; Pollnac and Poggie, 1979); to kinship (Poggie and Gersuny, N.D.; Pollnac, 1978; Poggie, Pollnac and Gersuny, 1976); and to other aspects of social organization such as cooperatives and work organization (Robbins, Robbins and Pollnac, 1977; Poggie and Gersuny, 1974; Bort, 1978).

This study deals with a single psychocultural characteristic of small-scale fishermen which appears to be adaptive and important in understanding cooperative formation. The characteristic is that of independence, which is a pervasive feature of small-scale fishermen around the world. By independence I mean the propensity to think and behave free of the influence of others.

This characteristic is assumed to be associated with a need for independence.

One does not have to look long in the descriptive literature on small-scale fishermen to encounter references to the feature of independence among practitioners of this art. Several examples from the literature are as follows: from the Caribbean island of St. Kitts, Aronoff (1967) reports that fishermen there emphasize independence and self-reliance in giving reasons why they chose to fish; Harrison (1970), reporting on the Malay of Southwest Sarawak, notes that fishing seems to develop independent discipline of mind; Fraser's (1960) study of the Malay of South Thailand stresses individualism in the economic orientation of these fishermen; Kottak (1966) reports that successful fishing at Arembepe, Brazil is related to individualism; Poggie and Gersuny's (1974) study of small-scale fishermen in southern Rhode Island shows the importance of independence in self-perception; Pollnac and Ruiz-Stout (1977) note that Panamanian fishermen frequently cite independence as an important characteristic of their work; and finally, Leighton et al. (1963) cite independence as one of the most cherished qualitities of small-scale Nova Scotia fishermen they studied.

1. Independence as an Adaptive Characteristic

I hypothesize that independence is a psychoculturally adaptive characteristic for small-scale fishermen. There are a number of reasons why independence may be adpative for fishermen. These reasons have to do with the special contingencies of working on a small boat in an aqueous environment in search of often unseen prey.

Small-scale fishermen around the world are faced with similar conditions. They are physically removed from support and help of the land-based society. They carry out their work alone or in small groups with considerable "diviaion of labor." (There is simply not enough room for redundant workers on small fishing boats.) Decisions in the face of considerable uncertainty must be made on an individual basis, and these decisions have immediate effects on the auccess of fishing, on the well-being of gear, vessel, crew and self. Deciaive and rapid decisions are required because of the often rapidly changing nature of the ocean and the elusive prey. When I first conducted participant observation fieldwork among small-scale fishermen in southern New England, one thing I underscored in my field notes concerned how the work was carried out by the two man crew independently of each other and with virtually no verbal communication between them. Each crew member did his work and made his decisions independently. There appeared to be an egalitarian ethos that went along with the self-perceived independence of the actors in this fishery (Poggie and Gersuny, 1974). This initial observation proved to be a common feature of work in other small-scale fishing operations that I have observed.

Other researchers have pointed out the egalitarian nature of small-scale fishing crews (e.g., Kottak, 1966; Burrows and Spiro, 1953; Diamond, 1969). Norr and Norr (1974) have emphasized the need for interdependence as the basis of this ethos. I wish to emphasize that egalitarianism is the only non-coercive way that individuals with high need for independence can be organized into a crew.

II. Independence and Formation of Cooperatives

If we accept the view that independence is an adaptive characteristic for a wide range of small-scale fishermen as the evidence would suggest, then it follows that cooperative behavior among small-scale fishermen will be realized only under special conditions. Individuals who have been selected by the conditions of the work environment for high need for independence, will be individuals who can only be organized into social groups in very special way.

This would be true for small crews as argued above and even more so for fishermen's cooperatives where a large number of individuals must cooperate.

III. The Development of the Point Judith Fishermen Coop and Independence

The formation of the Point Judith (Rhode Island, U.S.A.) Fishermen Cooperative is an interesting case in point. Research has shown that independence is the most salient feature of self-perception in this population of fishermen (Poggie and Gersuny, 1974). It is also widely acknowledged that the Point Judith Fishermen's Cooperative is one of the most successful fishermen's coops in the United States. The formation and organization of this coop appear to have nicely accommodated the high need for independence of its membera with a cooperative organization that serves the collectivity.

The Point Judith Fishermen's Cooperative was formed in 1948 in response to a disadvantageous local marketing situation faced by the unorganized fishermen. The coop came into being because of the work of several younger fishermen recently back from military service in World War II. (One can speculate that the cosmopolitan experience of being in the service had something to do with this bold move.) There had been talk of a coop before this time, but it did not materialize because of the antipathy of local middlemen, insufficient information, and fear of failure. The important part to note here is that the coop was formed by the fishermen themselves with the intent of correcting a deleterious marketing situation and providing gear and supplies at a favorable price. Thus the coop was a marketing and supply one. These were both functions that individual fishermen by themselves could not improve. They were functions that could clearly be improved by cooperative action without impinging on the independence of individuals where independence served as an adaptive characteristic. That is, out of the water away from the land. Fishermen retained individual ownership of their boats and the right to fish when, where, and for what they thought best.

The coop is organized in a way that fishermen feel that it is theirs. Officers in the coop are elected by the members, meetings are held where individuals may air their feelings; owner and non-owner members own shares and receive patronage refunds each year. The board of directors includes fishermen of various types, so that diverse interests are represented. The coop manager and president recognize the need for members to feel that they control their piece of the coop and go out of their way to project an egalitarian ethos in their dealings as officers of the coop. They are also aware of the limits of their authority. The current manager tells the story of how an earlier manager tried to tell the fishermen what days to bring in fish by posting a sign to that effect. The response of the fishermen was to tear down the sign. The manager is emphatic about the fact that he cannot direct the type of fishing and when boats should land fish even if he wanted to. These are areas that fall into the domain of individual decision making. This arrangement has persisted with the thriving coop for 31 years.

Today (1978), when a sample of 30 fishermen who are coop members were asked what the disadvantages of the coop are, their responses indicate no perceived basic flaw in the organization but only some concern with several operational questions such as improving unloading facilities, maintaining quality of fish and whether price could be better at times. There was some dissatisfaction expressed about the management of the coop and about lack of flexibility when one was a member, but these appear not to be serious widespread complaints. In fact, the highest frequency answer to the question was that there are no disadvantages.

IV. Coopepes

I turn now to the case of Coopepes (the recently formed small-scale fishermen's coop of Puntarenas, Costa Rica). This cooperative was mandated by a development program initiated in 1970 by the Presidential Office of Planning of Costa Rica. The Office solicited assistance from the Inter-American Development Bank which assigned the project to the Cooperative FAO/BID Program for design.

The basic objectives of the program in the artisanal (small-scale) sector were to enhance the productivity and distribution of fin fish by organizing a cooperative in Puntarenas and operating a fish terminal to give general services to the fleet and to sell fish. The cooperative was to receive forty-seven 31-foot, 3-ton capacity fiberglass boats fully equipped with navigational and safety technology. They were to be used on the Pacific coast in the Gulf of Nicoya and over the continental shelf.

In 1976, government officials and the BID advisor carried out a campaign to sign up members to a cooperative as one of the preconditions for obtaining the loan necessary to carry out the full development program. It was important for government planners to show progress in the formation of a cooperative as the first step in the development plan, and a relatively large number of individuals (approximately 500 in the Gulf of Nicoya region) were signed up. It was clear to the officials that many individuals signing up were not full-time fishermen, had only a vague notion of what the cooperative was about, except that they were promised advantages; and, most importantly for our purposes here, that the vast majority of successful fishermen did not join. The coop attracted many marginal fishermen to its ranks.

When I began to study the coop in 1978, it was struggling to continue its existence. Only 50 widely dispersed fishermen were selling to the coop. Trucking costs relative to production were very high. The new boats had not arrived. My intent was to try to understand why the coop had not attracted mainline artisanal fishermen into the organization. My ideas about coopepes came from adaptational theory as related to small-scale fishermen and from what I had learned about the success of the Point Judith coop. It is argued that the way the Puntarenas coop was organized impinged on the need for independence of successful artisanal fishermen; and for this reason, it was primarily attracting marginal fishermen to its ranks.

V. The Test

In order to measure self-perception of independence in this population, a seven step semantic differential test was administered to a sample of 50 non-coop artisanal fishermen from Puntarenas.[1] In this test respondents were asked to rate fishermen and administrators along the dimension of intelligent-stupid, independent-dependent, rich-poor, generous-stingy, honest-dishonest, caring about others-egocentric, and good-bad. Although the prime concern was with the independent-dependent dimension, by including several other dimensions in the test, it was possible to assess validity by seeing if fishermen were portraying themselves only in a socially desirable light. As seen in Figure 1, this proved not to be the case. For example, fishermen rank themselves as less intelligent than administrators. The rationale for selecting administrators as the comparison group was that it is general knowledge that they earn more than fishermen, thus allowing a further check on validity as well as providing the needed comparison group. As seen in Figure 1 administrators are ranked higher than fishermen on the rich-poor dimension. Thus the instrument appears to be eliciting valid responses.

In order to test the proposition that fishermen perceive themselves differently from administrators on these dimensions, the difference in the rating between fishermen and administrators each respondent gave for each of

the dimensions were entered into t tests of significance.[2] As seen in Figure 1, fishermen perceive themselves as less intelligent, more independent, poorer, more generous, more honest, but neither more concerned about others nor more "good" than administrators. As seen from the t values, the strongest perceived differences are in wealth and independence. It is important to note also that in addition to perceiving themselves differently from administration, fishermen perceive themselves to be significantly above the midpoint of the scale on independence ($X^2 = 26$, $p < .001$).

VI. Discussion

These data support the argument concerning the relative independence of successful fishermen presented above. If these fishermen behave according to their perceived independence, then it follows that a cooperative organization that is incompatible with this hypothesized adaptive characteristic will be resisted by successful fishermen. Copepes' organization is indeed incompatible with this psychocultural characteristic.

We may list several specific reasons where it is incompatible:

1. It was set up by non-fishermen to meet a need felt by government officials and not by local fishermen.

2. It required fishermen to sell to one buyer, the coop, without guarantee of being provided some of the price and non-marketing advantages provided by competing local middlemen (Pollnac, 1978).

3. It would impose gear and boats selected by others.

4. It would impose fishing locations selected by others (some of the new boats are meant for offshore work which is unfamiliar to local fishermen).

5. Despite provisions to the contrary in the charter of the coop, in the eyes of the fishermen and perhaps in reality it would organize fishermen into a hierarchical organization run by non-fishermen with potentially little sense of individual control for fishermen.

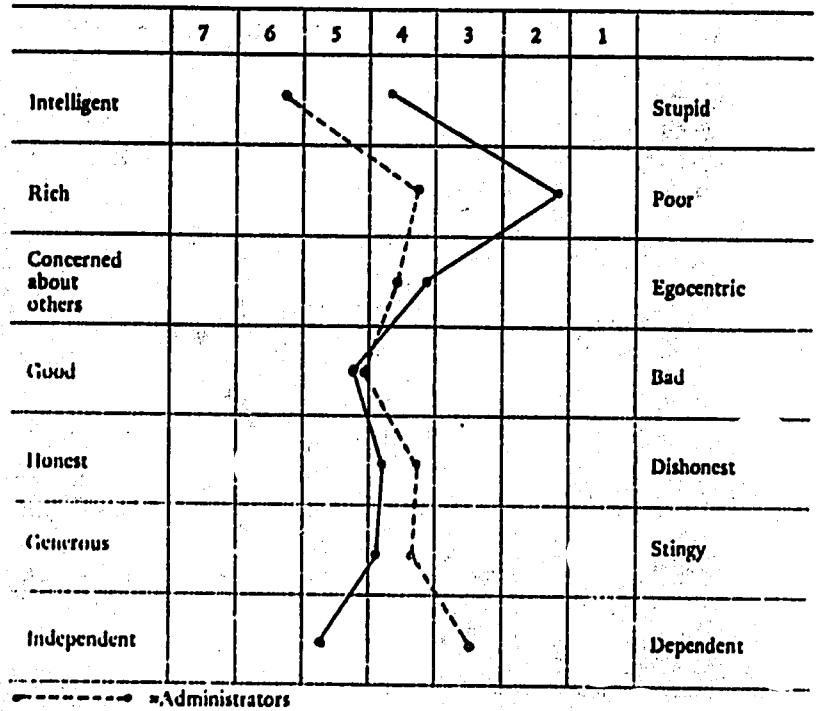
It is my interpretation that it is this incompatibility that is most important in understanding why Coopepes did not attract successful fishermen to its ranks and, in fact, why it has not been successful. However, there is a secondary issue that has emerged since its formation that should be mentioned, as it might be misunderstood as the "cause" of the "problem" of Coopepes. There is the general feeling that the coop has been badly managed and that the first three managers have been dishonest. When my 1978 sample of 50 fishermen was asked what the problems of coopepes are, they emphasized poor management in their responses. Forty percent of the responses concerned this issue while only six percent mentioned "poor members."

While it is true that there is a widespread view even among fishermen that the main problem of the coop is that it has been poorly run, current attempts to improve the situation of the coop by upgrading leadership will probably not work. The coop has the wrong constituency, and this appears to be due to the incompatibility problem at its onset, and not to bad administration after the coop was formed.

There are several recommendations that an applied anthropologist could make to help decision makers reach desired goals. It is possible to learn what successful fishermen expect a coop to do for its members and to structure the coop in light of these expectations. Respondents were asked to indicate "What is a coop supposed to do for its members." Fishermen emphasized that a coop should provide equipment and supplies and other necessities at a good

FIGURE I

Fishermen-Administrator Differences on Several Dimensions (N=50)



	t	p* ≤
Intelligent – Stupid	6.05	.001
Rich – Poor	10.99	.001
Concerned – Egocentric	1.59	NS
Good – Bad	.81	NS
Honest – Dishonest	2.03	.05
Generous – Stingy	2.26	.05
Independent – Dependent	7.51	.001

*df = 49, two tail test

price. Sixty percent of the answers were concerned with this function. Thus the majority of fishermen appear to have a supply coop in mind.

One Costa Rican government official has suggested that perhaps a two stage coop would help correct the coop situation in Puntarenas. Under this plan, successful fishermen who already have boats would be organized into a service coop designed to help them with problems of icing their fish and keeping boats operating. The second coop would be a financial coop designed for fishermen without boats, who would be organized into a government managed coop for the purpose of utilizing the new boats.

These solutions are probably somewhat better than the first attempt in that a service coop is exactly what the majority of already successful fishermen appear to expect from a coop. However, there remains the difficult problem of organizing the service coop in a way that it does not impinge significantly on successful fishermen's need for independence.

The second coop, the government managed one, would appear to have a high probability of failure for several reasons. First we might assume that many of the potential members of this coop will be marginal fishermen, that is those who have been relatively unsuccessful under current conditions. Placing the new higher level technology in the hands of these individuals without careful screening and training could invite serious difficulties. Secondly, a government managed coop will probably lead to the inefficiency that is common in company owned fishing boats in other parts of the world because, as noted by Stokes (1978), worker ownership reduced employee-related drags on economic performance. These include absenteeism, poor workmanship, high turnover, and strikes. A scheme where coop members could earn a share of their boat earnings and qualified skippers could work for ownership of their craft would seem to be in order in this situation.

Although this analysis does not deal with all of the psychocultural variables that might impinge on the question of who will join fishermen's coops and how they can be organized to function effectively (e.g., perceptions of cooperative organizations may also affect their acceptance--see Study Two), it does illustrate the utility of applying the adaptational theory developed by anthropologists. The formation of small-scale fishermen's coops in development situations has considerable obvious utility for government officials and financial institutions working from above, but the organization of fishermen's coops that work, requires the kinds of insights and awareness of psychocultural differences that can be provided only by the type of local level analysis discussed in this chapter. These analyses, of course, can be most effective for planning purposes when they are conducted before fishermen's cooperatives are actually formed.

FOOTNOTES

[1]Because of the unavailability of a list of fishermen and temporal constraints, it was not possible to draw a truly random sample. Interviews were conducted with all fishermen who could be contacted at selling points and other spots where fishermen gathered, no fishermen refused to be interviewed. It is estimated that the sample here represents about ten percent of the population of non-coop, small-scale fishermen in Puntarenas.

[2]This is a one sample test of difference in means in which the null hypothesis is that there are no differences between the groups. Thus in the formula $t = \frac{\bar{X} - u}{S/\ n-1}$, $\bar{X}$ = mean differences between fishermen and administrators on the dimensions, S is the standard deviation on the dimensions, while u the expected difference would equal zero because of the null hypothesis that there are no differences between the groups (Blalock, 1969, p. 148).

[3]Because some readers might object to the use of t-test with what may be considered quasi-interval or even non-interval data, a one sample chi-square test run on the data. In terms of significance the results were equal to those of the t-test.

Study Two Beliefs About Benefits of Fishermen's Cooperatives on the Pacific Coast of Costa Rica

By J.J. Poggie, Jr.

The purpose of this study is to describe and analyze small-scale fishermen's perceived benefits of belonging to a cooperative in several communities in the Gulf of Nicoya and in the northwest region of Guanacaste, Costa Rica.

One of the central features of the development program initiated in 1970 by the Presidential Office of Planning of Costa Rica was to establish a small-scale fishermen's cooperative. Although the cooperative was formed, it has not functioned well. By understanding the small-scale fishermen's perceptions of the benefits of cooperatives, it may be possible to obtain further insights into ways that the cooperative structure may be modified to better meet the needs and expectations in the various communities involved. Social and cultural research in a number of fishing communities in the New England region of the United States has shown that considerable variation exists within relatively small areas. Policy decisions that do not take this variability into account may be less effective (Poggie and Pollnac, 1979). There is reason to believe that comparable diversity exists on the west coast of Costa Rica and that this diversity should be known and incorporated into fishery policy decisions. As is true with other aspects of policy planning, it is better to have this information before policy decisions are made and action programs are set into motion.

I. The Sample

Data from a total of 187 small-scale fishermen from four communities were used in this analysis. Two communities from the Gulf of Nicoya region were Puntarenas (N=67) and Costa de Pajaros (N=50). The other two communities were Playa del Coco (N=39) and several small relatively isolated communities between Cuajiniquil and the Nicaraguan border which in composite are considered as the fourth community (N=31). This community will be referred to as "North." Relative to the total population of fishermen in these four communities, there samples represent approximately 8 percent, 11 percent, 35 percent and 39 percent, respectively (MAG, 1976).

II. Tests

As part of a larger interview schedule, fishermen were asked in an open-ended question to indicate what they consider to be the benefits of belonging to a fishermen's cooperative. Participant observation data were also obtained on social structural and economic features of community life. Of particular importance here is the number of fish dealers in the community who carry on many of the same functions of a cooperative (Pollnac, Chapter 18, this volume). Data from the open-ended question were content analyzed and categorized into nine categories (see Table 2).

A number of independent variables were also measured by means of direct responses to question in the interview schedule. These included: 1) age; 2) years fishing experience; 3) number of kinsmen who fish; 4) boat ownership; 5) number of kinsmen who fish with the respondent; 6) hours fished per trip; 7)

days fished per week; 8) current perception of socioeconomic position; 9) years of formal education; 10) whether father is/was a fishermen; and 11) whether father is/was a farmer. Current perception of socioeconomic position (variable 8, To $\bar{X}$) was measured by means of a ten-step self-anchoring scale (Cantril, 1963).

Table 1 shows the community level differences in these variables. These variables are sufficiently different among the communities to justify controlling for community in the analysis of the relationship of the dependent and independent variables.

III. Analysis

For the four communities, frequency of first response of perceived benefits of belonging to a fishermen's cooperative are presented in Table 2. The findings presented in Table 2 support the contention that there is considerable diversity of perceived benefits of cooperative membership.

In the Puntarenas sample, 48 percent of respondents felt that there are no benefits to belonging to a cooperative; 16 percent said they did not know what the benefits would be, and an equal percentage thought that it would bring mutual help to fishermen. Nine percent thought it would bring better income. Other categories of response accounted for the remaining responses, but all were under 5 percent of the total. In Costa de Pajaros, 52 percent said they did not know what the benefits would be; 20 percent saw no benefits, and 8 percent of the total saw the advantage in mutual help or other miscellaneous positive benefits. Six percent saw a chance to participate in a savings plan as the main advantage, while 4 percent and 2 percent cited better income and loans, respectively.

Responses in the northwestern region were different in pattern from those in the two Gulf of Nicoya communities. At Playa del Coco the most frequent response (31% of total) was equipment/supplies, while "don't know" was second most frequent with 28 percent of the total. "No benefits" received 10 percent of the total, and "better income," "other positive," "selling point/marketing" each received 8 percent of the total. Mutual help and loans received 5 and 3 percent, respectively. In the North community "don't know," with 52 percent of the responses, was the most frequent response, and "equipment/supplies" was the second with 32 percent of the total. "No benefits" and "mutual help" had 6 percent each, while savings plan had 3 percent of the total.

The analysis shows a relationship between patterns of responses to perceived benefits of cooperatives and a community level variable. Variable 12 (Table 1) is the number of middlemen in each community. As seen in Table 3, there is a perfect positive rank order correlation between number of middlemen and response category 7 (no benefits), and a perfect negative rank order correlation between response category 4 (supplies/equipment) and number of middlemen. This relationship will be discussed further below.

The next step in the analysis is to determine how the dependent and other independent variables are related to each other. Because "lack of knowledge" about the benefits of cooperatives formed the single most frequent response in two of the communities, a new variable (K/NOK) knowledge vs. no knowledge about the benefits of cooperatives was created and tested against independent variables 1 through 11. Table 4 shows the results of this part of the analysis. In each community (K/NOK) was significantly related to at least one of the independent variables.

In Puntarenas and Costa de Pajaros boat owners had more knowledge about cooperatives than non-owners. In Costa de Pajaros and North, the more kinsmen individuals had fishing with them, the less knowledge they had about the benefits of cooperatives. In Playa del Coco the interrelated variables of age and years of fishing experience are related to (K/NOK). The older and more experienced a fishermen is, the more likely he is to have knowledge about the

TABLE 1. Community Level Difference on Independent Variables

Variable	Puntarenas	Costa de Pajaros	Playa del Coco	North	Probability
(1) Age $\bar{X}$	32.8	27.6	27.6	28.7	<.05
(2) Years fished $\bar{X}$	12.4	11.8	11.8	5.9	<.01
(3) No. of family who fish $\bar{X}$	1.9	7.1	4.9	2.4	<.001
(4) Own boat (%)	30	50	33	45	>.05
(5) No. kin fish with $\bar{X}$	.43	1.0	.82	.48	<.01
(6) Hrs. fish/trip $\bar{X}$	10.5	5.2	9	17	<.001
(7) Days fish/week $\bar{X}$	5.6	5.5	6.2	6.1	<.001
(8) To $\bar{X}$	4.7	4.1	5.0	4.9	>.05
(9) Education $\bar{X}$	4.1	3.2	6.2	4.4	<.001
(10) Father Farmer (%)	24	28	41	58	<.01
(11) Father Fisherman (%)	40	68	28	9	<.001
(12) Number of fish dealers per community	17	6	1	.75*	----
N =	67	50	39	31	Total 187

*Four communities with three dealers.

TABLE 2. Benefits of Belonging to A Fishermen's Cooperative

Category	Puntarenas		Costa de Pajaros		Playa del Coco		North	
	(f)	percent	(f)	percent	(f)	percent	(f)	percent
(1) Better income	6	9	2	4	3	8	-	-
(2) Saving plan	2	3	3	6	-	-	1	3
(3) Loans	1	1	1	2	1	3	-	-
(4) Equipment/ supplies	1	1	-	-	12	31	10	32
(5) Mutual help	11	16	4	8	2	5	2	6
(6) Other positive	3	4	4	8	3	8	-	-
(7) No benefits	32	48	10	20	4	10	2	6
(8) Don't know	11	16	26	52	11	28	16	52
(9) Selling point/ marketing	-	-	-	-	3	8	-	-
	67	100	50	100	39	100	31	100

$\boxed{}$ = highest frequency response in community.

benefits of cooperatives. Also in this community, individuals with fathers who were fishermen had more knowledge about cooperatives than individuals who had fathers with other occupations.

IV. Discussion

The results of this analysis show that there is considerable variation from community to community regarding perceived benefits or lack of benefits of belonging to a fishermen's cooperative. Both situational and individual factors help to explain some of this variation. A systematic relationship exists between the number of fish dealers in a community (situational variable) and perceived lack of benefits of belonging to a cooperative as well as with perceived benefits in the form of supplies and equipment.

Besides the obvious point of supplying a selling point, middlemen also serve the important function of obtaining supplies and equipment for fishermen. In fact, as shown by Pollnac (This volume), Costa Rican middlemen carry on a variety of functions besides purchasing of fish for resale to others. Pollnac cites providing loans, picking up parts and providing other "help" as some of the other functions of middlemen. It would appear that where there are sufficient middlemen in a community who compete with one another to supply a variety of functions to fishermen, perceived benefits of a cooperative are low. Where there are not enough middlemen in competition to supply the needs, then the perceived benefits increase.

Some might argue that the high negative evaluation of cooperatives in Puntarenas is due to its main activities being located there; and, thus, this is where its weakness and shortcomings are most visible. However, the data do not support this view. There was a branch of the cooperative in Playa del Coco which did not function at all well and eventually closed down just before the data reported here were collected. Yet, it is in Playa del Coco that we find the highest total positive responses (63%) concerning the benefits of belonging to a fishermen's cooperative. This suggests that the "negative visibility issue" is not a valid alternative explanation.

Regarding knowledge or lack of knowledge about benefits of belonging to cooperatives, we note that in each of our four "communities" different combinations of variables predict whether an individual will have or lack knowledge of the benefits of cooperatives. Although it is not possible at the present time to explain why these various combinations of variables are related to K/NOK, there is an important policy implication to the findings. This implication is related to other findings of the project which indicate that there is considerable diversity and complexity of beliefs, opinions, and knowledge, as well as their correlates in the four communities.

It is clear from this analysis that programs related to cooperative formation and education must take into account the diversity within and between communities. Blanket policy decisions that disregard this diversity are less likely to be successful than those that deal with the complexity as a normal social and cultural feature of human life. It is, of course, impossible to deal with the social and cultural complexity unless studies are carried out as a prior step to policy decisions. In the case studied here, it would appear that greater effort in cooperative development in communities with lower numbers of middlemen and efforts to adjust the cooperative's structure to needs of the fishermen in communities with high concentrations of middlemen may have been in order.

TABLE 3. Relationship of Variable 12 and Response 7 and 4

Variable	Rank		
	Variable 12 Number of fish dealers per community	Response 7 No benefits	Response 4 Supplies/equipment
Puntarenas	1	1	3.5
Costa de Pajaros	2	2	3.5
Playa del Coco	3	3	2
North	4	4	1

TABLE 4. Knowledge of Cooperatives vs. Independent Variables

Variables	Puntarenas			Costa de Pajaros			Playa del Coco			North		
	K	NOK	P	K	NOK	P	K	NOK	P	K	NOK	P
(1) Age $\bar{X}$	33.5	29.1	>.05	29.6	25.8	>.05	29.9	21.8	<.05*	29.7	27.7	>.05
(2) Yrs. fished $\bar{X}$	12.7	10.6	>.05	12.8	10.9	>.05	14.4	5.4	<.05*	6.5	5.4	>.05
(3) No. of family who fish $\bar{X}$	2.0	1.5	>.05	6.5	7.7	>.05	5.9	2.5	>.05	2.1	2.8	>.05
(4) Own boat (%)	34	9	<.05*	63	39	<.05*	39	18	>.05	53	38	>.05
(5) No. kin fish with $\bar{X}$	.40	.50	>.05	.67	1.35	<.05*	1	.4	.05	.2	.8	<.10*
(6) Hrs. fish/day $\bar{X}$	10.3	10.7	>.05	4.8	5.6	>.05	7.3	4.8	>.05	15.7	19.8	>.05
(7) Days fish/week $\bar{X}$	5.6	5.6	>.05	5.6	5.4	>.05	6.4	6.0	>.05	6.0	6.1	>.05
(8) To $\bar{X}$	4.7	4.7	>.05	4.0	4.3	>.05	5.0	4.9	>.05	4.5	5.2	>.05
(9) Education $\bar{X}$	4.1	4.5	>.05	2.5	3.8	<.05*	6.1	6.5	>.05	5.0	3.9	>.05
(10) Father Farmer (%)	27	9	>.05	29	27	>.05	36	54	>.05	60	56	>.05
(11) Father Fisherman (%)	39	46	>.05	67	69	>.05	39	0	<.001*	7	12	>.05

* = significant relationship alpha = .10

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CHAPTER 18. THE ROLE OF MIDDLEMEN AS PERCEIVED BY SMALL-SCALE FISHERMEN IN THE GULF OF NICOYA, COSTA RICA

BY R.B. Pollnac

An important aspect of small-scale fishing is that as technology becomes more efficient, enabling production in excess of the subsistence level, a need for a distribution system develops. Fish is a highly perishable product which is not easily stored without complex techniques such as drying or freezing technologies. Firth (1966) notes that a fisherman's catch, in comparison with a farmer's product, needs more outlay in equipment and labor if it is to be stored. This, he suggests, results in a tendency for a greater development of middlemen among fishermen. Further, a fisherman's many hours at sea is phyaically exhausting, and when he arrives at shore he usually does not have the time or energy to process or distribute his highly perishable product; thus, the distribution of surplus catch is usually performed by a specialist who is often referred to in the literature as a middleman or fish dealer.

In many fishing communities, females take over the function of buying and selling fish. Female "middlemen" are found throughout the world in regions as widely spread as the Caribbean (Aronoff, 1967), El Salvador, Brazil (Forman, 1970), Ghana (Gladwin, 1970), India (Norr, 1972), Thailand (Fraser, 1966), and Okinawa (Glacken, 1955). Sometimes this division of labor functions to keep at least some of the profits within the family--the men fish, and their female relatives sell the product (Forman, 1970; Gladwin, 1970).

Nevertheless, the middleman is not always a kinsman. In many regions the middleman is an unrelated entrepreneur whose sole motive is to make a profit by buying and selling fish. Further, it is often claimed that middlemen exploit the small-scale fisherman (Jimenez-Castro, 1976; Alexander, 1977; Witham, et al., 1978). Often, however, even in regions where outsiders and the government view the middlemen as exploiting the fisherman, the middleman is doing an excellent job at performing a vital function and making very little profit. For example, Firth (1966), noting that it is a common accusation that middlemen reap the benefits of the fishery, reports that among the Malay in his sample, the middlemen make very little profit for the time and energy they expend. Our preliminary observations in Costa Rica have led to the same conclusion. Further, the fishermen themselves often recognize the multifunctional nature of the middleman and are content with the existing system despite their continuous complaints about prices (a common complaint of primary producers around the world). For example, in Malaysia the small-scale fishermen reportedly appreciate the role that the middlemen plays as a financier for capital equipment (Sabri, 1977). Blake (1977) notes that among Madras fishing populations in India, the middleman functions as both business contacts for fishermen and dependable sources of cash when production drops off and when large expenditures are necessary (e.g., for weddings, funerals, and holidays).

The purpose of this chapter is to examine fishermen's perceptions of middlemen and the role that they play in the small-scale fishery in the Gulf of Nicoya.

1. Sample and Methods

A sample of 80 small-scale fishermen from the Gulf of Nicoya were interviewed; 50 from an urban area (Puntarenas) and 30 from a rural community (Costa de Pajaros). The middleman, or fish buyer, is an important individual in the structure of the small-scale fishing industry in the Gulf of Nicoya. On the short strip of coastline where interviews were conducted in Puntarenas there were seven active middlemen. At Costa de Pajaros five were active.

Other middlemen existed in both areas, but they were either outside the area sampled or not active during the research period. Ostensively, the middleman performs the important function of purchasing fish from the fisherman for resale to other middlemen or retailers. He does, however, provide other services for the fisherman. The number of active middlemen in the region and statements made by fishermen suggest that competition exists between the various buyers; hence, fishermen were asked why they sell to one middleman rather than another.

II. Analysis

The percent distribution of responses to the question concerning why fishermen sell to one middleman as opposed to another can be found in Table 1.

The most frequent rationale for selecting one buyer over another is the prices paid for fish. The second most frequent rationale is that a fisherman would rather deal with a buyer who helps him in some way, such as providing loans, picking up parts, etc. Fishermen also select buyers on the basis of what they perceive as fair treatment. This category includes the attributes of honesty, immediate payment for product, not discarding marginally spoiled fish, etc. Nine percent of the fishermen report that they sell to a specific buyer because they are in debt to him, while eight percent claim they make their decision on the basis of friendship. A small proportion of the fishermen choose middlemen who never refuse their product. Some middlemen refuse to buy when the market is glutted, and the fishermen are forced to let their product rot. Several fishermen noted that they deal with a specific buyer because he is located closer to their home. The "other" category includes idiosyncratic responses such as "character of buyer," "landing facilities," and "more responsible."

The first, and therefore most salient, high frequency responses were cross-tabulated with area of residence. The expectation that urban fishermen would be more likely than rural to select buyers on the basis of price was supported by the data (44 versus 23 percent, respectively; $X^2 = 3.47$, $p < .05$; one-tailed test). As argued elsewhere in this volume; urban fishermen are more involved in the cash economy; thus, we would expect that prices paid by middlemen would be their most salient attribute in the urban area. In contrast, the rural fishermen are more interested in the help that the middleman provides in the form of loans, picking up parts for equipment, etc. (37 versus 14 percent, respectively; $X^2 = 5.52$, $p < .02$). Finally, there is no relationship between area of residence and the "fair treatment" category ($X^2 = 0.02$, $p > .10$).

III. Summary and Conclusions

The analysis of perceived functions of middlemen indicates that while 48 percent of the fishermen emphasize prices as an important factor in selection of buyers, 45 percent emphasize other forms of help such as loans, picking up parts, etc. This suggests that institutions proposed to replace the middlemen must also provide these other services if they are to succeed. Rural and urban differences with respect to this variable suggest that when changes are implemented, differential emphasis on the various functions should be included in information programs in the two areas.

Overall, these findings in combination with the brief review of the literature presented above suggest that there is a complex relationship between middlemen and social and technological aspects of the small scale fishery. The assumption of middleman as exploiter, however, has led to many attempts to replace him before fully understanding the multidimensionality of his role in the fishing community.

TABLE 1. Distribution of Rationales for Selection of Middlemen

Rationale	Percent*
Better prices	48
Provides help (loans, etc.)	45
Fair treatment	31
In debt to middleman	9
Friendship	8
Always buys fish	6
Closer to residence	4
Other	10

N = 80 *Total exceeds 100% because entries reflect categorization of the first three responses to an open-ended question.

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CHAPTER 19 THE STRUCTURE AND PERFORMANCE OF WHOLESALE MARKETING OF FINFISH IN COSTA RICA

BY A.C. Scheid and J.G. Sutinen

The small-scale fishing industry of Costa Rica has been described as a rather primitive operation characterized by a large number of middlemen, small output, high distribution costs, and relatively high consumer prices (Tilic and Artavia, 1971). The relatively high price of good quality fish limits the consumption by lower income groups and deprives them of an important source of animal protein (Lovel and Moss, 1971).

In recent years, the Government of Costa Rica, along with other governments of Central America, has expressed a strong interest and commitment to the development of the artisanal fishery sector. Among the expressed goals of development are the improvement of the standard living of the small-scale fishermen and the provision of fish to middle and lower income consumers at prices they can afford. One method of trying to meet both the needs of fishermen and consumers is by improving the marketing system. If fish can be moved from producers to consumers at lower costs while maintaining the same standard of services, both the fishermen and the consumers may stand to benefit.

Policy makers concerned with improving the performance of the marketing system are often concerned with the level of competition in the industry and the extent to which potential economies of scale are realized. The perfectly competitive model often is used in economics as a standard by which the structure and performance of the market may be compared and evaluated. In a competitive market characterized by large numbers of buyers and sellers, low barriers to entry, and complete knowledge of the nature of alternative choices on the part of producers and consumers, there is an economically efficient allocation of resources. Since each firm maximizes its profits by equating the given price to its marginal cost, competitive prices correctly reflect both consumer demand and the cost of the resources employed.

In so far as the wholesale sector of the small-scale fishery is competitive, its prices and marketing margins will reflect the true costs of providing its marketing services. If imperfect competition exists among the firms of the wholesale sector, the marketing margins may be higher than under more competitive conditions. Prices paid to the fishermen may be lower than the competitive equilibrium level and prices paid to the retailers may be higher than the competitive level. For these reasons policy makers concerned with the welfare of fishermen and consumers are interested in knowing more about the current level of competition in the wholesale sector and how it might be improved.

Marketing development programs are also concerned with potential economies of scale and the extent to which such economies are realized in the industry. To the extent that unit costs are lower for larger scales of production, economies of scale are said to prevail. If economies of scale exist in the marketing sector and if many firms operate at levels too low to secure the benefit of such economies, substantial marketing cost reductions may be obtained through a policy aimed at increasing the output of those firms currently operating at suboptimal scales. One means of ensuring that such cost reductions are passed on to the fishermen and consumers would be the pressure of competition.

A review of the literature on marketing in under-developed countries reveals two divergent views of the role played by the middlemen in traditional marketing systems. On one side is the popular view that the middlemen is a central obstacle to development because he often exploits the producers and consumers of the products he handles. In some cases it is argued that there are only a few intermediates at certain marketing levels and through collusive

action they are able to fix prices and extract excessive profits. In other cases it is argued that the unnecessarily long chain of middlemen from producer to the consumer results in high marketing costs. Middlemen are also accused of acquiring monopolistic control by providing much needed credit to the producers and forcing their creditors to sell them their product at relatively low prices (Rao, 1973; Fuentes, 1976).

On the other side of the argument are those who hold that the traditional marketing middlemen has been unfairly maligned and that he usually plays a vital and necessary role in the marketing operations of the less developed countries. According to this point of view, most attacks on marketing middlemen are based on a misunderstanding of the variety of functions they perform and an exaggeration of their power. In general, fishermen and marketing middlemen are considered to have a mutually beneficial, symbiotic relationship which operates smoothly in a traditional environment (Bauer and Yamey, 1954; Lele, 1976; Lawson, 1977).

Despite the different and sometimes conflicting views about the conduct and performance of marketing middlemen in less developed countries, little research has been carried out on the structure and performance of the wholesale marketing sector in less developed countries. Much of the literature on marketing in less developed countries remains largely descriptive and barren of analysis.

The general objective of this chapter is to examine the market structure and performance of the wholesale sector of the small-scale fishery of Costa Rica. Specifically, this chapter:

1) analyzes the current market structure of the wholesale sector of the small scale fishery and discuss its influence on market conduct and performance, and;

2) examines the level of potential economies of scale in the provision of marketing services at the wholesale level.

1. Description of the Wholesale Sector

The wholesale sector is a large and vital part of an overall marketing system which provides for the flow of fresh fish small-scale fishermen to the consuming public. The movement of fish from producer to consumer involves the marketing services of primary buyers (port wholesalers), truckers, and retailers. The primary buyers buy the fish from the fishermen on the docks and beach landing sites and perform the services of assembly and storage. They next either sell the fish to transporters or transport the fish themselves to the retail outlets in the capital city of San Jose and other population centers in the vicinity of San Jose. The retailers then carry out the final marketing stage of selling the fish to the ultimate consumers.

Primary Buyers. The primary buyers provide the first link in the marketing chain that carries the produce of the artisanal fishermen to the consuming public. They purchase the fish directly from the fishermen at the port or beach sites around the Gulf of Nicoya. Their installations for handling and storing fish before it is transported on to the retailers are in general rather modest. Their buildings are sometimes extensions added onto private homes or small lean-tos. Data gathered interviews in 1976 indicated that the average building size was about 44 square meters and the average ice box and/or refrigerators capacity was about 5,000 pounds.

The data from daily purchasing receipts collected from the primary buyers between September 1976 and February 1977, revealed a total of 28 different primary buyers operating in the port of Puntarenas and in various outlying landings sites around the Gulf of Nicoya (see Figure 1). For the most part, these buyers are concentrated near the landing areas of Puntarenas, the

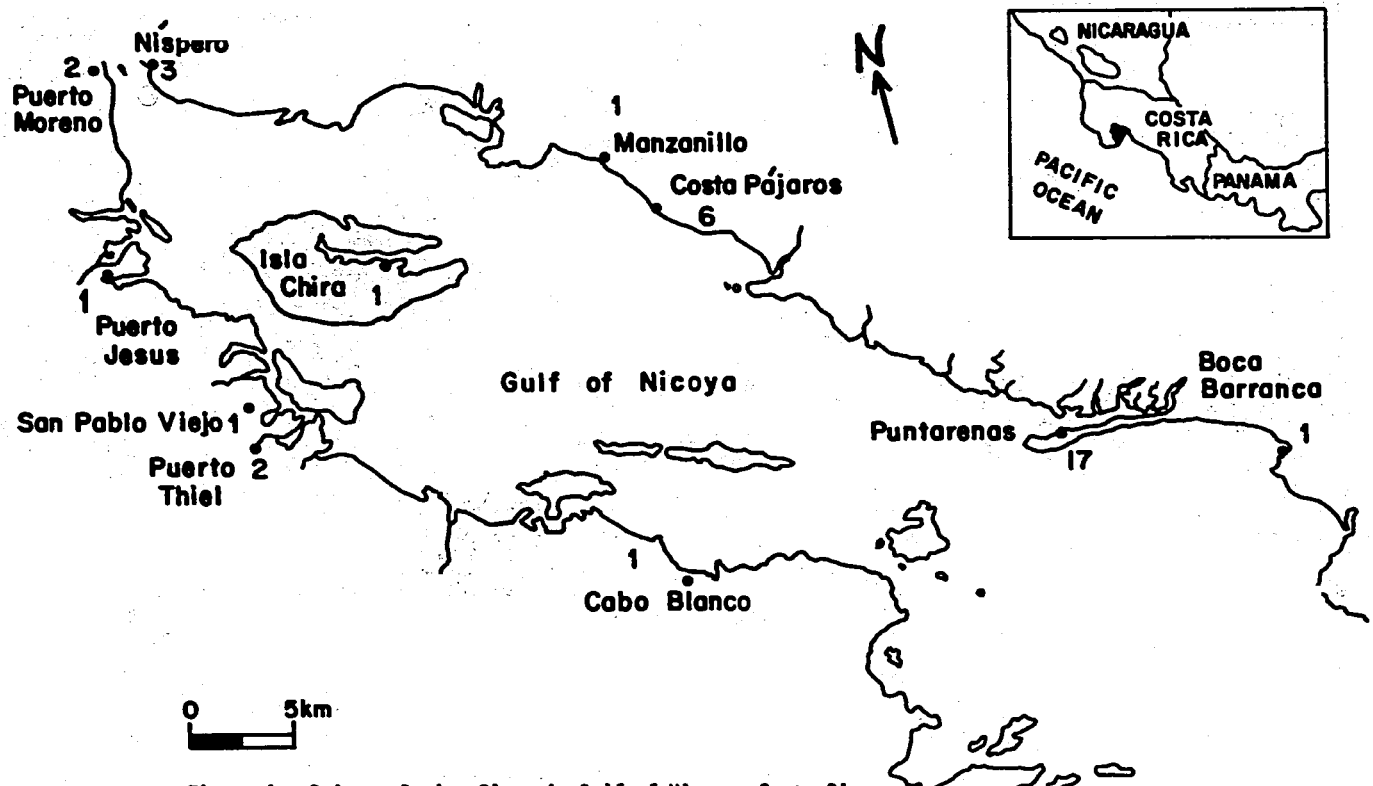

Figure 1. Primary Buying Sites in Gulf of Nicoya, Costa Rica.

principal port of both the artisanal and commercial fishing industries of Costa Rica. In addition to the 28 buyers originally identified in 1976, there are three new buyers who entered the industry since that time.

Several types of ownership may be distinguished among the primary buyers. Twenty-four firms are owned by individuals and six by partnerships or corporations. There is one fishermen cooperative (COOPEPES) and one fishermen union (UNPEPES). (The union is different from the cooperative in that it is not regulated by the bylaws and legal safeguards of an officially inscribed cooperative. The union is much smaller and united to a great extent by family relationships.)

One way of measuring the size of the various primary buyers is in terms of the amount of fish that they purchase. Due to gaps in data collection, there are weeks when the purchasing data are missing for some firms. For this reason, the ranking of firms in terms of the total purchase amounts recorded for each firm is not a reliable indicator of relative size in the industry. A better estimate of the relative differences in firm size is obtained by calculating the weekly average amount purchased by each firm, using only those weeks for which data are available. The ranking of the buyers in terms of their weekly average purchases along with the number of weeks recorded is given in Table 1.

Another index of relative size among the primary buyers is the icebox capacity of the individual firms. Table 2 lists the icebox capacity of the firms that have been interviewed. As one might expect, some of the firms with the largest holding capacity are among those who are the largest weekly purchasers of fish; i.e., firms 1 and 9. However, the data also indicate that some of the buyers, such as firms 2 and 5, have lower than average capacity levels and some of the smaller weekly purchases, such as firms 7 and 14, have larger than average holding capacity. This suggests that some firms are using their available capacities levels better than others.

Species and Classification of Fish. A large variety of fish is purchased by the primary buyers operating in Puntarenas and other landing sites along the Gulf of Nicoya. Although not all the buyers use the same categories of classifying the fish they purchase, the majority follow a classification which combines size and type of species. The major classifications generally used on the wholesale level are: large first class fish (primera grande), small first class fish (primera pequena), classified fish (clasificado), small shark (cazon), two larger types of shark (posta blanca and posta negra), cola and agria, and chatarra.

Table 3a presents the eight major species or classifications of finfish which the small-scale fishermen landed in the region of Puntarenas during the period between September 1976 and February 1977, when purchasing data were collected. The largest amount of fish purchased by the primary buyers during this period fell under the category of "Cola and Agria." Small first class fish was a distant second in terms of the amount purchased (see Table 3b).

The large and small first class fish categories brought the fishermen the highest ex-vessel prices per pound, with a weighted average price of 3.31 colones and 2.60 colones, respectively (8.5 colones = U.S. $1.00). Cazon, Posta Blanca, Clasificado, and Cola and Agria fell in the middle price range of 1.86 to 1.40 colones per pound. Posta Negra had a weighted average price of .98 colones per pound while the commercially less attractive fish in the "Chatarra" category brought a weighted average price of .61 colones per pound (see Table 4a for the ranking of finfish according to their weighted average price).

Because of the relatively large amount purchased, the middle price fish category of Cola and Agria generated more revenue for the fishermen than any other species or category of fish landed during the survey period. Posta Negra and the species in the Clasificado category were the least important fish in terms of revenue paid out to the fishermen by the buyers (see Table 4b).

TABLE 1. Average Weekly Purchases (lbs.)
(September, 1976 to February, 1977)

Primary Buyer	Average Weekly Purchases (lbs.)	Percentage of Industry Purchases	Cumulative Percentage	Number of Weeks Recorded
1	10,607	12%	12%	21
2	10,067	12	24	10
3	6,387	7	31	21
4	6,253	7	38	13
5	6,167	7	45	21
6	5,607	6	51	21
7	4,410	5	56	20
8	4,400	5	61	21
9	4,314	5	66	13
10	3,901	5	71	20
11	3,892	4	75	21
12	3,633	4	79	20
13	3,371	4	83	17
14	3,211	4	87	5
15	2,644	3	90	20
16	1,845	2	92	21
17	1,583	2	94	5
18	1,343	2	96	20
19	1,098	1	97	14
20	436	1	98	3
21	354	*	--	7
22	317	*	--	6
23	309	*	--	17
24	208	*	--	3
25	161	*	--	15
26	129	*	--	3
27, 28, 29 only one week recorded				

*Less than one percent.

TABLE 2. Primary Buyer Icebox Capacity

Buyer	Icebox Capacity (lbs.)
1	10,600
7	8,500
6	8,000
9	8,000
14	8,000
15	6,400
4	6,000
12	4,800
3	4,500
5	4,000
11	4,000
*30	3,500
16	3,300
2	3,000
8	3,000
*32	3,000
*33	1,900
18	1,500
*31	700

Total Capacity Recorded: 98,700 lbs.
Average Firm Capacity: 5,195 lbs.
Standard Deviation: 3,620 lbs.

*Not included in the purchasing data collected during the period of September 1976 to February 1977.

Source: Personal interviews conducted by University of Rhode Island and Department of Fisheries of Costa Rica, 1978.

TABLE 3

a) Species and Classifications of Fish Purchased by the Primary Buyers

A. Primera Grande: corvina, robalo
B. Primera Pequena: corvina, robalo, pargo, aquada, cabrillo, mero
C. Clasificado: macarela, berrugate
D. Cazon
E. Cola y Agria: cola, agria, bagre, cuminate, pargo
F. Posta Blanca: posta blanca, posta gata
G. Posta Negra
H. Chatarra: jurel, liza, raya

b) Ranking of Finfish by Amount Purchased (Sept. 1, 1976 to Feb. 15, 1977)

	Species	Weight (lbs.)	Percent of Total Amount Purchased
1.	Cola y Agria	441,340	35.9
2.	Primera Pequena	229,399	14.9
3.	Chatarra	212,130	13.8
4.	Cazon	201,184	13.1
5.	Primera Grande	171,634	11.2
6.	Posta Blanca	113,955	7.4
7.	Clasificado	48,365	3.1
8.	Posta Negra	7,551	.4

TABLE 4

a) Ranking of Finfish by Weighted Ex-vessel Average Price (Sept. 1, 1976 to Feb. 15, 1977)

1.	Primera Grande	3.31
2.	Primera Pequena	2.60
3.	Cazon	1.86
4.	Posta Blanca	1.44
5.	Clasificado	1.43
6.	Cola y Agria	1.40
7.	Posta Negra	.98
8.	Chatarra	.61

b) Ranking of Finfish in Terms of Revenue to Fishermen

		Revenue	Percent of Total Revenue
1.	Cola y Agria	773,974	28.7
2.	Primera Pequena	596,445	22.1
3.	Primera Grande	568,240	21.1
4.	Cazon	374,854	13.9
5.	Posta Blanca	164,626	6.1
6.	Chatarra	128,557	4.8
7.	Clasificado	69,013	2.6
8.	Posta Negra	7,406	.3

II. Market Structure of the Wholesale Sector

Economic theory and empirical studies suggest at least four critical structural variables that influence the level of competition and performance in a market. These structural characteristics are: the concentration of buyers and sellers, barriers to entry, product differentiation and vertical integration.

Concentration. Market concentration is defined as the number and size distribution of sellers and buyers in the market. Both theory and empirical evidence suggest that the level of concentration within an industry affects the interdependence of action among firms. The greater the degree of concentration, the greater the ease of oligopolistic (oligopsonistic) coordination and the consequent market performance which approaches that of the monopoly (monopsony) situation.

Concentration indexes have thus come to serve as proxies for market power, the extent to which individual firms are able to exert some influence over market prices. Available data on the number of buyers and the quantities of fish they purchase from the fishermen allow for a measurement of concentration on the buyers' side of the market. High concentration among the buyers would be an indication of oligoposony.

Since most of the fresh finfish sold to fish retailers in San Jose passes through the hands of the primary buyers of the Gulf, the level of concentration on the buyers' side of the market probably also indicates the level of concentration on the sellers' side.

Indexes of Concentration. Concentration ratios and curves are frequently used as partial indicators of the level of concentration that exists in the relevant market. A market concentration ratio is defined as the total industry sales or purchases accounted for by the largest few firms, ranked in order of market shares. Partial indexes of concentration typically report the percent of industry sales or purchases held by a portion of the firms in the market (for example, the 4, 8, 12 and 20 largest firms in the market). Summary indexes, on the other hand, include all the firms in the market.

The market concentration ratios for the primary buyers were calculated by measuring the percentage of the industry's average weekly amount purchased which is accounted for by each firm. That is:

$$\text{Market Share Ratio of Firm 1} = \frac{\text{Average Weekly Purchase}^{1} \text{ of Firm 1}}{\text{Average Weekly Purchase Amount of Industry}}$$

Table 5 presents the concentration ratios for the largest 4, 8, 12 and 16 firms, where the relevant geographical market is defined as including the region of the Gulf of Nicoya and the relevant market product is fresh finfish. The largest four buyers purchased 38 percent of the industry's average weekly purchases, while the largest 8, 12, and 16 accounted for 62, 80, and 92 percent, respectively, of the industry's average purchases.

While the concentration ratios apply to only a portion of all the firms in the industry, the Lorenz curve presents a summary indicator of concentration for the total industry. It indicates the disparity between the cumulative percentage of total purchases and tha cumulative percentage of total firms in the industry. The Lorenz curve in Figure 2 indicates that 50 percent of the industry accounts for more than 80 percent of the total purchases. Both the concentration ratios and the Lorenz curve indicate that a rather large percentage of the fish purchases are made by a relatively small number of buyers.

When the relevant market is defined in terms of each specific category of fish, the results are quite similar. Table 6 indicates that the largest four buyers purchase from 36 to 80 percent of each category of fish. Concentration at the eight firm level ranges from 63 to 95 percent of total purchases. In

TABLE 5. Concentration Ratios for the Four, Eight, Twelve, and Sixteen Largest Buyers*

Largest Four Firms:	.381
Largest Eight Firms:	.616
Largest Twelve Firms:	.796
Largest Sixteen Firms:	.923

*Based on purchasing data collected during the period September, 1976 to February, 1977.

every category of fish, a relatively small percentage of the buyers account for a large percentage of total purchases. The greatest concentration occurs in the market categories of Posta Blanca and Posta Negra and the least concentation in the market categories of Cola and Agria and Chatarra.

In order to evaluate the level of competition reflected in the concentration ratios of the primary buyers, it is useful to recall the general conclusions of economic theory and empirical studies. Oligopoly theory and most empirical studies predict a positive effect of concentration on prices and price-cost margins. There is, however, some disagreement about how much buyer concentration is necessary before non-competitive influences become sufficient to affect conduct and performance. Theorists such as Chamberlin and Bain point to some critical level of concentration, while others, like Cournot and Stigler, suggest that margins rise at an increasing rate with concentration. In general, the theory states that as the number of buyers grows smaller there is greater opportunity for indirect or direct collusive behavior.

Empirical studies in the field of industrial organization suggest certain levels of concentration at which non-competitive behavior begins in certain industries. Bain (1951) and Mann (1966) conclude that "a critical level" of concentration occurs roughly when 70 percent or more of the market is controlled by the eight largest firms. Rhoades (1973) finds a critical level of concentration where the largest four firms control 30 percent of the market. Kaysen and Turner (1965) propose that substantial oligopoly exists when the top eight firms handle 50 percent of the industry's sales and the largest 20 firms at least 75 percent.

When the relevant market is considered to be the market for fresh finfish in the Gulf of Nicoya region, the four firm buyer concentration level meets the criteria of Bain, Mann, and Rhoades, but concentration at the eight firm level falls slightly below their criteria for a critical level of concentration. In terms of the Kaysen-Turner criteria, there exits a critical level of concentration at both the eight and twenty firm levels.

When the relevant market is considered in terms of the different categories of fish, the top four firms in each category are above the 30 percent concentration level. At the eight firm level, concentration is above 70 percent in 5 out of the 8 market categories. In every market category, the concentration at the eight and twenty firm level is well above the critical levels of concentration suggested by Kaysen and Turner.

The concentration levels suggest the existence of oligopsony market power on the buyers' side--when the relevant market is defined as one general market for finfish and also when it is defined according to the different categories of fish. If it is assumed that most of the fish sold to the retailers in San Jose passes through the hands of these primary buyers of the Gulf of Nicoya, their market power on the buyers' side also reflects their market power on the sellers' side as well.

Some caution should be used in attempting to draw conclusions from the concentration indicators of the primary buyers. The period during which this data were gathered was relatively short--only about five months. It is too short a period to attempt to draw anything more than some general, tentative conclusions. Nevertheless, the relatively high level of concentration at the primary buyer level is at least a preliminary indication of market conditions which provide the opportunity for imperfect competition.

Concentration Trends. At present, data concerning possible trends in the level of concentration are limited. In 1971, Tilic and Artavia reported that there were eight primary buyers operating in Puntarenas. Field studies carried out during the summer of 1976 revealed that the number of buyers in Puntarenas had risen to 15. Since that time at least three small firms (Firms 18, 20 and 27) have gone out of business and one large firm (Firm 6) has been bought out by another large buyer (Firm 5). In 1977, two small firms (Firms 30 and 34) entered the industry.

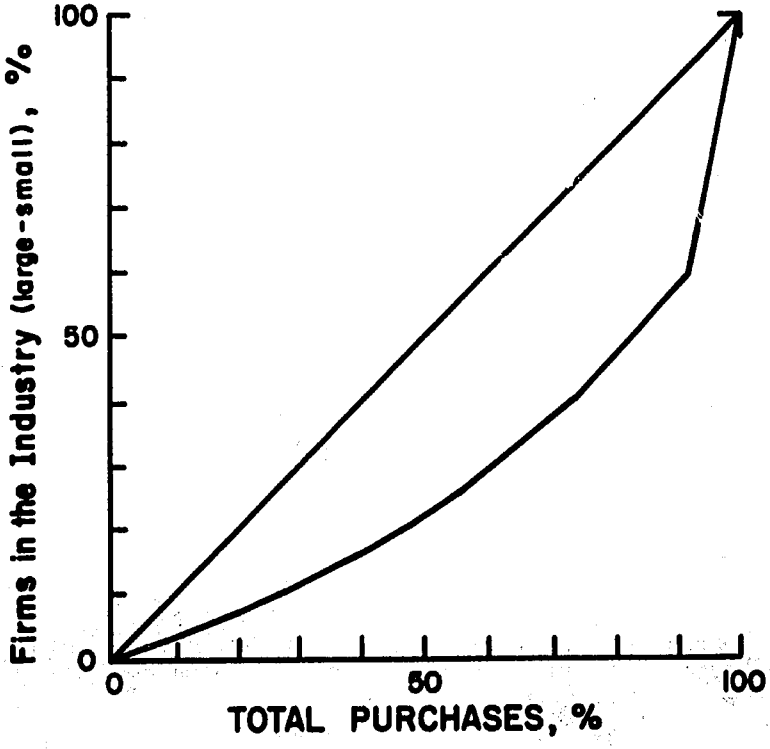

Figure 2. Lorenz Curve for Fin Fish Purchased at Primary Buyer Marketing Level

TABLE 6. Concentration Ratios for Four, Eight, Twelve, and Sixteen Largest Primary Buyers, by Species (September, 1976 to February, 1977)

Species	Largest:			
	Four Firms	Eight Firms	Twelve Firms	Sixteen Firms
Primera Grande	43.5	73.2	85.7	96.3
Primera Pequena	42.7	68.1	87.15	96.4
Clasificado	58.0	84.2	95.1	99.6
Cazon	56.8	85.5	95.9	98.3
Cola and Agria	36.1	63.6	84.8	93.8
Posta Blanca	80.5	92.3	98.1	99.8
Posta Negra	80.4	95.1	99.4	100.0
Chatarra	41.0	67.3	83.3	93.1

The three small firms who went out of business in the last two years represented less than one percent of the industry purchases during the 5 month survey period. The firm which was bought out (Firm 6), on the other hand, was the sixth largest buyer during that period with about 6 percent of the total purchases. Its takeover by Firm 5, the fifth largest buyer with 6.7 percent of the total purchases, indicates a significant increase in the concentration among the largest buyers since 1976.

Barriers to Entry. The extent to which monopoly or monopsony conditions are allowed to persist in the long run depends on the height of the barriers to entry. The static theories of competition and monopoly emphasize that the existing firms will be able to persistenly earn pure profits only if the entry of new firms is somehow blocked. Some indication of potential barriers to entry existing at the primary buyer stage may be revealed by examining the amount of capital investment needed to enter the industry, the conditions of supply, and the entry and exit patterns observed in recent years.

Interview data collected in 1976 and 1978 indicate that some of the major capital investment items of the primary buyer include a small building, icebox and/or freezer facilities, and scales. The buildings owned or rented by the buyers are often quite modest, sometimes merely a small extension built into a private home or a small wooden shed. The market price for such buildings ranges from 6,000 to 50,000 Colones (8.5 Colones = U.S. $1.00). Five of the 15 buyers interviewed rented the building in which they worked. Their rent ranged from 200 to 3,500 Colones per month. From 800 to 14,000 Colones were spent on refrigeration equipment and from 600 to 1,500 Colones on scales. Estimated total capital investments of the firms interviewed ranged from 2,000 to 37,800 Colones with the average investment at about 14,000 Colones.

Interview data indicate that the required investment capital needed to enter the industry is even higher than the figures quoted above because the majority of buyers also provide loans and advances to the fishermen. Some buyers in the outlying areas also sell fuel and trip provisions to the fishermen. Since the majority of the buyers provide one or more of these services, it is fair to assume that a new firm entering the industry would be required to provide some of these same services if it were to compete successfully with the other buyers. At present, there are no data concerning the amount of extra capital needed to provide these services.

Another factor which may add to the investment capital necessary to enter the industry is the fluctuation in the amount of fish supplied from week to week. Data on fish landings indicate that there are weeks when many buyers have very little fish to buy and sell, with the result that their revenues are very low during some periods. The cycle conditions of fish supply may thus require buyers to have sufficient operating capital to be able to "ride out" periods of low supplies and low revenues.

One final factor may raise the amount of capital investment necessary for entry into the industry is the possible requirement of vertical integration in order to compete successfully as a primary buyer. If vertical integration is necessary to entry, the capital investment required must also include the investment needed to operate at the other stage(s) as well. The increase in the investment needed for entry may be a significant barrier to potential entrants.

In summary, a variety of factors including extra credit and supply services, cyclical supply conditions, and vertical integration may make the capital investment necessary for entry at the primary buyer stage sufficiently high so as to constitute a significant barrier to entry.

Product Differentiation. Product differentiation refers to those real or perceived qualities of the market services of the buyers which differentiate them from their competitors. The important sources of market service differentiation among the buyers, alluded to above, are the geographical differences and the provision of extra, ancillary services. By being conveniently located to fishermen, some buyers may be able to build up a

specific clientele who view their marketing services to be significantly different from those buyers who are located farther away. In a similar fashion, buyers who provide loans and supplies to fishermen differentiate their services from those buyers who do not provide such services. These aspects of product differentiation are important structural variables in so far as they permit some buyers to raise prices above the general market level without losing their customers; something that would be impossible if the services of all the buyers are exactly the same.

Neither theory nor the currently available data permit any definite predictions about the difference in market price that results from product or service differentiation among the buyers. In general, however, it may be stated that the greater the amount of service differentiation among buyers the greater is the opportunity for buyers to exert influence over the prices they pay.

Vertical Integration. The last major structural characteristic to be considered is vertical integration within the marketing system of the small scale fishery. Vertical integration of primary buyers with other marketing stages by means of ownership or informal agreements is quite prevalent. Table 7 illustrates the extent of ownership integration at various stages of the marketing system. About 60 percent of the primary buyers are identified as integrated backwards to the supply stage by means of vessel ownership. Nearly 70 percent of the buyers are integrated forward at the transport stage through the ownership of one or two trucks. Three buyers are completely integrated from the supply stage to the retail stage.

Vertical integration of marketing stages is further extended by means of informal agreements between various marketing stages. Table 8 describes the nature of these agreements between buyers and fishermen as well as the number of vessels included in such arrangements. In most cases, the arrangements are based on long term friendship, loan and supply services, and agreements to buy fish during periods when the market is glutted with fish. The data in Table 8 indicate that there are about 55 fishing vessels integrated with buyers through private ownership or through membership in the fishermen's cooperative and union. About 160 vessels are listed as having informal contractual arrangements with buyers.

Interview data gathered from buyers allows for a rough estimation of the percentage of weekly purchases supplied by means of ownership integration and informal contracts at the supply level. Table 9 presents the estimated percent and amount of the average weekly purchases supplied through the firms' own vessels and/or through informal agreements. About 25 percent of the industry's average weekly supply of fish comes from vessels which are owned by the buyers. The remaining 75 percent comes from other vessels which, for the most part, have informal agreements with the buyers.

The payment incentive for a primary buyer to integrate with the harvesting level--either through ownership or informal agreements--is to assure a minimum supply during those periods when fish landings are relatively low. Among the primary incentives for the fishermen to integrate at the buyer level is to obtain a guaranteed outlet for their fish during periods when landings were very high. In some cases, integration with the buyers by means of informal contracts is a means by which fishermen could avail themselves of credit and supply services provided by the buyers.

Studies of vertical integration in agricultural markets suggest several negative effects which may result when a large part of the market becomes vertically integrated. The formal and informal integration of the supply stage by buyers has the effect of "thinning out" the market alternatives for those fishermen who are not integrated. With the majority of the buyers in some way integrated at the supply level, non-integrated fishermen may find that there are few available buyers for their fish, especially during times of large fish landings.

In a similar fashion, the integration of the buyer and transport stages

TABLE 7. Ownership Integration of Marketing Stages

Integrated Stages:	Fishing Vessel - Primary Buyer - Transport - Retail			
Firms: 5, 15, 38				
Integrated Stages:	Fishing Vessel - Primary Buyer - Transport			
Firms: 6, 12, 16, 18, 32, 39				
Integrated Stages:	Fishing Vessel - Primary Buyer			Retail
Firms: 1				
Integrated Stages:	Fishing Vessel - Primary Buyer			
Firms: 4, 7, 10, 30				
Integrated Stages:		Primary Buyer - Transport - Retail		
Firms: 8, 13, 14				
Integrated Stages:		Primary Buyer - Transport		
Firms: 2, 3, 11, 17				

TABLE 8. Fishing Vessel and Primary Buyer Integration

Primary Buyer Code #	Ownership	Union	Coop	Informal Agreement*	
1	1 Launch			15 Launches 7 Boats	Primary buyer agrees to buy fish from fishermen when there is an abundance. Fishermen agree to sell fish to primary buyer when there is scarcity.
2				15 Launches	Buyer provides financial assistance for ice and repairs to fishermen. Friendship bond.
3				8 Launches 2 Boats	Primary buyer pays a "good price." Long-time relationship between primary buyer and fishermen.
4	3 Launches			11 Launches	Small loans, repairs, advice of maintenance and repair of motors. Location of primary buyer in Barrio El Carmen is convenient for the fishermen.
5	2 Launches			20 Launches 5 Boats	Primary buyer pays "good price" to fishermen.
6	4 Launches			1 Boat	Long-time relationship.
7		8 Boats 4 Boats			
8				12 Launches	Buyer sells ice and food to fishermen and provides loans for repairs and trip expenses. Long-time relationship.
9				8 Boats	Written contract.
10	1 Boat				
11	1 Boat			5 Launches	Primary buyer sells food, fuel, ice and other trip supplies to the fishermen.
12			18 Boats		
13				15 Launches	Buyer supplies ice and fuel to fishermen and takes responsibility for the bank loans.
14				3 Boats	Long-time relationship.

*All of the contract arrangements appear to be informal, berbal agreements except for Firm #9 which has a written contractual agreement with eight boats.

TABLE 8, continued

Primary Buyer Code #	Ownership	Union	Coop	Informal Agreement*	
15	1 Launch			5 Launches	Buyer brings ice and fuel to Nispera and lends money to fishermen for trip expenses. Loans are later deducted when fish is sold.
16	1 Boat			5 Launches 2 Boats	Primary buyer provides loans for fishermen under the condition they sell to him. Friendship bond.
17				5 Boats	Buyer provides the use of his wharf for fishermen. Long-time relationship.
18	1 Boat				No Data
19	No Data				No Data
30	1 Launch			5 Boats 1 Launch	
31	1 Launch 2 Boats				
32	1 Boat			10 Boats 1 Launch	
38	1 Launch 2 Boats				
39	2 Boats				No Data
40				1 Launch	
Total	25	12	18	162	

*All of the contract arrangements appear to be informal, verbal agreements except for Firm #9 which has a written contractural agreement with eight boats.

TABLE 9. Amount of Fish Supplied Through Ownership Integration and Informal Agreements

Buyer	Average Weekly Purchase	Estimated Amount From Own Vessel		Estimated Amount Through Informal Agreements	
Code #	(lbs.)	Percent	Weight	Percent	Weight
1	10,607	3	318	97	10,289
2	6,387	0	0	100	6,387
3	6,167	0	0	100	6,167
4	5,607	81.2	4,553	18.8	1,054
5	10,067	13.8	1,398	86.2	8,678
6	4,410	82.6	3,643	17.4	767
7	4,400	100	4,400	0	0
8	3,892	0	0	100	3,892
9	6,253	0	0	100	6,253
10	3,901	33.3	1,299	66.7	2,602
11	3,633	16.7	607	83.3	3,026
12	4,314	100	4,314	0	0
13	3,371	0	0	100	3,371
14	2,644	0	0	100	2,644
15	1,845	16.7	308	83.3	1,537
16	1,343	12.5	168	87.5	1.175
17	3,211	0	0	100	3,211
18	1,098	100	1,098	0	0
19	1,583	--	--	--	--
20	309	--	--	--	--
21	161	--	--	--	--
22	354	--	--	--	--
23	319	--	--	--	--
24	436	--	--	--	--
26	208	--	--	--	--
27	129	--	--	--	--

Approximately 25% of weekly purchase from own vessel and 75% through informal contracts.

thins out the market for the independent truckers. If most of the buyers have their own trucks and/or contractual arrangements, the independent trucker may find it difficult to buy enough fish to justify travel expenses. The decrease of the number of truckers transporting fish may in turn limit the alternative sources of supply for the retailers. As the major share of the wholesale market is handled by a highly concentrated number of buyers who own their own trucks, the retailers are faced with fewer alternative sources of supply than if there were a large number of non-integrated truckers.

The large amount of vertical integration may also serve to protect the high level of concentration at the buyer stage from the competition of potential entrants into the industry by raising the capital requirements for entry. For example, it was noted earlier that about 70 percent of the primary buyers are integrated at the transport level. The average capital investment at the transport level (estimated from the interviews of 23 truckers) is about 64,000 Colones. If in order to compete successfully at the primary buyer level, it is necessary to integrate with the transport level, the average capital investment needed to enter the industry raises from 14,000 to 78,000 Colones.

Oligopsony Power. The brief analysis of the structural variables of the small-scale fishery suggests the existence of oligopsonistic market conditions. Oligopsony power is indicated by the relatively small number of buyers handling a large percentage of the fish purchased from the small-scale fishermen of the Gulf of Nicoya. In some of the more isolated, outlying areas of the Gulf where only a few buyers operate, the degree of apparent oligopsony power is even greater.

Several factors appear to facilitate the existence of oligopsony power in the market of the small-scale fishery. As indicated in the interviews of the primary buyers (Table 8), the provision of loans to the fishermen by the buyers is quite common. The terms of such loans often require the fishermen to sell their fish to their creditors. The provision of loans also encourages fishermen to continue to sell their fish to particular buyers because the terms of future credit arrangements are likely to become more favorable if the relationship between buyer and fishermen has been maintained for a long period of time.

The extensive integration of the primary buyer and transport levels reduces the possible market outlets available to the non-integrated fishermen and thus strengthens the bargaining position of the buyers. Furthermore, is vertical integration is necessary for successful competition at the primary buyer level, the necessary capital investment for such an integrated enterprise may be sufficiently high to present an effective barrier to potential entrants in the industry.

Microeconomic theory suggests that a relatively inelastic supply function in the fishery would make potential oligopsony gains on a per unit basis greater than they would be with a more elastic supply schedule (Wharton, 1962, p. 39). Although data are not currently available on the elasticity of supply for the small-scale fishery of Costa Rica, there are, however, several factors typical of small-scale producers in less developed countries which may cause one to suspect a relatively inelastic supply function in the short run. Most of the fishermen are specialized producers who have no other alternative income-earning possibilities besides fishing. For the most part, they live close to the subsistence level and cannot afford to reduce their fishing effort in response to downward prices. Furthermore, the rapid deterioration of fish once landed, prevents the fishermen from withholding their fish from the market until prices are more favorable. When prices rise, the limited range of their fishing vessels and gear limits the extent to which the fishermen can increase their fishing effort.

Since much of the fish supply for San Jose comes from the Gulf of Nicoya, the power of the primary buyers on the buyers' side of the market may also indicate a corresponding power on the sellers' side. Those primary buyers who

account for the largest share of purchases at the ex-vessel level may well account for a large share of the fish which is sold to the retailers of San Jose. The greater the inelasticity of the wholesale demand for fish, the greater would be the per unit oligopoly gains.

To the extent that significant oligopsony power exists at the primary buyer level, the price paid to the fishermen may be less than it would be under more competitive conditions. To the extent that the buyers also have oligopoly power, their selling price to the retailer may be higher than at the competitive market equilibrium. The market power to push prices down at the ex-vessel level and push prices up at the wholesale level would result in wholesale marketing margins which were higher than they would be under more competitive conditions.

III. Market Performance of the Wholesale Sector

The preceding section describes the marketing system of the small-scale fishery and examines some of the major structural characteristics which affect its conduct and performance. In order to estimate the possible impact of such structural characteristics on market performance, this section investigates ex-vessel price differentials, the level of wholesale marketing margins and their cost components, and the extent to which potential economies of scale are utilized.

Ex-vessel Prices. Data on ex-vessel prices during the period September 1976 - February 1977 allow for a comparison of prices paid by the different buyers located in the Port of Puntarenas. If fishermen search for the best price for their fish, one expects prices paid at the ex-vessel level to be relatively similar from buyer to buyer, other things equal. Table 10 presents the prices paid by the different buyers in Puntarenas for the species of Corvina Grande, Cazon, and Chatarra. The data suggest that the monthly prices for these three categories of fish are often significantly different among the buyers. Of the three categories of fish, the prices for Corvina Grande varied the most among the buyers.

Such price differentials may be explained in part by the credit and supply services provided by the buyers. For example, some fishermen may continue to sell their fish to a particular buyer even though his prices are lower because of some agreement based on the provision of credit or other services. More investigation is needed before any conclusion can be made about the causes of the observed price differentials. Nevertheless, the data indicate that the decision of fishermen to sell to one buyer rather than another is based on factors other than strictly price considerations.

Table 11 lists the average ex-vessel prices for firms in Puntarenas and in the outlying areas of the Gulf. For all classes listed, the average prices offered in Puntarenas are higher than in the outlying areas. However, this difference is statistically different for lower class fish only (the t statistics for the null hypothesis that the average prices are equal are given in parentheses). The added costs involved in transporting the fish from the outlying areas could account for this difference in prices. The lack of a significant difference for first class fish could be a result of the higher quality of the first class fish landed in the outlying areas. A great proportion of the landings in the outlying areas are first and second class fish caught with hand lines, while in Puntarenas the majority of fish landed are caught with gill nets. And it is well known that gill nets yield lower quality fish: after entrapment by the net the fish can remain dead in the warm water up to six hours gills can be torn and scales ripped off. These quality differences should be more important for the value of higher class fish than lower class fish. Therefore, we observe the higher quality of the fish in the outlying areas almost off-setting the added transportation costs, while for lower class fish the prices are significantly reduced by the added

TABLE 10. Ex-Vessel Prices Paid by the Buyers of Puntarenas for the Species of Corvina Grande, Cola & Agria, and Chatarra (Sept. 1976 - Feb. 1977)

	Species: Corvina Grande					Species: Cola & Agria					Species: Chatarra				
Code #	Sept.	Oct.	Nov.	Dec.	Jan.	Sept.	Oct.	Nov.	Dec.	Jan.	Sept.	Oct.	Nov.	Dec.	Jan.
15	2.65	2.55	3.20	2.93	4.00	1.34	1.30	1.20	1.47	1.29	.60	.60	.59	.66	.33
9	3.16	3.20	2.54	--	--	1.34	1.46	1.53	--	--	.78	.75	.70	.70	--
2	2.43	2.78	--	--	--	1.34	1.41	1.46	1.53	1.60	.60	.60	.60	.63	.60
12	2.27	--	3.50	3.50	3.50	1.25	--	2.00	1.94	1.70	.60	--	.60	.76	.65
77	2.54	2.75	2.86	3.00	3.95	1.50	1.50	1.50	1.50	1.50	.41	.40	.39	.45	.41
4	3.11	3.32	3.86	3.72	4.14	1.17	--	1.60	1.92	--	.61	.60	.60	.60	.60
20	--	--	2.40	--	--	1.27	1.40	--	--	--	.60	.61	.60	.60	.60
14	--	--	--	--	--	1.21	--	--	--	--	.92	.70	.68	.55	.70
17	--	3.40	--	--	--	1.70	1.40	--	--	--	.70	.70	.70	--	--
Average	2.75	3.03	3.10	3.47	3.95	1.35	1.42	1.04	1.62	1.52	.65	.63	.62	.64	.59
S.D.	(.37)	(.33)	(.53)	(.41)	(.26)	(.15)	(.06)	(.22)	(.21)	(.15)	(.13)	(.10)	(.09)	(.09)	(.13)

TABLE 11. Ex-Vessel Prices Paid by the Primary Buyers in Puntarenas and in the Outlying Areas of the Gulf of Nicoya (Sept. 1976 - Feb. 1977)

Firm	Weighted Average Ex-Vessel Prices (colones per pound)							
	Primera Grande	Primera Pequena	Clasi-ficado	Cazon	Cola & Agria	Posta Blanca	Posta Negra	Cha-terra
- - - - - - - - - - - - - - - Puntarenas - - - - - - - - - - - - - - - - - -								
1	3.47	2.63	1.25	1.89	1.59	1.25	.55	.63
2	3.30	2.61	1.53	1.84	1.45	1.38	.85	.61
3	3.39	2.58	1.49	1.81	1.45	1.52	1.24	.66
4	3.07	2.19	1.34	1.59	1.39	1.18	1.00	.56
5	3.13	2.58	1.51	1.82	1.39	1.43	1.15	.74
6	3.49	2.82	1.54	1.88	1.53	1.06	.78	.60
7	3.24	2.86	1.63	1.37	--	--	--	.59
8	3.01	1.74	1.61	1.92	1.66	1.53	1.02	.70
9	3.30	2.73	1.63	1.79	1.39	1.11	1.30	.67
10	3.88	2.81	1.50	1.93	1.52	1.45	.90	.75
11	2.85	2.14	1.57	1.61	1.41	1.22	.40	.39
Average	3.28	2.52	1.51	1.76	1.48	1.31	.92	.63
- - - - - - - - - - - - Outlying Areas of the Gulf - - - - - - - - - - - - - - -								
1	3.20	2.40	1.06	1.43	1.19	.97	--	.50
2	3.40	2.48	1.30	--	--	.86	.60	.57
3	2.72	2.28	1.21	.84	1.23	--	--	.49
4	3.26	2.29	--	--	1.25	.59	--	.50
5	3.00	2.53	1.25	.80	1.50	--	--	--
Average	3.12	2.40	1.21	1.02	1.29	.81	.60	.52
t-values	(1.1)	(.75)	(4.52)	(5.34)	(2.92)	(4.38)	-	(2.16)
d.f.	14	14	13	12	12	11	-	13

transportation costs.

Marketing Margins. The difference between the amount consumers pay for the final product and the amount producers receive is generally referred to as the marketing margin. The ex-vessel/retail margin is the difference between the price paid by the consumer and the dockside value of an equivalent weight of the product. Within this margin are included the payments received by the various marketing agents that perform services in moving fish from fishermen to consumers. Such services include assembly, storage, transport and retailing. In the small-scale fishery of Costa Rica, the ex-vessel/retail margin is made up of individual margins at the primary buyer, transport, and retail levels of the market. The difference between the ex-vessel price and the primary buyer's price is the primary buyer's margin. The difference between the primary buyer's price and the transporter's price is the transporter's margin. Finally, the retailer's margin is the difference between the transporter's price and the retailer's price.

Out of their respective marketing margins, the primary buyers, transport wholesalers, and retailers pay for the labor, equipment, capital, etc., employed in carrying out their market functions. These marketing costs also include payments for managemnet, enterprise, and risk. Under competitive conditions, the net return on investment received by each intermediary is not larger than that needed to keep him in that particular line of business. If residual profits were larger, other firms would be attracted into the industry and profits would be reduced. If, however, oligopsony or other forms of imperfect competition exist in the market, the middlemen may be in a position to obtain a larger margin than would be possible if the number of buyers were greater and the competition sharper.

Table 12 presents the weighted average weekly prices during the five-week period for six major categories of fish: Corvina Grande, Primera Pequena, Corvina Pequena, Clasificado, Corvina Agria, and Chatarra. Table 13 presents the monthly average prices during the six-month period for the same species.

The wholesale prices listed in Tables 12 and 13 are the prices received by the transport wholesaler from the retailer. Thus, the margin between the ex-vessel price and the transporter's price represents the wholesale margin--the margin received by the primary buyer and the transporter stages combined. The price data currently available do not allow for separating out the margin accruing to the primary buyer or the transport marketing stage alone.

The graphical presentation of the weekly and monthly prices of several important categories of fish in Figures 3 and 4 indicates that ex-vessel prices remain relatively stable while wholesale and retail prices fluctuate rather sharply from period to period for all categories except Chatarra.

Marketing margins may be computed in both absolute cash terms and as percentages of retail prices. Tables 14 and 15 show the average cash margins for the different categories of fish. For most categories, the per pound retail margin is higher than the wholesale margin. Penn (1974, p. 14) suggests several possible reasons for retail margins being higher than wholesale margins: 1) fish are usually sold by retailers in quantities of less than 10 pounds in each transaction while they are sold by hundreds of pounds in each transaction at the wholesale level; 2) higher operating and overhead costs are usually present at the retail level; and 3) the greatest spoilage and shrinkage losses are often assumed by the retailer.

Despite the fluctations of cash wholesale margins for individual categories of fish, the overall weighted average margin per pound of fish handled showed little variation during the six-month period (January through June, 1977). Over this period the weighted average price was .92 colones per pound with a standard deviation of .10 colones (Table 16). The rather steady wholesale margin for fish is explained by the fact that the reductions in margins for certain categories of fish were offset by increases in the marketing margins of other species.

When marketing margins are expressed as percentages of the retail price,

TABLE 12. Average Weekly Retail, Wholesale, and Ex-Vessel Prices (per pound) (Sept. 5 - Oct. 10, 1976)

Species	Week 1	Week 2	Week 3	Week 4	Week 5
Corvina Grande					
Retail	4.89	4.85	4.21	--	5.01
Wholesale	3.74	3.78	3.51	--	4.14
Ex-Vessel	2.79	2.87	3.17	3.01	3.17
Primera Pequena					
Retail	3.85	3.38	4.34	--	4.86
Wholesale	3.24	2.96	2.85	--	3.20
Ex-Vessel	2.55	2.44	2.68	2.59	2.59
Corvina Pequena					
Retail	4.47	4.76	4.69	5.01	4.76
Wholesale	2.46	2.50	3.00	3.51	2.20
Ex-Vessel	2.28	2.36	2.32	2.49	1.60
Clasificado					
Retail	3.75	3.44	3.25	--	4.76
Wholesale	2.04	2.15	2.31	--	2.20
Ex-Vessel	1.11	1.53	1.55	1.89	1.60
Corvina Agria					
Retail	4.51	3.76	3.71	--	3.34
Wholesale	1.98	2.13	2.24	--	2.30
Ex-Vessel	--	--	--	--	--
Chaterra					
Retail	1.86	1.78	1.99	1.75	2.03
Wholesale	1.14	1.18	1.23	1.25	1.13
Ex-Vessel	.69	.68	.71	.66	.66

TABLE 13. Average Monthly Retail, Wholesale, and Ex-Vessel Prices (colones per pound) (January-June, 1977)

Species	Jan.	Feb.	March	April	May	June
Corvina Grande						
Retail	5.83	4.48	6.14	5.08	5.74	4.84
Wholesale	5.22	4.75	5.11	4.58	4.02	3.90
Ex-Vessel	3.85	3.74	4.00	3.80	2.83	2.74
Primera Pequena						
Retail	--	5.84	5.00	--	4.60	4.33
Wholesale	--	4.38	4.13	4.33	3.20	3.24
Ex-Vessel	2.90	2.94	2.98	2.89	2.21	2.10
Corvina Pequena						
Retail	5.13	3.64	5.45	4.09	5.00	4.77
Wholesale	3.92	2.64	3.58	3.28	3.66	4.20
Ex-Vessel	2.01	2.26	2.98	2.89	2.21	2.10
Clasificado						
Retail	4.48	4.95	3.36	4.38	3.64	3.50
Wholesale	2.56	2.17	2.47	2.69	2.44	2.16
Ex-Vessel	1.52	1.36	1.50	1.48	1.45	1.54
Corvina Agria						
Retail	3.92	4.11	3.65	4.10	3.64	4.14
Wholesale	2.47	2.33	2.46	2.74	2.10	1.94
Ex-Vessel	1.46	1.48	1.72	1.54	1.39	1.28
Chatarra						
Retail	2.29	1.80	1.68	2.39	2.09	2.00
Wholesale	1.22	.93	1.02	1.00	1.07	1.04
Ex-Vessel	.64	.66	.69	.66	.60	.58

TABLE 14. Retail and Wholesale Cash Marketing Margins Per Pound (Sept. 5 - Oct. 10, 1976)

Species	Week 1	2	3	4	5	Average
Corvina Grande						
Retail Margin	1.15	1.07	.70	--	.87	.95
Wholesale Margin	.95	.91	.34	--	.97	.97
Primera Pequena						
Retail Margin	.61	.42	1.49	--	1.66	1.04
Wholesale Margin	.69	.52	.17	--	.61	.50
Clasificado						
Retail Margin	1.71	1.29	.94	--	2.56	1.62
Wholesale Margin	.93	.62	.76	--	.60	.73
Corvina Agria						
Retail Margin	2.53	1.63	1.47	--	1.04	1.67
Wholesale Margin	--	--	--	--	--	--
Chatarra						
Retail Margin	.72	.60	.76	.50	.90	.70
Wholesale Margin	.45	.50	.52	.59	.47	.51

TABLE 15. Retail and Wholesale Cash Marketing Margins per Pound (January-June, 1977)

Species	Jan.	Feb.	March	April	May	June	Average
Corvina Grande							
Retail Margin	.61	-.33	1.03	.50	1.72	.94	.74
Wholesale Margin	1.37	1.01	1.11	.78	1.19	1.16	1.10
Primera Pequena							
Retail Margin	--	1.46	.87	--	1.40	1.09	1.20
Wholesale Margin	--	1.44	1.15	1.44	.99	1.14	1.23
Clasificado							
Retail Margin	1.92	2.78	.89	1.69	1.20	1.34	1.64
Wholesale Margin	1.04	.81	.97	1.21	.99	.62	.97
Corvina Agria							
Retail Margin	1.45	1.78	1.19	1.36	1.54	2.20	1.59
Wholesale Margin	1.01	.85	.74	1.20	.71	.66	.86
Chatarra							
Retail Margin	1.07	.87	.66	1.39	1.02	.96	1.00
Wholesale Margin	.58	.27	.33	.34	.47	.46	.41

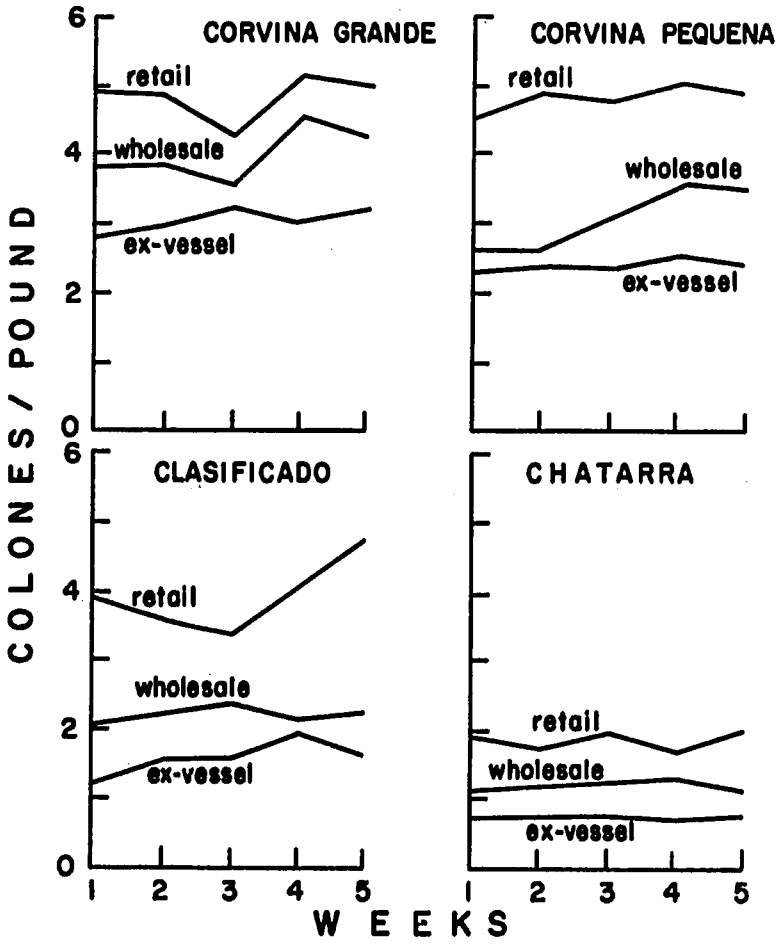

Figure 3. Ex-vessel, Wholesale and Retail Prices, by Week (September 5 - October 10, 1976)

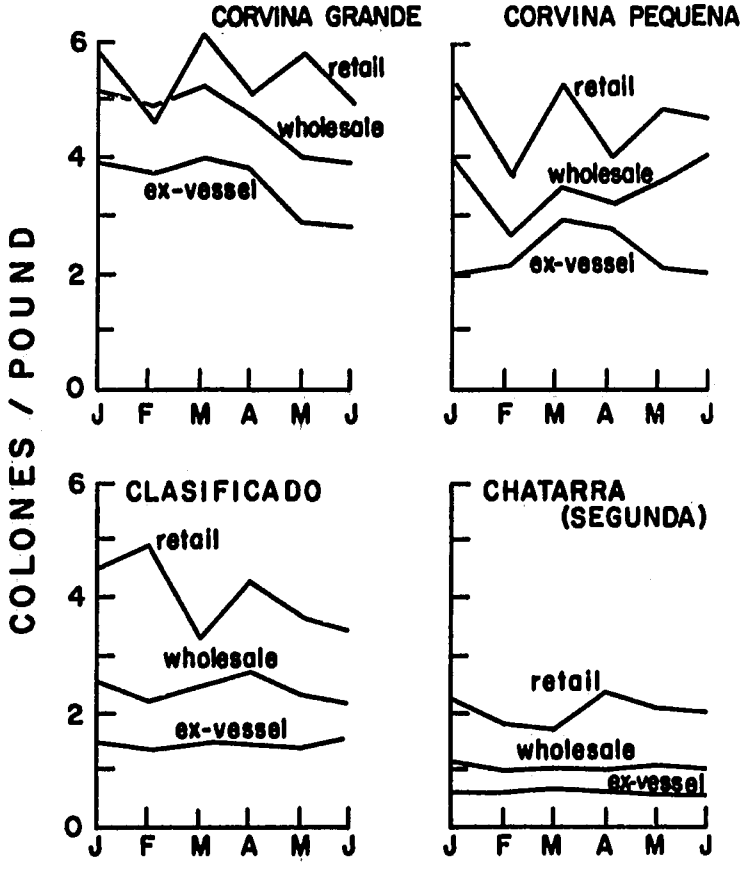

Figure 4. Ex-vessel, Whoesale and Retial Prices by Month (January through June, 1977).

TABLE 16. Monthly Weighted* Average Wholesale Margins (January-June, 1977)

	Colones per Pound
January	1.02
February	.88
March	.87
April	1.06
May	.88
June	.80

*Margins of the major categories of fish were weighted according to their percentages of the total purchases at the primary buyer level during the five-month survey period, Sept. 1976 to Feb. 1977. It is assumed here that the mix of different categories of fish purchased remains the same during these six months.

TABLE 17. Distribution of the Consumer's Dollar Spent on Fish, According to the Average Prices of the Five-Week and Six-Month Survey Periods

Market Functions	Corvina Grande	Primera Pequena	Corvina Pequena	Clasi-ficado	Corvina Agria	Chatarra
- - - - - - - - - - - - - Sept. 5 - Oct. 10, 1976 - - - - - - - - - - - - -						
Retail	.20	.24	.37	.40	.43	.37
Wholesaling	.16	.14	.13	.20	--	.27
Harvesting	.64	.62	.50	.40	--	.36
Total	1.00	1.00	1.00	1.00	--	1.00
- - - - - - - - - - - - - - - Jan.-June, 1977 - - - - - - - - - - - - - - -						
Retail	.13	.20	.24	.36	.40	.48
Wholesaling	.21	.24	.24	.25	.22	.20
Harvesting	.66	.56	.72	.39	.38	.32
Total	1.00	1.00	1.00	1.00	1.00	1.00

they indicate the share of the consumer's colone that accrues to the retail, wholesale and harvesting sectors. The distribution of the consumer's colone spent on fish is presented in Table 17.

Out of each colone spent by the consumer on fresh Corvina Grande during the six-month period, the retailer grossed 13 cents, the wholesaler 21 cents, and the fisherman 66 cents. By contrast, in the sale of fresh fish in the low-valued Chatarra category, the retailer retained 48 cents for each consumer colone spent, the wholesaler 20 cents, and the fisherman 32 cents. Penn (1974, p. 17) explains that "in general, market margins (except at the harvesting level) tend to be proportionately higher for lower priced fish as labor and overhead expenses are fixed for all products regardless of their differences in value." In addition, fish which are purchased more frequently by consumers may have a lower retail margin because of their large turnover of sales.

Fisherman's Share. The fisherman's share of the retail price varies according to the different categories of fish considered. During the five-week survey period, the average fisherman's share was 64 percent for Clasificado, 36 percent for Chatarra. The average fisherman's shares calculated over the longer six-month period revealed similar percentages for the same species and categories of fish. The weighted average fisherman's share for the seven major categories of fish (Primera Grande, Primera Pequena, Clasificado, Cola and Agria, Cazon, Posta Blanca, and Chatarra) landed during the six-month period was estimated to be approximately 41 percent. Thus, on the average, for each colone spent on fresh whole fish by consumers in retail fish outlets, fishermen received about 41 cents and the wholesale and retail sectors received 22 and 37 cents, respectively.

By way of comparison, over the last 20 years the U.S. fisherman's share of the retail price of fresh groundfish filets has averaged about 41 percent (Penn 1974). Since fish filets require more processing at the wholesale level, it may be assumed that the fisherman's share of the retail price for fresh whole fish would be somewhat larger than 41 percent. In the agricultural sector, U.S. farmers in recent years have received about 50 percent of the retail price for dairy products and about 55 percent for meat products (U.S. Department of Agriculture, 1978).

Marketing Cost Components. To develop a better understanding of the marketing margin at the wholesale level of the small-scale fishery, the variable and fixed marketing costs of the primary buyers and transport wholesalers are examined. Estimates of various cost components at these two marketing levels are based on data gathered from interviews of 12 primary buyers and 23 transporter-wholesalers conducted during the latter part of 1978.

Among the major cost components for the primary buyers are the variable costs for ice, maintenance and repair, and labor. The fixed marketing costs include depreciation, rent, and interest on investment. For the transporters, the major variable costs are ice, fuel, maintenance and repair, and labor. The fixed costs are comprised of depreciation, insurance, and interest on investment. (Tables 1.A and 1.B in Appendix 1 list the monthly variable and fixed costs for the primary buyers and transporters, respectively.)

For the primary buyers, the cost of ice represents the largest percentage of the total monthly costs. Table 18 indicates that about 44 percent of total monthly costs are expenditures on ice. The next largest cost component at this level is labor which accounts for about 28 percent of total monthly costs.

The largest cost component for the transporters is labor costs which account for about 41 percent of total monthly costs (see Table 19). Expenditures on repair and maintenance of the trucks and other equipment is the next largest cost item, accounting for about 18 percent of total monthly costs.

A rough estimate of the marketing cost per pound of fish handled at the primary buyer and transport levels was obtained by dividing the average

TABLE 18. Major Cost Components and their Average Percentage of Total Costs at the Primary Buyer Level (1978)

	Average	(SD)
Ice	44.2	(15.5)
Maintenance & Repair	4.8	(1.99)
Labor	28.4	(9.11)
Capital Costs*	17.2	(11.5)

*Capital costs include depreciation and interest on investment.

TABLE 19. Major Cost Components and their Average Percentage of Total Costs at the Transport Wholesale Level (1978)

	Average	(SD)
Labor	40.7	(12.5)
Maintenance & Repair	17.6	(8.4)
Capital Costs*	17.2	(6.5)
Ice	12.5	(5.6)
Fuel	8.9	(3.2)

*Capital costs include depreciation and interest on investment.

TABLE 20. Cost Per Pound of Fish Handled by the Primary Buyers

Primary Buyer	Total Monthly Costs	Average Monthly Amt. of Fish Handled	Average Cost/Lb. of Fish Handled
	---colones*--	-------pounds-------	-----colones-----
1	2,769	6,000	.46
2	2,832	4,000	.51
3	5,961	24,000	.25
4	7,028	24,000	.29
5	---	6,000	--
6	5,688	28,000	.20
7	2,299	12,000	.19
8	4,592	7,750	.59
9	2,777	12,000	.23
10	5,035	16,000	.31
11	---	8,500	--
12	3,899	16,000	.24

*8.5 colones = U.S. $1.00

TABLE 21. Cost Per Pound of Fish Handled by the Transport Wholesalers (1978)

Transport Wholesaler	Total Monthly Costs	Average Monthly Amt. of Fish Handled	Average Cost/Lb. of Fish Handled
	---colones*--	-------pounds-------	-----colones-----
1	15,945	39,200	.41
2	---	24,000	--
3	8,186	12,000	.68
4	4,973	6,000	.83
5	7,094	17,600	.45
6	8,691	12,000	.72
7	4,234	2,800	1.51
8	6,357	28,000	.23
9	---	3,875	--
10	6,932	15,000	.46
11	7,399	12,877	.57
12	2,940	1,562	1.88
13	4,928	2,400	2.05
14	4,322	3,875	1.11
15	5,194	16,000	.32
16	9,005	7,200	1.25
17	---	---	--
18	---	---	--
19	---	10,400	--
20	2,624	---	--
21	---	4,000	--
22	5,315	15,250	.35
23	7,014	13,000	.54

*8.5 colones = U.S. $1.00

monthly costs of each firm surveyed by the average monthly amount (lbs.) of fish each handled. Marketing costs per pound of fish at the primary buyer level ranged from .19 to .71 colones; at the transport level costs ranged from .23 colones to 2.05 colones per pound (see Tables 20 and 21).

Economies of Scale. The computation of per pound marketing cost for firms at various levels of output provides a basis for investigating possible marketing economies of scale at the primary buyer and transport marketing levels. By regressing the unit marketing costs on the level of output, the average marketing cost curve for each marketing level was estimated. The best fit was provided by the following log linear equations:

$$(1)\quad \text{Log PBAMC} = \underset{(2.95)}{4.248} - \underset{(3.76)}{.5723}\ \text{Log Q}, \quad R^2 = .64$$

$$(2)\quad \text{Log TAMC} = \underset{(8.79)}{5.5724} - \underset{(9.5)}{.6550}\ \text{Log Q}, \quad R^2 = .87$$

where: PBAMC = average marketing cost at the primary buyer level,
TAMA = average marketing cost at the transport level,
Q = quantity of fish handled,
and t-values are in parentheses.

The estimated average cost functions are graphed in Figures 5 and 6.

The falling unit costs associated with increasing scale may be the result of several factors. The equipment and special skills used at each level come in indivisible lumps and their fixed costs are advantageously spread over a relatively large output. Also, some equipment, such as refrigerators and iceboxes, may be scaled up at less than proportional increases in capital costs up to some critical capacity level. Also, the quantity of ice required appears to increase at a proportionately slower rate as the quantity of fish handled at the primary buyer level increases.

The average cost functions for ice at the primary buyer level was estimated by means of an ordinary least squares regression procedure. The log-linear function again provided the best fit.

$$(3)\quad \text{Log AIC} = 5.277 - \underset{(8.58)}{.767}\ Q, \quad R^2 = .95$$

where AIC = average ice cost per pound of fish handled.
The estimated function which is graphed in Figure 7 indicates the extent to which economies of scale are present for the use of ice at the primary buyer level. Since the unit cost of ice does not increase as buyers purchase increasing amounts of ice (i.e., there are no pecuniary economies), the economies of scale with regard to ice appear to result from the condition that the quantity of ice needed to maintain the fish increases at a decreasing rate as the quantity of fish handled increases. No significant indication of such economies could be found at the transporter level.

Minimum Optimal Scale. The output level at which scale economies become exhausted and the average cost curve becomes horizontal is referred to by economists as the "minimum optimal scale" (MOS). Estimation of the minimum optimal scale for the average marketing cost of the wholesale sector is problematic because the shape of the average cost curves beyond the empirical observations is uncertain. Although the log function provides a reasonably good fit of the empirical observations, it is uncertain if it can be extrapolated to predict average costs beyond observed output levels.

Economic theory suggests that a continuously falling long-run average cost curve provides conditions leading towards a "natural monopoly" in an industry. In such situations, a monopolist could expand to a scale which saturates the potential market demand because he could obtain lower unit costs than a group

of smaller-scale competitors (Scherer, 1970, p. 520).

The present situation of the wholesale marketing sector where there are several large, medium, and small-scale firms does not indicate the movement towards a natural monopoly. If the average cost curve of the wholesalers does, in fact, continue to fall beyond the observed output levels, certain institutional constraints or limited supplies may be preventing the largest firm from increasing its scale still further. On the other hand, if the average cost curve actually begins to rise beyond the observed output levels, the firms with the lowest average costs may be operating at or near minimum average costs.

Scherer (1970, p. 21) suggests that such MOS estimation uncertainty can be resolved by defining the MOS as the output of the firms with the lowest unit costs on which operating data are available. Another approach to MOS estimation has been taken by the British research group of Pratten, Selberston, and Cockerill (Pratten, 1971). They have benchmarked their MOS estimates to that scale "above which any possible subsequently doubling in scale would reduce total average unit costs by less than 5% ..." (Pratten, 1971, p. 26).

Due to the lack of information on the shape of the cost curves beyond where there are empirical observations, Scherer's criteria appears the more convenient of the two for the MOS estimates in the present study. Based on his criteria, the MOS point at the primary buyer level and the transport levels is estimated to be at a monthly output of about 28,000 pounds. The minimum unit cost at the primary buyer level is about .20 colones per pound and at the transporter level it is approximately .32 colones per pound.

The estimated cost curves at the primary buyer and transport marketing levels provide some indications of firms operating well below the MOS point and at significantly higher unit costs. Of the ten observations at the primary buyer level (Figure 5), three are operating at less than one-third the MOS level and have unit costs from 225 to 350 percent higher than the minimum average cost. At the transport level (Figure 6), five of the fifteen observations are operating at less than one-third the MOS level and have unit costs from 350 to nearly 900 percent higher than the minimum average cost.

The analysis of the market structure in the previous section reveals that the majority of the primary buyers are integrated at the transport level. An estimate of the average cost curve faced by such integrated enterprises may be obtained by summing the unit cost curves at the primary buyer and transport levels is given in Figure 8. Again, using Scherer's criteria, the optimal scale occurs at about 28,000 pounds per month where the unit cost is about .52 colones per pound.

Economic theory suggests that if the marketing sector were perfectly competitive, their marketing margins would equal the cost of providing the marketing services (Shepherd, 1958, Ch. 2). Furthermore, competition would lead the firm in the long run to operate near the industry's minimum average cost. A comparison of the estimated minimum wholesale marketing cost per pound and the weighted average wholesale marketing margin for the wholesale sector provides an indication of the extent to which the performance of the wholesale sector deviates from the norm of perfect competition. The estimated average marketing margins charged by the wholesale sector during the period January-June, 1977 (see Table 16) was .92 colones per pound, which is about 77 percent over the estimated minimum cost of .52 colones per pound.

It is important to point out that these are only preliminary estimates based on very limited data. The intention here is to suggest a way of judging the industry's performance by use of the competitive market standards. More data over a longer period of time are needed to ascertain the level of accuracy of these present estimates.

It should be noted that the relatively large difference between the industry's marketing margin and its minimum average marketing cost may be a short-run phenomenon. In the long run the difference may grow smaller as

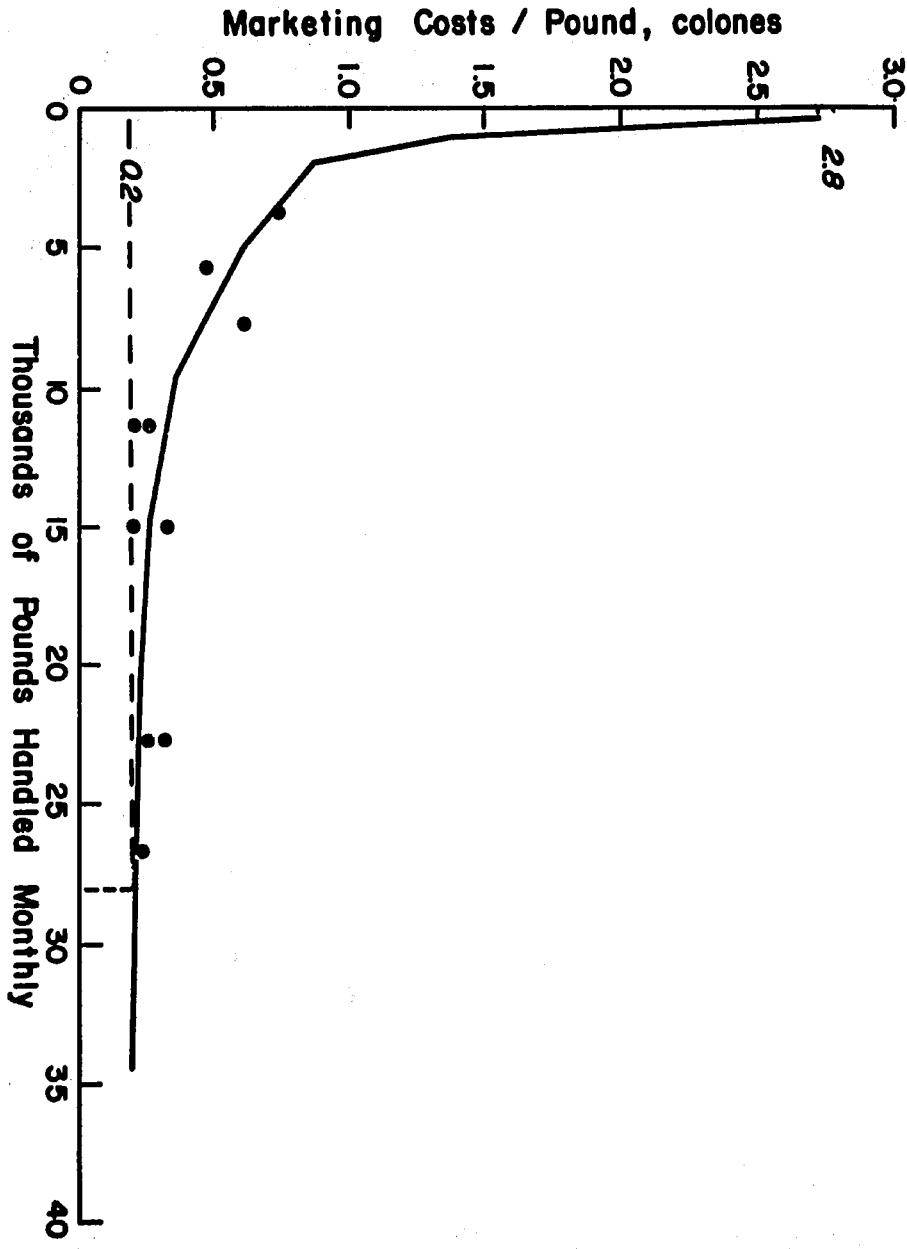

Figure 5. Average Marketing Cost Curves for Primary Buyer Marketing Stage.

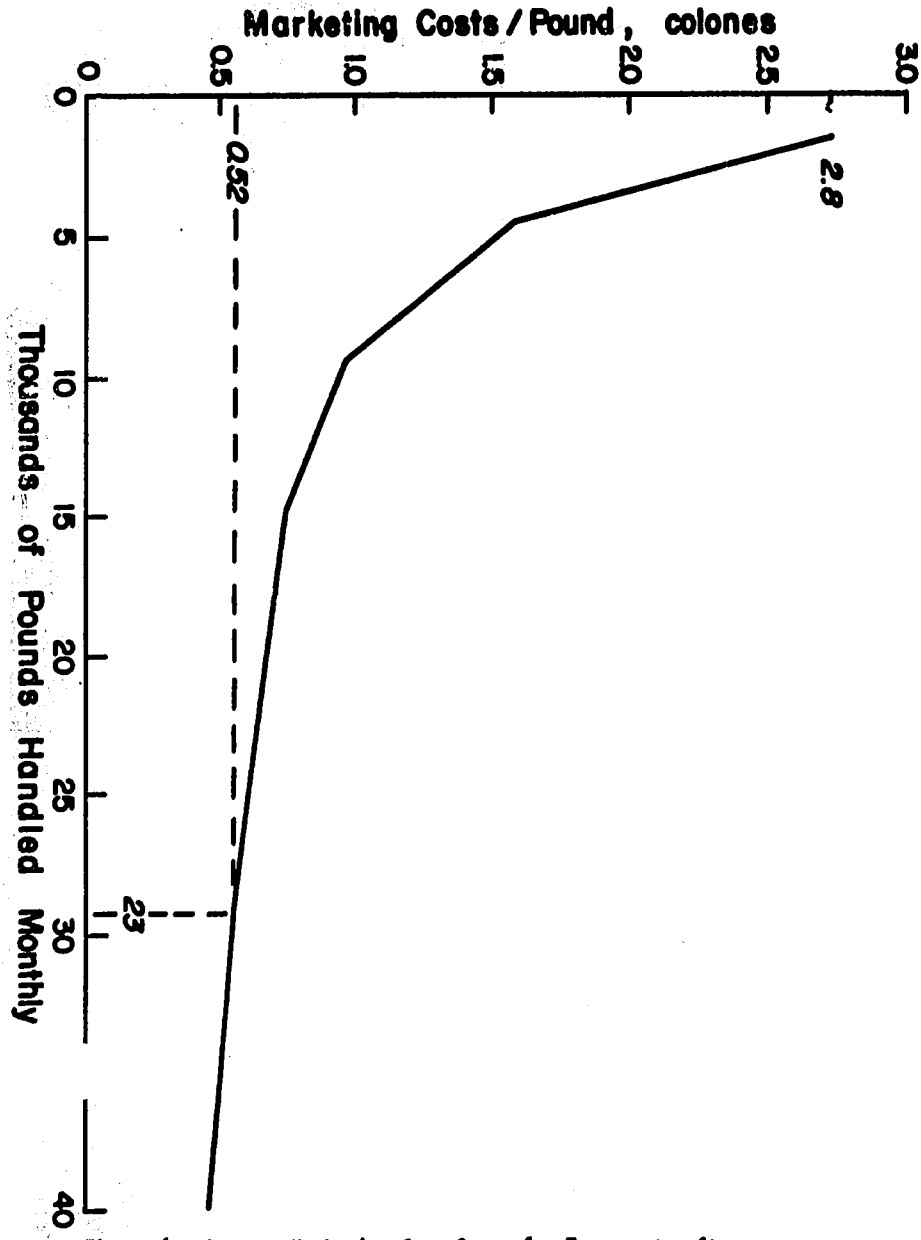

Figure 6. Average Marketing Cost Curve for Transporter Stage.

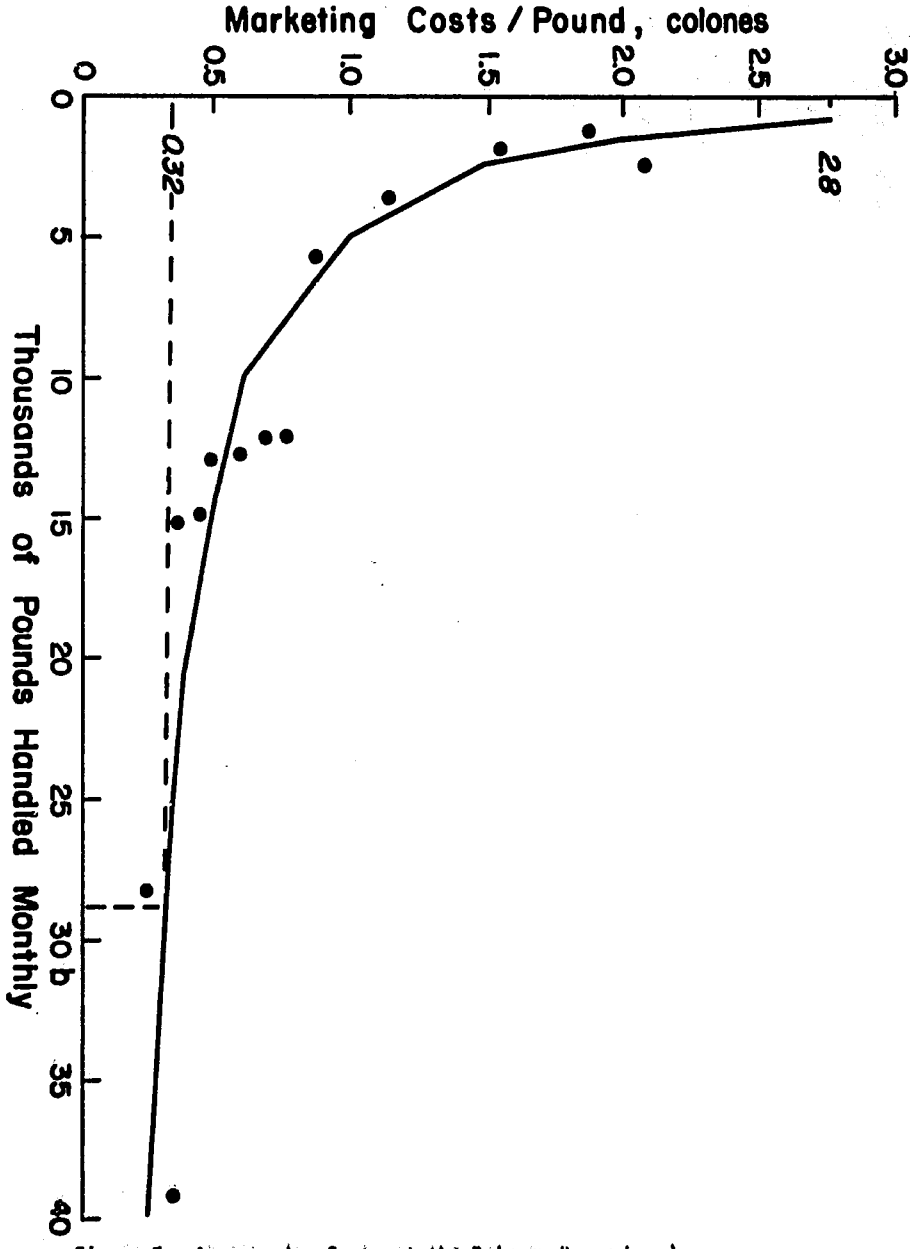

Figure 7. Average Ice Costs at the Primary Buyer Level.

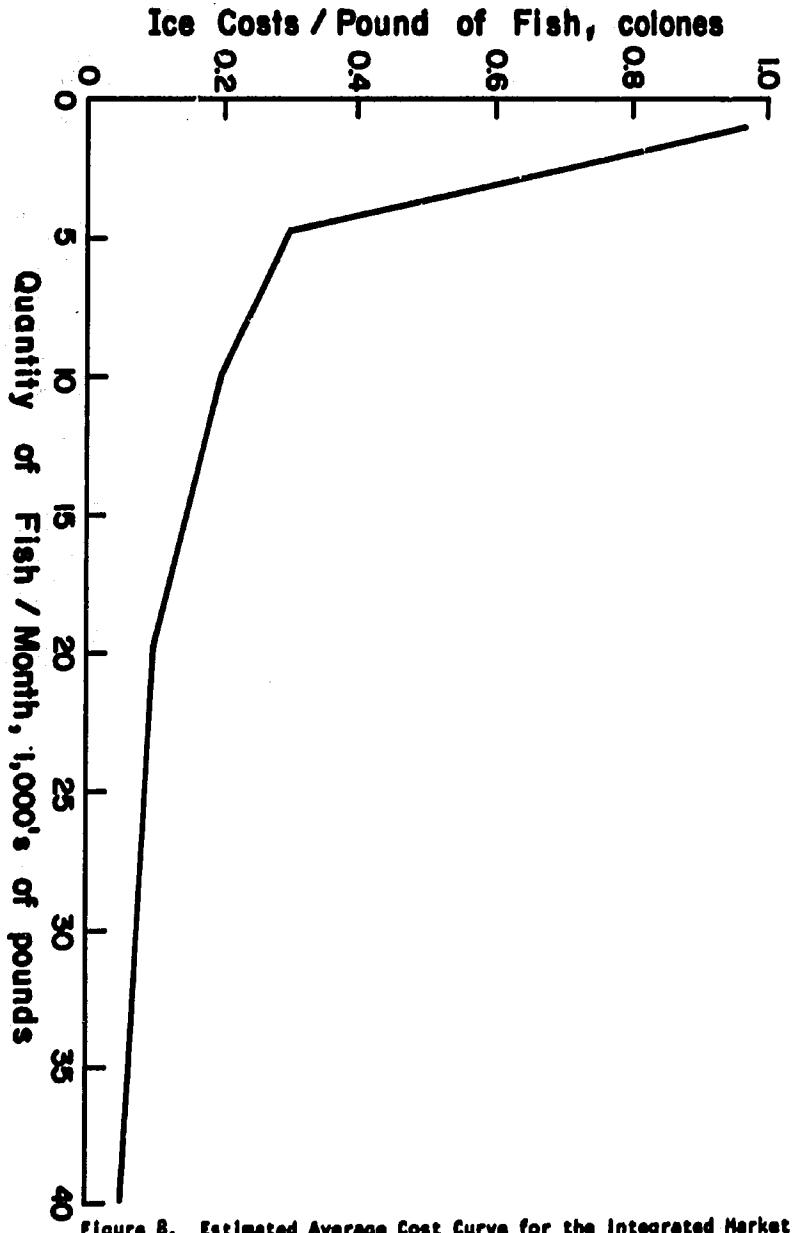

Figure 8. Estimated Average Cost Curve for the Integrated Marketing Stages of Primary Buyer and Transporter.

suboptimal firms expand and new firms enter the industry. Time series data over a longer period of time are needed to judge whether the observed marketing performance is of a short-run to long-run nature.

It is also possible that the estimated costs of some firms are biased downward because some of the true opportunity costs of risk management or labor have been underestimated. Furthermore, those firms observed operating at higher average marketing costs may be able to survive because of locational advantages or other uniquely differentiated marketing services. If such firms can remain viable despite relatively high costs and prices, they must be meeting the needs of some fishermen. In some cases, the benefits of such differentiated services may compensate or even outweigh the costs (Scherer, 1970, p. 406).

Inefficiency Costs and "Umbrella Prices". With the present analysis of average costs at the wholesale level, two important economic issues become apparent: 1) some firms are handling suboptimal quantities of fish; and 2) wholesale prices are sufficiently high to allow firms operating at relatively inefficient scales to survive the industry. Based on the monthly output levels of the primary buyers which were estimated from the purchasing receipts collected over a five-month period (Sept. 1976-Feb. 1977), the majority of the buyers are handling less than the minimum optimum quantity of 28,000 pounds and thus are incurring marketing costs above the minimum level. The largest two buyers in the industry operate at well above the estimated MOS point with output levels of over 40,000 pounds per month. The remaining firms in the industry are below the MOS level with estimated output levels which range from about 26,000 pounds to 1,000 pounds per month. Table 22 presents an estimate of the monthly cost of operating at suboptimal scales for 18 buyers whose monthly average output is below the MOS point. The estimated cost resulting from marketing operations at suboptimal scale is about 62,125 colones (U.S. $7,275) per month.

The existence of a large number of firms operating at suboptimal scales is an indication that the competitive market mechanism may not be working to bring marketing prices down toward the minimum average cost. There could be a "price umbrella" effect at the wholesale level where efficient firms (those operating at the MOS level) set their marketing prices at such a high level that inefficient firms (those operating below the MOS level) are also able to survive and prosper.

Although there is insufficient data currently available to explain the nature of the apparent price umbrella effect, the discussion of market structure in the previous section suggests several possible contributing factors. The high level of market concentration may allow for direct or tacit agreements among large buyers to set marketing prices well above their average costs. The relatively high costs of entering the industry as an integrated enterprise and the added costs of providing ancillary supply and credit services to the fishermen may prevent new firms from entering the industry to compete for returns above average cost. Furthermore, the specialized services of certain firms such as credit provisions and convenient location may differentiate marketing services enough to discourage existing firms from competing with one another in terms of price.

Policy Considerations. Assuming that economies of scale exist at the wholesale sector of the small-scale fishery and that there is some minimum optimal scale at which all economies of scale can be secured, a crucial question remains: Is there room for many firms in the market, each large enough to enjoy all scale economies? The answer depends on the size of the market and the minimum optimum size of output. Based on data collected during the five month survey period (September 1976 to February 1977) the average monthly amount of fish handled by the primary buyers of the Gulf of Nicoya is about 350,000 pounds. With the MOS at about 28,000 pounds, a maximum of about 13 firms would be able to operate in the industry at the minimum unit cost level.

TABLE 22. Estimated Monthly Cost for Operation at Suboptimal Scale in the Wholesale Sector of the Small-Scale Fishery (1978)

Firms Operating Above Minimum Optimum Scale	Amount Above Minimum Unit Cost	# of Pounds Handled/Month	Cost of Inefficiency
	-----colones-----		--colones--
1	.03	25,548	766
2	.04	25,012	1,000
3	.04	24,668	987
4	.08	22,428	1,794
5	.14	17,640	2,470
6	.14	17,600	2,464
7	.16	16,256	2,761
8	.22	15,604	3,433
9	.22	15.568	3,425
10	.25	14,532	3,633
11	.30	13,484	4,045
12	.33	12,844	4,239
13	.34	10,576	3,596
14	.81	7,380	5,978
15	.96	6,332	6,079
16	1.05	5,372	5,641
17	1.35	4,392	5,929
18	2.28	1,704	3,885
			62,125

Estimated total monthly inefficiency cost, 62,125 colones (U.S. $7,275).

The elimination of firms operating at less than the MOS level may be simultaneously desirable, in that unit cost savings would be realized, and undesirable, in that the reduction of firms may increase the level of market concentration and permit firms to increase their prices over the competitive level. In the present situation, however, there may be reason to expect that prices would change little, if at all, since the current prices already appear to be well above the minimum average cost. The argument for the tradeoff of increased market power for the economies of scale receives further support from Williamson (1968) who concludes that in most cases only a small reduction in costs due to greater economies of scale would be necessary to offset any large increases in price that might result from a simultaneous increase in market power.

The difference between the current wholesale marketing margin and the estimated minimum average marketing cost indicates the level of cost savings that would potentially be passed onto the fishermen and/or consumers through a more competitive wholesale sector operating at the minimum optimal scale. Based on the very limited data available, the potential cost savings are estimated to be about .42 colones per pound of fish handled (the estimated average marketing margin of .92 colones per pound minus the estimated minimum average marketing cost of .52 colones per pound). With an estimated average of about 350,000 pounds handled per month, there would be a monthly savings of about 147,000 colones. Although complete or partial industry operation at the minimum optimal scale would reduce current marketing costs at the wholesale level, the extent to which cost savings would be passed on to the fishermen and/or consumers would depend on the level of competition in the market.

IV. Conclusions

This study suggests to policy makers that there is much room for improving the marketing efficiency and level of competition among the firms of the wholesale sector of the small-scale fishery. If the estimated average marketing cost curve is accurate, the significant marketing cost savings could be achieved by a policy which encourages firms to operate at the minimum optimal scale. To the extent that fishery policy can also stimulate greater competition among the buyers, such marketing cost savings would be passed onto fishermen and/or consumers and wholesale margins would become commensurate with the true cost of the marketing services.

These conclusions concerning the specific structure and performance of the wholesale sector are tentative. More in depth study using data covering a longer period of time is needed in order to verify these preliminary findings.

TABLE A.1, NOTES

[a]The depreciation of the building is calculated by the equation: Year's depreciation = $V(1) - V(2)$, where $V(1) = P(1+r)^{-t}$ and $V(2) = P(1+r)^{-t-1}$. The estimation of the rate of depreciation, r, is based on survey data concerning original value, present value, and age of building.

[b]Straight line depreciation assuming no salvage value is used for all equipment. This is calculated by dividing the orginal cost by the expected life of the equipment. The estimated life of the various items is as follows: icebox or freezer, three years; scale, one year for scales costing 400 colones or less and two years for scales costing more; baskets, two years; carts, four years; and other small items, one year.

TABLE A.1. Monthly Costs for Primary Buyers (1978)

	Primary											
	1	2	3	4	5	6	7	8	9	10	11	12
Variable Costs												
Ice	1,200	1,800	3,200	2,394	1,200	1,440	300	1,200	1,400	3,200	7,800	1,395
Water	50	25		400		22	55	49		50		101
Electricity	30	50		120		40	150	227		15	3,600	83
Boxes			120							6	250	
Elastic & Paper Supplies	50			750							500	
Telephone		*155	*245	300	---	255	**911	1,800	*237	118	---	*233
Maintenance & Repair	167	**325	2,050	2,400	**475	1,480	**199	1,800	800	1,000	3,220	1,175
Labor	550											
Other												
Total Variable Costs	2,047	2,355	5,615	6,232	---	3,237	1,496	3,806	2,437	4,389	15,370	2,987
Fixed Costs												
Depreciation												
A) Building[a]			22	62					35			
B) Equipment[b]	359	78	194	306	130	276	67	442	191	192	272	306
Rent	250	212				2,000	666	212			3,500	500
Insurance										140	500	
Interest on Investment[c]	113	20	130	378		105		132	114	264		106
Other		167				70	70			50		
Total Fixed Costs	722	477	346	746		2,451	803	786	340	382		912
Total Costs (VC + PC)	2,760	2,832	5,061	7,028	---	5,688	2,299	4,592	2,777	5,035	---	3,899

[c]The interest rate on investment (opportunity cost) is estimated to be 12 percent, the interest rate of the Central Bank of Costa Rica in 1978.

*The estimate of monthly maintenance and repair costs is based on the regression of observed maintenance and repair costs on total capital investment. The estimated log function is: Log of maintenance and repair costs = 3.187 + .244 (log of total investment), (t-ratio .767, F-value .588, 4 observations).

**The estimate of montly labor costs is based on the regression of observed monthly labor costs on monthly quantities of fish handled. The estimated log function is: Log of labor costs = 2.00 + .939 (log of quantity), (t-ratio 5.767, F-value 33.26, R^2 .932, 7 observations).

TABLE A.11, NOTES

[a]Depreciation of trucks is calculated by the equation, Year's depreciation = V(1) - V(2), where $V(1) = P(1+r)^{-t}$ and $V(2) = P(1+r)^{-t-1}$. P is the original purchase price of the truck and t is the age of the truck. The rate of depreciation, r, is estimated at 15 percent, based on the average rate of yearly depreciation given by eight surveyed truck owners. The yearly depreciation value was divided by 12 to obtain the monthly truck depreciation.

[b]The depreciation of equipment other than trucks was estimated by means of a straight line depreciation, assuming no salvage value. This was calculated by dividing the original cost by the expected life of the equipment. The estimated life of the various items was as follows: icebox or freezer, three years; scale, one year for scales costing 400 colones or less and two years for scales costing more; baskets, two years; carts, four years; and other smal items, one year.

[c]The interest rate on investment (opportunity cost) was estimated to be 12 percent, the interest rate of the Central Bank of Costa Rica in 1978.

*The estimate of monthly ice costs is based on the regression of observed monthly ice costs on monthly quantities of fish handled. The estimated log function is: Log of monthly ice costs = -.418 + .763 (log of Quantity) (t-ratio 3.621, F-value 13.11, R^2 .700, 11 observations).

**The estimate of monthly labor costs is based on the regression of observed monthly labor costs on monthly quantities of fish handled. The estimated log function is: Log of monthly labor costs = .5349 + .286 (log of Quantity) (t-ratio 1.662, F-value 2.762, R^2 .507, 10 observations).

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TABLE A.11. Monthly Marketing Costs for Transport Wholesalers (1978)

	1	2	3	4	5	6	7	8	9	10	11	12
Variable Costs												
Ice	2,880	*1,447	960	960	480	1,152	*281	640	360	800	900	180
Fuel	1,650	868	490	475	550	378	420	401		880	445	194
Maintenance & Repairs	3,226		1,503	1,328	2,258	1,569	474	200	627	856	1,545	329
Labor	5,000	3,840	3,920	1,200	**3,440	4,000	**2,036	**3,928	**2,232	2,640	**3,146	**1,722
Other	90		4		17	25	12	4	205	417		13
Total Variable Costs	12,846		6,877	3,963	6,745	7,124	3,223	5,173		5,593	6,036	2,438
Fixed Costs												
Depreciation												
A) Truck(s)[a]	675	762	412	347	363	514	302	430	502	404	474	172
B) Equipment[b]	472		174	56	63	212	103	106	158	150	83	42
Insurance	600	336	33	162	33	147	147	25	233	248	196	33
Interest on Investment[c]	1,352	1,125	700	445	700	694	459	623	740	537	610	255
Other												
Total Fixed Costs	3,099		1,319	1,010	1,159	1,567	1,011	1,184	1,642	1,339	1,363	502
Total Costs (VC + FC)	15,945		8,186	4,973	7,904	8,691	4,234	6,357		6,932	7,399	2,940

TABLE A.11, Continued

	13	14	15	16	17	18	19	20	21	22	23
Variable Costs											
Ice	144	360	1,080	2,000			440	320	*369	1,024	*907
Fuel	340	432	732	325		1,470	668	340	550	635	860
Maintenance & Repairs	1,760	581	427	1,165	1,961	1,653	1,202	639	466	1,216	879
Labor	2,340	2,000	1,980	3,600	800	2,500	4,160	240	**2,252	1,600	2,800
Other	64	15	60	335	30	595		5		38	220
Total Variable Costs	4,648	3,388	4,279	7,425			6,470	1,544	3,637	4,513	5,666
Fixed Costs											
Depreciation											
A) Truck(s)[a]	36	343	281	522	307	1,114	615	381	27	184	380
B) Equipment[b]	25	97	111	201	117	556		83		172	142
Insurance	39	39	33	228	29	208		54	54	52	254
Interest on Investment[c]	180	455	490	629	470	1,650	900	562	180	394	572
Other											
Total Fixed Costs	280	934	915	1,580	923	3,528		1,080		802	1,348
Total Costs (VC + FC)	4,928	4,322	5,194	9,005				2,624		5,315	7,014

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CHAPTER 20: AN ECONOMIC ANALYSIS OF FISH MARKETING IN EL SALVADOR

By M.D. Shank and J.G. Sutinen

This study evaluates the market structure and performance of the wholesale merchant sector of the public fresh fish marketing system in El Salvador. The study identifies the major market structure elements which influence the level of competition among the primary buyers, transporters, and wholesalers which make up the wholesale market sector. Concepts from industrial organization such as seller concentration, buyer concentration, product differentiation, economies of scale, and barriers to entry were used in the analysis of market structure. The average marketing costs of the collective wholesale merchant sector are calculated and average marketing cost and average total cost functions are estimated.

The result of the study indicate that oligopsony market power for fin-fish exists at the primary buyer level at some harvest locations. The results also indicate there are high degrees of seller concentration and oligopoly market power at the wholesale level. The estimation of the average variable and total marketing cost function indicates that the industry exhibits decreasing costs over the the relevant range. Many firms appear to be operating at output less than that which would minimize average cost. However, there is other evidence that the scarce factor of trustworthy personnel, usually limited to the number of family members that can fill a key position within the firm, may determine more the optimal size of firms than technical economies.

The information system of providing price and quantity information back to the fishermen is controlled by the wholesale section. This works to the advantage of the buyer and to the disadvantage of the fishermen.

Empirical evidence supports the hypothesis that vertical integration leads to cost savings. Where the source of these savings lies, be it transaction costs or other savings, could not be determined by the data.

I. Transporter-Wholesaler Market

Thirty-one transporter who bring fresh marine fin-fish to San Salvador were interviewed. It is estimated that there are no more than five others not interviewed that transport fresh marine fin-fish. This group includes those which may not own vehicles. Of these thirty-one, sixteen are not integrated as wholesalers. Twenty-one firms operating as wholesalers of fresh marine fin-fish were interviewed. Six other firms which handle non fin-fish products were also interviewed, but because of conversion problems involved in changing shellfish measures to fin-fish weights, they are not included in the concentration statistics. It is estimated that no more than four additional wholesalers who operate in the wholesale market were not interviewed.

Concentration ratios and curves were inputed for the individual classes based on quantity of fish marketed. Aggregated fin-fish concentration is based on value to allow for the influence of prices in a multiproduct setting to be reflected in a firm's total market share. Because most firms' owners are self-employed and the majority of businesses are family operated, employment would not have been a good measurement device. The concentration curves are presented in Figures 1 and 2. Concentration ratios for the four and eight-firm levels are listed in Table 1. Also presented in Table 1 are Herfindahl indices for the corresponding classes.

The sales of each firm were classified by quality classes and then concentration ratios are computed accordingly. An individual firm can have a market share in more than one quality class. The aggregate classification is all firms, all classes of of fin-fish.

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Figure 1 CONCENTRATION CURVE, FRESH FIN-FISH BY PRODUCT CLASS, SAN SALVADOR WHOLESALE MARKET, TRANSPORTER LEVEL

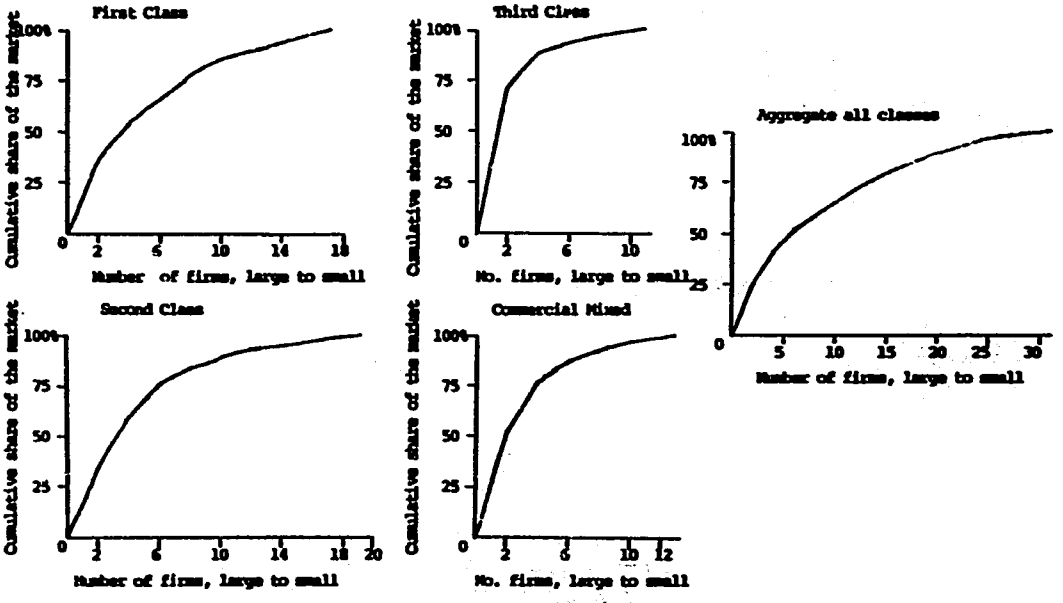


Figure 2 CONCENTRATION AND LORENZ CURVE, FRESH FIN-FISH, SAN SALVADOR WHOLESALE MARKET, WHOLESALER LEVEL

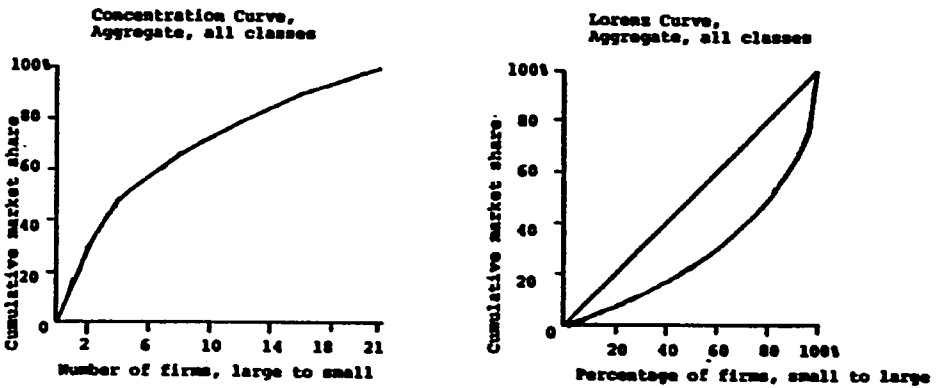


TABLE 1

CONCENTRATION INDICES OF SELLER CONCENTRATION FOR FRESH MARINE FIN-FISH, WHOLESALE MARKET

Class Index	First	Second	Third	Concentration Mixed	Aggregate
-------a. Transporter level, integrated and non-inegrated----------					
CR4	.53	.59	.88	.76	.48
CR8	.77	.83	.97	.92	.60
H-Index	.10	.11	.38	.17	.06
# Firms	17	19	11	13	31
-------b. Wholesaler level, integrated and non-integrated----------					
CR4	.57	.54	.88	.76	.48
CR8	.84	.84	1.00	1.00	.67
H-Index	.11	.11	.39	.17	.08
# Firms	12	14	8	6	21

All classes and the aggregate show significant concentration. However, the third and commercial mixed classes exhibited much stronger concentration characteristics than the first and second classes. The Herfindahl indices were found to be consistent with the concentration ratio measures.

Lorenz curves are a measure of inequality or disparity. If all firms have an equal market share, the curve would be a diagonal line, referred to as the line of absolute equality. Lorenz curves for the four classes and the aggregate are presented in Figure 3. In as much as the third and commercial mixed classes exhibit much more concentration, they also reflect the largest degrees of inequality within firm market shares.

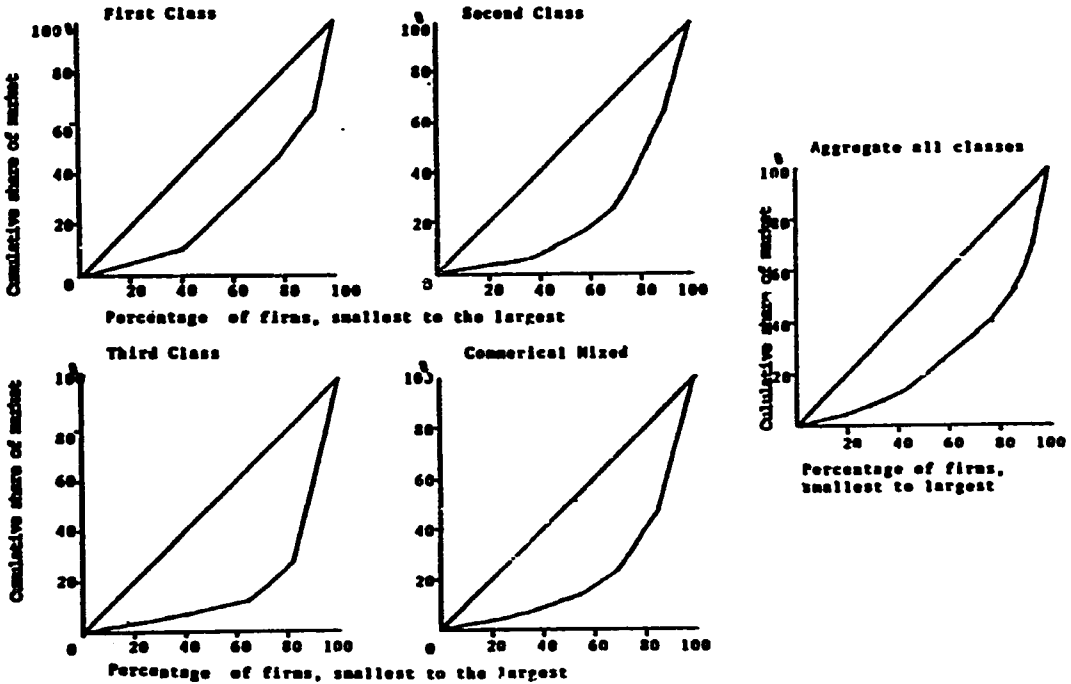
2. Wholesaler-Retailer Market

The number of retailers that regularly purchase at the wholesale market is estimated at 120. There are an additional 7-80 "ambulantes," or wandering vendors who sell door to door in auburban neighborhoods. Also, a number of cafeterias, restaurants and other commercial concerns purchase fish in this market. One could safely say that more than 200 retailers make up the buyer side of this market. Most are small, and very few control an appreciable share of the market. Given this situation, it is hard to believe that buyers at this level could counter any significant seller concentration with concentration power of their own.

3. Marketing Costs and Economies of Scale

The presence or absence of scale economies is important for explaining market concentration and developing policy. The existence of scale economies is a condition permitting relatively large firms to market their products at lower average cost than smaller firms. However, one cannot assume that profitability is solely a function of scale economies. Other variables affect the relationship, and as Scherer (1970) states: ". . . profitability reflects the overall suitability of firm sizes to their market environment, and not just production and cost advantages." Still, one method often used to assess

Figure 3 LORENZ CURVE, FRESH FIN-FISH BY PRODUCT CLASS, SAN SALVADOR WHOLESALE MARKET, TRANSPORTER LEVEL



the likelihood of scale economies is to examine the average cost function associated with the firm's marketing activities.

3.1 Cost Data

One important aspect of the interview process was to gather information about the costs of operating within the marketing system. Costs were grouped into monthly fixed and variable categories.

Monthly fixed costs were broken into three categories: 1) interest, or the opportunity cost on the firm's captial stock; 2) amortization on the replacement value of capital goods; and 3) other fixed costs. The first group of costs were derived as follows. A capital stock based on market value was computed by subtracting depreciation costs from the purchase price of fixed equipment such as: vehicles, scales, boats and outboard motors, freezers, ice boxes, and display trays. Different life expectancies were used for different equipment items. A monthly interest cost which represents the cost of borrowed capital, or an opportunity cost which represents the foregone opportunity of owner equity, was computed based on the capital stock. The rate of opportunity cost was 12 percent, which is a rate used by the Federal Reserve Bank of El Salvador. A 12 percent interest rate was used for the cost of capital. This was considered to be a representative cost for institutional loans, such as those used by automotive agencies. Vehicles by and large made up the greatest part of capital stock.

A second group of fixed costs was imputed by taking the replacement costs of similar equipment and amortizing the monthly allotment necessary to be able to purchase a new piece of equipment. This allowed for inflation. Straight line depreciation was used.

Other fixed costs were addded up as reported. Such costs included: yearly vehicle registration, rent for a market stall, electricity, water, insurance premiums, and other costs which did not change with output.

Variable operating costs were broken into five groups: ice; labor; repair; and maintenance; fuel or transport if they did not own a vehicle; and miscellaneous, which included newspaper, plastic bags, border crossing fees, and basket replacement. Per unit variable costs and per unit total average costs are listed in Table 2. They are listed according to vertical arrangement, product type and destination.

3.2 The Model

If all the marketing functions were separately performed (i.e., no vertically integrated firms), profits at each marketing level would be given by

Level	Function	
Fishing:	$\pi_1 = P_1q - C_f(q) - F_f$	(1)
Primary Buying:	$\pi_2 = P_2q - C_{pq}(q) - P_1q - F_{pb}$	(2)
Transporting:	$\pi_3 = P_3q - C_{tr}(q) - P_2q - F_{tr}$	(3)
Wholesaling:	$\pi_4 = P_4q - C_w(q) - P_3q - F_w$	(4)

where: P_1 = ex-vessel price to fishermen;

P_2 = price paid by transporters;

P_3 = price paid by wholesaler;

P_4 = price paid by retailer;

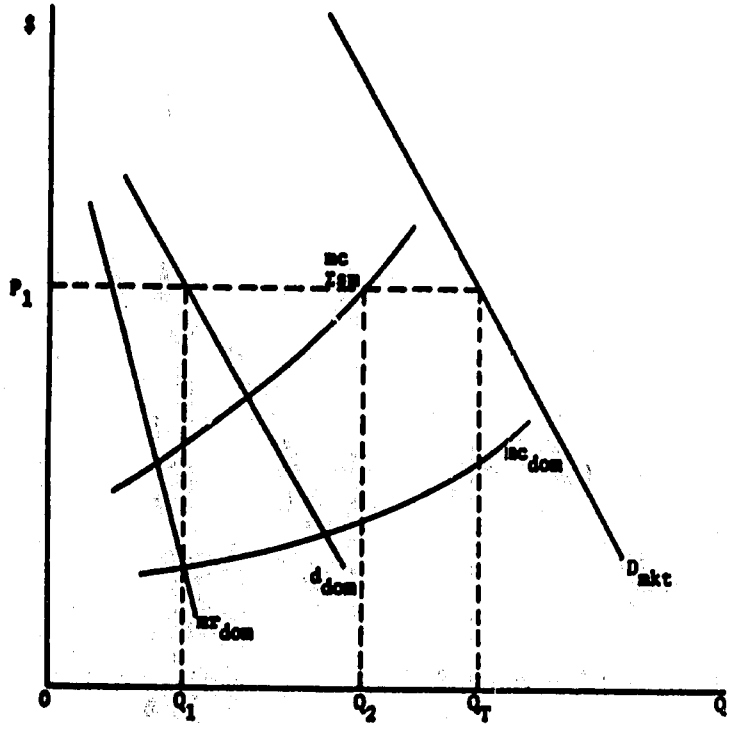


Figure 4 EQUILIBRIUM IN THE LOWER-VALUED SPECIES MARKET UNDER DOMINANT FIXX PRICE LEADERSHIP

C_f = total costs of fishermens variable inputs;

C_{pb} = total variable cots of primary buying;

C_{tr} = total variable costs of transporting;

C_w = total variable costs of wholesaling;

q = some quantity, assumed constant through all levels;

F_i = fixed costs of the reprective levels.

Data are available for firms representing five different vertical integration arrangements. Using the function/symbol correspondences fishing (F), primary buying (PB), transporting (TR), and wholesaling (W), these five arrangements are:

Notation	Functions Integated
FPBTRW	fishing, primary buying, transporting, wholesaling
PBTRW	primary buying, transporting, wholesaling
FBTR	primary buying, transporting
TRW	transporting, wholesaling
W	wholesaling.

For firms integrated from fishing through transporting profits are represented as

$$\pi_{FPBTR} = P_1q - C_{fpbtr}(q) - F_{fpbtr}; \qquad (5)$$

for firms integrated from primary buying through wholesaling, profits are represented as

$$\pi_{PBTRW} = P_4q - C_{pbtrw}(q) - P_1q - F_{pbtrw}; \qquad (6)$$

for firms integrated from primary buying through transporting, profits are represented as

$$\pi_{PBTR} = P_3q - C_{pbtr}(q) - P_1q - F_{pbtr}; \qquad (7)$$

and for firms integrated from transporting, profits are represented as

$$\pi_{TRW} = P_4q - P_2q - C_{trw} - F_{trw}. \qquad (8)$$

The cost function of the wholesaling only firm would remain as represented in equation (4). Dividing the cost functions in equations (4) and (6) through (8) by q, the quantity of fish handled, yields the general functions representing the average handling costs for each of these cases. The average handling cost functions are denoted by $AHC_{FPBTRW}(q)$, $AHC_{PBTRW}(q)$, $AHC_{PBTR}(q)$, $AHC_{TRW}(q)$, and $AHC_W(q)$. These average cost functions are examined next to test whether they exhibit decreasing, increasing or constant costs. Before doing so, the fixed costs are ignored to first examine only the average variable costs, denoted by $AVHC_i$.

The average variable handling cost functions are best fitted by a log linear function of the following form:

$$\ln AVHC_i = \alpha + \beta_0 \ln Q + \beta_1 D + \beta_2 D_2 + \beta_3 D_3 + \beta_4 D_4$$

where i = FPBTR, PBTRW, PBTR, TRW, and W. The D'e are dummy variables,

where $D_1 = 1$ represents the FPBTR arrangement,
$D_2 = 1$ represents the PBTRW arrangement,
$D_3 = 1$ represents the PBTR arrangement,
$D_4 = 1$ represents the TRW arrangement, and
$D_1 = D_2 + D_3 = D_4 = 0$ represents the W arrangement only.

Results from an ordinary least squares regression were as follows, where t-values are in parentheses:

$$\ln AVHC = \underset{(1.07)}{1.3} - \underset{(2.2)}{0.26}\ln Q + \underset{(6.1)}{1.45}D_1 + \underset{(4.5)}{1.161}D_2 + \underset{(5.8)}{1.29}D_3 + \underset{(2.5)}{1.2}D_4 \quad (10)$$

$R^2 = .72$ $\quad DW = 1.98$ $\quad F(5,25) = 12.9$

From equation (10) in which β_0 is negative, average variable handling costs decrease with larger quantities. The positive signs of the dummy coefficients indicate that shifting from the base operation of wholesaling to other vertical combinations increases average cost, as intutition would suggest.

Since handling costs consists of fuel, ice, labor repairs and maintenance, and miscellaneous costs, it is desirable to isolate these cost items to determine the source of scale economies.

For fuel we find

$$\ln Fuel = \underset{(0.68)}{0.69} - \underset{(4.5)}{0.47}\ln Q \quad (11)$$

$R^2 = .62$ $\quad DW = 1.8$ $\quad F(1,14) = 20.5$

β_0 is significant at the 99 percent level on a two-tail test. Equation (11) indicates fuel is a significant source of scale economies. This result, too, is consistent with intuitive reasoning. The amount of fuel necessary for one trip to market should not increase appreciably by adding more quantity per trip, at least over a reasonable range. For example, such a result would not hold if one had to add another truck.

Dummy variables indicating the different harvest sites and dummies indicating different vertical combinations were not significant, and therefore were rejected as explanatory variable. Most likely the smallness of the country and the many different types of vehicles used for transporting precluded the utilization of these variables of such a small sample size. Regressions run on the other variable cost items (ice, labor, repairs and maintenance, and miscellaneous costs) showed no significant relationship to quantity handled. This leads to the conconclusion that these costs are constant as quantity increases.

In the case of ice, there is a large variation in the type of storage container used (i.e., ice box, straw basket, steel barrel, and bed of a truck) and the quantity of ice used per pound of fish varies considerably for each method. Transporters also report they use different amounts of ice according to the species of fish, that some species do not require as much ice as others. The purchase price for ice varies according to where it is purchased; e.g., the price can vary from ¢2.50 per 100 pounds in Acajutla to ¢5.00 in an isolated port. Dummy variables used to account for the different types of storage containers and ports of purchase improved the results, but not to a significant level.

Breaking the observations down into groups based on storage method, port, and vertical combination might be one method to overcome this problem, but with the available data the number of observations within each group becomes too small to work with. No information on the ice costs for individual

species or quality classes was available.

The equation for total average costs (i.e., including fixed costs) was estimated also. Results from the equation using average total cost were as follows:

$$\text{Ave. total cost} = \underset{(-1.02)}{-1.29} - \underset{(-1.83)}{0.23}\ln Q + \underset{(6.98)}{1.78}D_1 + \underset{(4.0)}{1.1}D_2 + \underset{(5.56)}{1.33}D_3 + \underset{(2.24)}{1.16}D_4 \qquad (12)$$

$R^2 = .73$ $\qquad DW = 2.24$ $\qquad F(5.25) = 13.4$

4 Vertical Integration

4.1 Definition

Vertical integration should not be considered a binary type of characteristic. A continuum of gradually increasing influence and control, extended through inputs or management is a better description. An example of the continuum concept is illustrated by the question posed through the use of contractual or other arrangements by one firm with another. Does this constitute vertical integration? Many have used the term vertical integration to express the concept of any degree of coordinating a forward or backward stage previously alien to the firm.

Coase (1937) argues that vertical integration only occurs when a market transaction previously organized by two firms is now organized by one. The fact that a market transaction still takes place with the use of a contract would eliminate the above example as a case of vertical integration. Coase labels such a case vertical coordination. Other authors such as Tomek and Robinson (1972), feel that any degree of coordinating is integration, but they do not distinguish between integration and coordination as Coase does. rutchfield (1965) avoids the problem by labeling these types of cases semi-integration.

For purposes of this study, the existence or absence of a market transaction between defined stages of fish marketing serves as the determinant of the presence or absence of vertical integration. And for use in this paper, vertical coordination refers to any non-price linkage between vertical stages.

4.2 Measures of Vertical Integration

As previously mentioned, one limitation to this study has been the exclusive reliance on cross-section data. For this reason also the ratio of value added to sales cannot be used as an index of vertical integration. The results can be extremely biased and difficult to interpret. The unavailability of data on the separate costs of each level of operation within a firm precludes the use of an index measuring the ratio of a firm's employment in each vertical stage to total employment. Use of the ratio of inventory to sales is constrained by the nature of the industry. Fresh fish is a highly perishable product and firms strive not to keep any inventory. Short distances make processing and storage less necessary.

Because of these many constraints involved with the use of traditional quantitative measures, this investigation will rely on two other methods. One is to describe the vertical arrangements and actions of the firms which should permit an overview of the utilization of vertical integration within the industry.

A second method is to account for the percentage of the total market handled by firms of different vertical arrangements to indicate the importance of vertical integration. This is presented in section 4.4.

4.3 Motives for Integration

Many reasons can be cited as to why firms integrate, but they can be reduced to two[1] basic advantages: lower costs and circumvention monopoly (De Chazeau and Kahn, 1959). In certain cases, vertical integration may serve to accentuate monopoly power. Discussed first are the methods by which vertical integration in the wholesale merchant sector has reduced costs. Following that is a discussion of the use of vertical integration to circumvent monopoly or monopsony.

4.3.1 Cost Reduction at Primary Buyer Level

Excluding the cooperatives, a large percentage of the vertical ties between primary buying and fishing operations motivated by cost reduction have been arranged in some form of vertical coordination. Why vertical coordination rather than vertical integration occurred in these cases will be the subject of this section.

Using Coase's theory that a firm will integrate only when a firm can organize a transaction more efficiently than was previously organized by two firms, a model is proposed to represent transaction costs during a wet or dry season. This model is

$$TTC = nc$$

where: TTC = total transaction costs;
n = number of transactions;
c = cost of an individual transaction, assumed constant and equal for every transaction.

Some knowledge of the behavior of these components between the wet and dry season can be inferred from the information presented in the chapter on the setting. During the dry season, for the same given quantity, n increases because there are more fishermen bringing in smaller quantities; c will also increase for two reasons. Because the burden of seeking out the fishermen rests on the primary buyer, a monitoring process must be established to watch for landings. Secondly, the buyer must stay open longer hours since fishermen's hours are not restricted by the weather. Consequently, if both n and c increase, it can easily be shown that for a primary buyer, TTC(d) > TTC(w) where (d) and (w) indicate the dry and wet season, respectively.

By means of vertical arrangements, a primary buyer could lower these transaction costs during the dry season. If he did not have to seek out the catch but instead was assured quantities, c would be reduced. Also it might be possible to arrange for landings to come at appropriate time periods, to reduce costs and/or avoid spoilage.

Most likely a buyer would not want to vertically integrate during the wet season, as no transaction cost savings would result. Vertical integration might even increase costs if demand conditions are such that surpluses commonly occur. A buyer would be absorbing large amounts of risk at the fishing

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[1]Professor Dirlam adds that vertical integration can be used as a techique to accentuate monopoly.

level. Additionally, he would have to absorb the costs of management of the entire organization of fishing operations. These costs would be considerable and it seems implausible that the management costs of fishing could be done any cheaper by a primary buyer integrating backwards.

From the primary buyers standpoint then, an ideal situation would be when a buyer would have vertical arrangements during the dry season but not the wet. Fully integrating does not allow such a luxury. One such solution to the problem, however, are the vertically coordinated arrangements found to exist and discussed in Chapter V.

4.3.2 Cost Reduction at the Transporter Level

In the wholesale merchant sector of this industry, very few if any transporters are not integrated into at least one other upstream or downstream function.

In Acajutla's situation, integrating as a primary buyer functions as a cost savings to the transporter. He is able to purchase directly from the fisherman at a price less than that fixed by the cooperative. This result can be applied to all the geographic harvest areas with cooperatives.

If a transporter could not integrate backward into primary buying and was likewise not operating as a wholesaler, he would be increasing the number of market transactions that the system is presently using. If it is true that the result of vertical integration has been to reduce transaction costs, and if the transporter must buy at competitive prices, it will be difficult for him to operate very long in the market without vertically integrating in one direction or another.

4.3.3 Circumvention of Monopoly (Monopsony)

There is at least one situation where vertical integration enabled a firm in one stage to circumvent monopsonistic power. This case is the integration of fishing operations forward into primary buying and transporting functions. Given the oligopsonistic structure in many of the harvest areas, it makes economic sense for a fisherman to benefit by circumventing the buyers.

One method of doing so is to join groups of fishermen together to create selling power. In essence, this is one major purpose of a cooperative. However, cooperatives sometimes have organizational and other problems. Therefore, in certain harvest areas, such as El Tamarindo, some fishermen have successfully been able to integrate forward, which is beneficial for them, but at the cost of decreasing the possibilities of improvement for all fishermen in the community. The remaining fishermen still have to face the oligopsonistic structure.

4.4 Degrees of Integration

A description of the vertical arrangements was presented in Chapter III. This section presents the integration measure of the percentages of the total fin-fish that pass through certain vertical channels enroute to San Salvador as discussed in section 4.2.

Percentages of the total fin-fish marketed through a specific vertical integration arrangement have been calculated for the wholesaling and transporting functions (see Table 3.) One assumption made in obtaining these figures was that a vertically integrated firm markets its own internal supply. That is, a wholesaler integrated as a transporter sells only what he brings to market and does not make purchases from other transporters. Although this assumption probably does not always reflect the real world situation, it was necessary because of unavailable data on cross-firm purchases vs. internal supply.

The fin-fish wholesaled to retailers in the market passes through four vertical arrangements depicted in Table 3. Fish transported to market was brought in by five vertical arrangements. Effectively, only 16 percent of the fish is transacted by non-integrated firms in market between the transporting and wholesaling levels, while 84 percent is handled via vertical integration.

TABLE 3

PERCENTAGES OF FIN-FISH MARKET HANDLED BY VERTICALLY INTEGRATED FIRMS, TRANSPORTER AND WHOLESALER LEVELS

Vertical Arrangement[a]	Wholesale Level	Transporter Level
	%	
W	16	
TRW	19	19
PBTRW	53	53
FPBTRW	12	12
PBTR		06
FPBTR		10

[a]The symbols W, TR, PB, and F, indicate integration into the functions of wholesaling, transporting, primary buying, and fishing, respectively.

Data constraints similar to those encountered for buyer concentration at the primary buying level preclude any estimations at this time for the amounts passing through vertical integration closer to the harvest level. Only three wholesalers are known to be integrated into retailing. Therefore, practically all the fish is transacted on the market between the wholesaler and retailer.

4.5 Limits to Integration

We need to consider the extent to which integration could be further employed as a cost reducing implement. It has been shown in the setting that two is the typical number of market transactions that take place between harvest and final consumption. Allowing the symbols F, PB, TR, and W to represent the functions of fishing, primary buying, transporting, and wholesaling, respectively, we can depict the vertical arrangements. The most common arrangements are:

FPBTR-W-R
F-PBTRW-R
FPB-TRW-R
F-PBTR-W-R

Only in the last case, which is generally limited to commercial by-catch merchants in La Union, is the number of transactions between the producer and retailer greater than two.

The question of why not just one transaction will now be discussed. Given the functions in the marketing system, such a scenario could only come about in one of the following arrangements:

(i) FPBTRW-R
(ii) F-PBTRWR
(iii) FPB-TRWR
(iv) FPBTR-WR

Arrangements (ii), (iii), and (iv) all include integration into the retail trade. However, such integration brings about an entry requirement of establishing clientele. Retailers report that they make their wholesaler purchases on the basis of product quality and price. Wholesaler likewise report that they sell to any and all retailers. However, retailers reported that clientele is a very important aspect of their sales. Observations in the marketplace confirmed these reports. Repeatedly one observed consumers returning to the same retailer. Many consumers did not make price comparisons for similar species between sellers. Retailers also reported that the costs of obtaining clientele was one of the biggest obstacles to creating a successful business venture. The ability to attract consumers is high on the list of skills and therefore this is one restriction to vertically integrating forward from wholesaling into retailing.

There are only three known cases of wholesalers integrating forward into the retailing stages. None of these firms is integrated further back than transporting. All of these are family owned operations, where the wife operates the retail stage. Also, the wives had already established the retail business before marriage.

Additionally, the daily hours of work in retailing are long. This creates other managerial limits on the amount of time available to run a firm. One might conclude from this evidence that integrating into retailing operations may increase management costs outweighing any transaction costs savings. These managerial limits most likely play a role in some of the other vertical arrangements listed.

Arrangement (i) is such a case where time constraints would restrict the vertical size of the firm. The cooperative in La Libertad is the only known case of arrangement (i). The cooperative has advantages firms do not. One is that decisions about fishing operations are decentralized, made by the individual fishermen. They also have specialized personnel who are in charge of marketing and sales. Private firms, on the other hand, report severe difficulties in finding trustworthy employees for integral parts of the operation, such as receiving landings or collecting payments. Thus a firm's proprietor, or family member, will have to be present continually at both the landing site and market. Given the timing of landings and the loading, transporting, sales and debt collection activities, the proprietor would have very few hours left in any given day to do other things, such as sleep. According to Coase (1937), the firm will be smaller the higher the absolute costs of and rate of increase in transactions costs and mistakes made by the entrepreneur. Given that most operations run seven days a week, these time constraints will increase transactions costs and the number of mistakes, and therefore sets absolute limits to vertical and horizontal expansion.

The size limit aspect of business relations or management in an underdeveloped country is very important. Managerial capacity is a scarce factor and limits the size of the firm by restricting it to the number of members who can fill key positions within the firm. Managerial capacity has an implication as to the optimal size of the firm. Normally if the industry is characterized by decreasing costs, the longrun average cost curve will be downward sloping. Firms can vary all inputs and therefore by increasing size become more efficient.

However, the scarce factor of trustworthy personnel may prevent a firm from realizing those full economies. The technical efficiencies may very well be lost in managerial diseconomies. Therefore, the point of minimum average cost on the long-run average cost curve will not be the same for all firms. Rather, the scarce factor determines the optimal size for a given firm.

4.6 Consequences of Vertical Integration

If vertical integration has in fact been motivated by and has reduced

transaction costs, vertical integration must be considered as having a desirable effect. Similarly, if vertical integration has reduced oligopsony power at certain levels in certain locations, this must be considered beneficial also.

The area of vertical integration acting as a barrier to impede entry at the primary buying level has not been through explored because of unavailable data. Therefore no qualitiative assessment of this entry barrier can be made at this time. This possibility definitely warrants additional investigation.

4.7 Application of Regression Results to Vertical Integration

The results reported in equation (10) and (12) allow a test of one other hypothesis. In theory, firms will integrate when there is a cost savings associated with integration. Such savings may result from several sources, one of which is transaction costs as proposed by Coase (1937). If integration does reduce costs then the handling costs of the vertical arrangement PBTRW should be less than the costs of the arrangement PBTR plus the costs of W. In other words, the null hypothesis is

$$AVHC_{pbtrw} < AVHC_{pbtr} + AVHC_{w}. \qquad (13)$$

Rewriting equation (10) we have

$$AVHC = \alpha Q^{-0.26} e^{(1.45D_1 + 1.16D_2 + 1.29D_3 + 1.2D_4}. \qquad (14)$$

AVHC is equal to average variable wholesaling costs only when D_1, D_2, D_3, and D_4 are equal to zero. Therefore, wholesaling costs can be expressed as

$$AVHC_{w} = \alpha Q^{-0.26} \qquad (15)$$

Average variable handling costs for the PBTR arrangement are represented by

$$AVHC_{pbtr} = \alpha Q^{-0.26} e^{1.16}. \qquad (16)$$

The right hand side of equation (13) then becomes

$$AVHC_{pbtr} + AVHC_{w} = \alpha Q^{-0.26} e^{1.16} + \alpha Q^{-0.26} \qquad (17)$$

This reduces to

$$= \alpha Q^{-0.26} [e^{1.16} + 1]. \qquad (18)$$

Average variable handling costs for the vertical arrangement PBTRW can be represented as

$$AVHC_{pbtrw} = \alpha Q^{-0.26} e^{1.29}. \qquad (19)$$

Combining (19) and (20) into hypothesis form, we have

$$\alpha Q^{-0.26} e^{1.29} < \alpha Q^{-0.26} + \alpha Q^{-0.26} [e^{1.16} + 1]. \qquad (20)$$

Since $e^{1.16} + 1 = 4.19$

and $e^{1.29} = 3.19$, the null hypothesis is not rejected.
Therefore, for at least one case, average variable handling costs of a vertically integrated firm are less than those for a vertical arrangement requiring

an additional market transaction.

The same test can be applied to the results of equation (12), average total costs. Only the parameter values change, so that the test becomes

$$e^{1.33} < e^{1.1} + 1. \qquad (21)$$

Since $e^{1.1} + 1 = 4.0$

and $e^{1.33} = 3.78$, the null hypothesis is not rejected either for average total costs. Unfortunately, we cannot identify the exact source of the economies, by they transaction or other cost savings attributed to vertical integration.

5. Product Differentiation

For the most part, very few efforts are aimed at differentiating products until it reaches the retail level. Almost all produce is sold in whole form, thus no processing or branding takes place. Only the differences in terms of freshness or quality or species classes are recognized.

Some differentiation takes place in terms of buyer and seller services. Buyers are known to provide reciprocal agreements with fishermen, an issue treated more fully in Chapter V. Sellers at several levels provide services extending the payment period for goods. However, since almost every firm provides these credit services, it is not really product differentiation, but creates an entry barrier, as a new entrant who does not provide these services will find himself at a disadvantage compared to the existing firms. Unfortunately, the degree of this barrier could not be assessed.

6. Barriers to Entry

Within the structural element, the final outcome seems to rest most on the threat of potential entry. For example, whether a firm or a group of firms utilize possessed monopoly power is dependent on the threat of potential entrants. Similarly, the manageability of collusion becomes increasingly more difficult with the addition of another firm. The role of entry barriers cannot be taken lightly in a dynamic situation.

Assessment of the degree of entry barriers must come about by the examination of various aspects of the industry which give some indication about the barriers. One such aspect is the capital requirements.

6.1 Capital Requirements

Several firms were surveyed to determine the actual amount of capital investment required to start the business. Across all vertical combinations, the quantities of investment were low, ranging between ¢100 and ¢750.[1] Those that entered as transporters did not own trucks, but took fish in baskets by bus. The opportunity of entry at low cost still exists.

Those that entered as non-integrated wholesalers reported a low initial capital investment also. Their minimal capital requirements included an ice box, scale, display tray, and a knife, all of which can be purchased with ¢100 to ¢750. A day's purchase of products can be obtained on credit. What might be more difficult for entry at a wholesaling level is the renting of a stall, as locations are limited.

Firms that entered with trucks reported a higher initial investment, from ¢5,000 to ¢7,500. Still, this investment level is considerably lower than the average present stock reported by all firms presently operating (see below). (Present average capital stock refers to the market value of capital investment and not replacement value.)

The only firms to report very high initial capital investments were the firms handling the by-catch of the Salvadorean shrimp fleet. Those firms reported initial outlays of more than ¢30,000. These costs reflect not only vehicles, but landing and refrigeration equipment maintained in El Triunfo.

An average present capital stock of approximately ¢20,000 was reported by transporters with vehicles. The maximum value in this group was near ¢50,000. This increase the validity of the hypothesis that while entry cost per se is

(1¢ = colon, where ¢1 = $0.40 U.S).

low, there are some barriers measured in terms of capital requirements to becoming large within the transporting function of the industry. Nevertheless, many of these present-day transporters report that this has been the manner of their rise through the ranks.

Industrial by-catch transporters based in El Triunfo report even higher capital stocks, as much as ¢75,000 or more. The contract buyers who began purchasing from the industrial companies when they first made the by-catch available are the same ones presently in operation. This may be an indication that the capital requirement may have created a high enough entry barrier to prevent any other firm from bidding up the bonus payment that the buyers make to the commercial shrimp companies.

Another barrier which must be mentioned is the need for a transporter of any significant size to have substantial amounts of operating capital. This need and the operation of the system was described earlier. These quantities of operating capital can amount to as much as ¢30,000 for the larger transporters, although an average amount is probably one-third that amount or less.

6.2 Entry and Exit

The number of firms within the industry that have exited is not known. Comparing the number of firms presently in the industry with the number reported by Tilic and McCleary (1971) would be one method of determining the number of entrants in recent years. Another method is to look at the age of firms.

The number of firms operating as wholesalers of all types of fresh fish products within the wholesale market has more than tripled since 1971. At that time Tilic and McCleary reported eight wholesalers. Today the number is approximately thirty, with twenty-one handling marine fin-fish. Many handle crustaceans and one specializes in freshwater species. There are, however, only eight or nine non-integrated wholesaler across all products which conforms to the number reported by Tilic and McCleary. Cross-checking the ages of these firms shows that the average age is seventeen years. Most likely, they are the nucleus group reported in 1971.

The physical structure of the market has changed to allow entry. The new location has more selling stalls than the old market, which has allowed some transporters to integrate forward. Most likely this expansion has reduced both buyer and seller concentration at the wholesale level.

Out of all transporters, twenty-one reported that they entered the business in the last nine years, at an average rate of 2.3 a year. Nine reported entering in the last two years, at a rate of 4.5 a year. Consistent with the latter rate is the finding that four transporters entered in the last year.

Trends appear among those buyers working specific harvest areas. El Tamarindo is undoubtedly the leader in new firms. The average age of firms interviewed from that harvest site is four years. This does not include the two Guatemalan-owned firms. Over half of these entered within the last two years. Perhaps part of this trend can be attributed to the growth of the Guatemalan market. Approximately four of these new firms go to Guatemala exclusively.

La Herraduar/Jaltepeque represents the other extreme. Only one firm has entered in the last decade, and the average age is fifteen years. Acajutla has had a few firms enter, but they have focused their efforts on nearby small, rural towns which had no supply of fish until these small transporters began taking produce to them. El Triunfo and La Union have had some new entrants in the last two years; about 15 percent of the total buyers in each of the respective communities.

7 Summary

The existence of scale economies has been empirically substantiated. All other things equal, one would expect to see a concentrated industry where a few large buyers operate more efficiently than many small firms. Such an expectation is particularly true for transporting, where over the reasonable range of the vehicle capacity fuel costs have proven to be a prime source of economies. These economies cannot be realized by public tranaport, however, since there is a constant cost for each bundle transported.

The hypothesis that vertical integration may be motivated by cost savings and therefore a vertically integrated firm is more efficient than its non-integrated counterpart is supported by the data. Unfortunately, the data do not allow the determination of the exact source of these efficiencies. Also, the test could be made for only one vertical arrangement.

CONDUCT AND PERFORMANCE

8 Conduct

A disadvantage of the snapshot image provided by cross-section data is the lack of extensive information on the behavior of firms that time series observations can provide. The major sources of information on conduct for this investigation come from hypothetical questions addressed to or conversations with firms in the industry. During the investigation, the author was able to discern some, but not all, aspects of behavior which affect performance.

8.1 Reciprocal Agreements

One observed behavior concerns the relationship between the primary buyers and fishermen. In many instances, buyers knowingly over-purchase from fishermen during the wet season when prices are depressed and producers have difficulty selling all their catch. Buyers confirm these actions and state that such tactics are part of a reciprocal agreement. In exchange for the conduct of the buyers in the wet season, the fisherman feels obliged to sell to the buyers in the wet season, the fisherman feels obliged to sell to the same primary buyer when competition for purchase of the supply increases greatly. Apparently, the gains from having produce during the dry season outweigh the losses from over-purchasing in the wet.

It is a beneficial arrangement for the fishermen, as the risk of highly variable income is reduced during the wet season. It is not known what the effect would be if this arrangement did not exist and price was the only method by which fishermen determined to whom they sold. No doubt more fish would be lost during the wet season since it is difficult to dry at that time, but prices might surge even more during the dry season and reduce consumer surplus.

This reciprocal behavior, then, has several effects. It evens out the variability in prices at the producer level. It reduces risk by avoiding losses at the producer level. In effect, the buyer is assuming part of the risk of fishing. It also may create some entry barriers at the buyer level if the agreements play such an important role that entrants who do not provide such

services cannot attract fishermen. The extent of the entry effect is hard to assess without more information.

Wilson (1978) found similar behavior in the New England fishing industry. After five years of investigation, Wilson found that buyers and sellers "prefer to establish long term bi-lateral relationships which over time exhibit limited mutual dependence and reciprocation." He attributes the situation primarily to costly market information and ambiguous quality price differentials. Given the present market information structure, he concludes that the situation is better for society than an impersonal arms-length transaction because it results in higher quality fish, greater responsiveness to inventory problems and wastes, and is more equitable.

In El Salvador, the same buyer-fishermen behavior was found to be used by some of the wholesalers in their selling arrangements with retailers. The practice has been shown to be carried out only by contract buyers, those that bring the commercial by-catch from the Salvadorean fleet.

By fortune of being supplied by the commercial fleet, variability in supply for these primary buyers is less than for a wholesale merchant relying on artisanal sources. Contract buyers, therefore, possess an additional form of market power: minimal supply variability. They are the only ones with a consistent supply of fish, which allows them to make reciprocal agreements. If the retailers promise to take certain amounts daily, then the contract buyers integrated as wholesalers can provide retailers a regular supply.

The market shares of the contract buyers seem to yield two types of power. The first is in size, since all three contract buyers maintain significant shares of the market relative to the other firms. A second power results from the certainty of supply, relative to the other firms' sources of supply.

Questioning the retailers about these reciprocal arrangements left the author with the impression that the arrangement is not as mutually beneficial as the one found at the buyer/fisherman level. Many of the retailers involved seem to feel that they had no other alternative, that using reciprocal agreements was the only way to survive in the market. It was noted, however, that the majority of the retailers entrapped in such a manner were small and exhibited high ratios of quantity supplied by the contract buyer to their total purchases.

8.2 Price Determination in the Wholesale Market

One of the basic functions of a market institution is to establish a market price. In a competitive market, anonymity exists because the institution serves as an intermediary between the participants. in an imperfect market, however, different behavior rules govern the participants and most of these rules are not formally established. "These rules, being informal in construction and application, are difficult to identify and describe correctly" (Robinson, 1978). The main function of an imperfect market institution also is to establish a market price, but instead of the invisible hand the burden of setting a price and creating a set of price-making rules fall upon the participants.

Examination of the market institution in an industry is one method to assess the industry's conduct. The wholesale market in El Salvador, defined as the market between the wholesaler and retailer, is an imperfect institution primarily because it violates the necessary condition of a large number of firms (or low entry barriers). It is very possible that some firms can affect price, especially within a quality class.

In an effort to determine how firms set prices, firms were asked their methods for establishing prices. The most common response was to add a fixed amount to the purchase price. Such practice seems reasonable by an industry using no accounting practices, a highly perishable product and close physical contact where all merchants know each other. Further conclusive information

about price determination was difficult to obtain because of the relative short time period of the survey and the unwillingness of the proprietors to fully explain the price-making rules (assuming that they completely understand them). However, known conditions and observations in the market suggest two theories of price determination; one in the lower-valued species market and the second in the higher-valued species market.

8.2.1 Price Determination in the Lower-Value Species Market

A necessary condition for the application of the dominant firm theory is that one firm controls such a large proportion of the product that each of the small firms cannot exert a perceptible influence on price by means of their output decisions. The dominant firm may then be able to set selling price to maximize profits in a manner similar to a monopolist, if the small firms follow the leader on price.

The fact that the contract buyers collectively control an estimated 54 percent of the commercial mixed class, and over 30 percent of the total fin-fish market suggests the use of the dominant firm model to partially explain price determination for the lower valued species (third and mixed commercial classes). This model assumes that the dominant firm is the most efficient. In the wholesale market in El Salvador, this assumption holds because of the downward sloping average cost curve. Also, the contract buyers are more efficient because they do not face the uncertainty in supply and prices which firms servicing the artisanal sector do.

Figure 4 shows the determination of price in a market characterized by a dominant firm price-leader (Koch, 1974). The solution assumes that the dominant firm knows the supply function of the minor firms; that all smaller firms have similar cost structures; and that the dominant firm is non-aggressive, which means that it takes the volume which remains after the small firms have taken what they want at the price established by the dominant firm.

The dominant firm faces the demand curve, d_{dom}, and its marginal revenue curve, mr_{dom}. The remaining small firms, collectively have the marginal revenue curve, $mr_{\Sigma sm}$. The demand curve for the entire market is D_{mkt}. The dominant firm maximizes its profits by equating its marginal cost with marginal revenue and therefore decides to sell output Q_1. It sets price at P_1. The small firms accept this dictum in a fashion similar to perfect competition; the price is given to them and they need only to decide how much they will produce at that price. Price P_1 appears to the small firms as a horizontal demand curve. They will equate their marginal cost with their marginal revenue and decide to produce output Q_2. Q_T is the total output, Q_1 plus Q_2.

Nicholls (1941) concludes that in a market dominated by a few large firms, the short run results in abnormal profits. The continuance of these profits, however, depends on whether or not other firms are able to enter the industry. Analysis of the entry barriers for this market in the previous chapter revealed that entry barriers are high, as a result of high capital investment and reciprocal agreements established by the dominant firm. Given this result, one could conclude that the dominance of a few firms is probably sufficient to prevent price spreads from falling to the minimum-cost level of pure competition. The net margin for these dominant firms is estimated to be ¢0.07 a pound, which is lower only than the wholesalers found in Table 6. The dominant firms' margin is included with the PBTRE category.

8.2.2 Price Determination in the Higher-Valued Species Market

Data gathered during the survey revealed no firm which dominated the first and second class quality classes such as found in the market for lower valued

TABLE 2

AVERAGE WEIGHTED MARGINS AND COSTS OF WHOLESALE MERCHANTS BY VERTICAL ARRANGEMENT BY PRODUCT TYPE BY DESTINATION

	Destination	San Salvador						Guatemala	
	Product Type:	Fin-Fish Only					Fin-Fish & Non F.-Fish	Fin-Fish Only	Fin-Fish & Non F.-Fish
1	Vertical Arrangement	W	TRW	PBTRW	PBTR	FPBTR	PBTRW	PBTR	PBTR
	No. of firms	(6)	(1)	(4)	(7)	(3)	(6)	(4)	(2)
2	Gross Margin, ¢ per pound[a]	0.122	0.101	0.161	0.106	0.106	0.277	0.484	0.530
1-2	Operating Cost, ¢ per pound[a]	0.023	0.049	0.078	0.082	0.069	0.145	0.158	0.048
4	Net Margin, ¢ per pound[a]	0.089	0.052	0.083	0.024	0.037	0.132	0.326	0.482
5	Average Total Cost, ¢ per pound[a]	0.032	0.063	0.106	0.091	0.135	0.160	0.240	0.079
1-5	Net Margin, ¢ per pound[a]	0.080	0.038	0.055	0.015	-0.029	0.117	0.244	0.451

[a] ¢ = colon, where ¢1 = $0.40 U.S. or $1 = ¢2.50.

species. It is proposed that conditions found in the higher valued species make the collusive price leadership model a realistic possibility. Collusive price leadership is relatively common where the mutual interdependence of the oligopolists in a market is recognized by the participants (Koch, 1974). The early morning activity of the merchants including communicating with each other to estimate how much of each quality clas is brought in each day gives evidence to the fact that they recognize interdependence among themselves. Markham (1941), points out that collusive price leadership works best when the products are highly substitutable and are subject to a single price policy. Fresh fish at this level is highly substitutable (within a quality class) and the pricing method of adding a fixed amount to the purchase price gives credence to the feasibility of a single price policy.

This collusion need not be formal; it may only involve mutual understanding that certain types of price competition are to be avoided. For example, prices will ordinarily be changed at certain times of the year (Koch, 1974), which characterizes well the market in question. Merchants repeatedly state that price changes occur only between the wet and dry season. They also admit that price might increase a bit more during the last ten days of the Easter season.

8.3 Other Behavior

Little more information was obtained in the survey concerning the behavior of the firms. There is some evidence that the firms increase their margin during the peak of the Lenten season, which is not a result of higher purchase prices paid to the fishermen, but an extraction of consumer surplus during the time of increased demand. This information, however, is based only on conversations with a few proprietors and should not be taken as conclusive evidence of such behavior.

No evidence of predatory competition or price discrimination was revealed during the course of the survey. Such activity, however, is more difficult to discern and requires more investigation.

9 Performance

9.1 Marketing Costs and Margins

The examination of profit rates was precluded by data restrictions. However, estimates were made of the marketing costs and margins between the producer and retailer levels. Marketing costs for the wholesale merchant sector are reported in Table 4.

The difference between the ex-vessel price received by the producer and the price paid by the consumer is known as the gross marketing margin. In a competitive market, the margin should be equal to the costs of marketing, including costs of capital and management. These marketing margins, broken down by average variable costs and total average costs are listed in Table 4 and Table 5. The margins are listed by absolute amounts, and expressed as a percentage of the merchant's selling price. In Table 5, the gross margins are presented according to the vertical arrangement. A large degree of variation in vertical arrangements and the lack of precise costs and revenue within a vertical stage prevented the computing of a margin for each of the vertical stages: primary buying; transporting; and wholesaling. Three assumptions must be noted for Table 5. One is that quantities for non fin-fish products are weighted according to value in an effort to convert dozens and units to pounds. Second is that the vertical arrangement including fishing operations uses a reported price that they pay for fish and not necessarily the input cost from fishing. Third is that these margins are for fish in the wholesale market in San Salvador only.

TABLE 4

COMPARATIVE PER POUND COSTS OF WHOLESALE MERCHANTS, BY VERTICAL ARRANGEMENT BY PRODUCT TYPE AND DESTINATION

Destination:	San Salvador						Guatemala	
Product Type:	Fin-Fish Only					F.-Fish & Non F.-Fish[b]	Fin-Fish Only	F.Fish & Non F.-Fish[b]
Vertical Arrangement	W	TRW	PBTRW	PBTP	FPBTR	PBTRW	PBTR	PBTR
Average Operating Costs, ¢ per pound[a]	0.023	0.049	0.078	0.082	0.069	0.145	0.158	0.048
Average Total Costs, ¢ per pound[a]	0.032	0.063	0.106	0.091	0.135	0.160	0.240	0.079

[a] ¢=colon, where ¢1=$0.40 U.S. or $1=¢2.50

[b] Non-fish products were weighted by value to convert to pounds.

TABLE 5

WEIGHTED AVERAGE GROSS MARGINS BY VERTICAL ARRANGEMENT BY PRODUCT TYPE, SAN SALVADOR AND GUATEMALA

Vertical Arrangement	Average Weighted Gross Margin, ¢Pound[a] Product Type	
	Fin-Fish Only	Fin-Fish & Non Fin-Fish
	San Salvador	
W	¢0.11	¢0.16
TRW	0.10	
PBTRW	0.16	0.27
PBTR	0.11	
FPBTR	0.11	
	Guatemala	
PBTR	0.48	0.53

[a]¢ = colon, where ¢1 = $0.40 U.S. or $1 = ¢2.50.

These marketing costs and margins are compared in Table 6 to see to what degree the net margins--gross margin minus costs--differ from zero, which is what the net margin would be if costs just equal the gross margin. All vertical arrangements resulted in a positive net margin except one. The one which resulted in a negative value included firms vertically integrating into the fishing level. One reason for this result is that the data did not correctly reflect the input cost of purchase from fishing, but rather reflected what the primary buying level paid to any producer. Consequently, a true production price was not used.

Although each of the other vertical arrangements resulted in a positive net margin, three factors must be taken into consideration before qualitatively assessing performance. One factor is that the opportunity costs of management were not included in the computation of marketing costs. Part of the reason for this is there is no basis for determining a proper return to management. The use of education levels does not seem appropriate because many of the proprietors are not formally educated, but they do possess specialized skills. Another problem is determining the marginal value of an additional family member who is capable of occupying a key management position.

A second factor to be accounted for in the assessment of these margins is risk. No quantitative measure for the burden of risk of marketing was included. The inability to determine the risk inherent to each marketing level prevents the inclusion of such a measure.

The last factor is the question of whether an opportunity cost of 12 percent is the proper level and if the interest rate of 10 percent for capital is correct for this industry. There are no easy answers to these questions. If time allowed, a sensitivity analysis of these returns, varying interest and opportunity costs and different returns to management, would have been useful. Determining at what interest or opportunity costs levels these margins approach zero can facilitate the appraisal of performance.

One other limitation remains. The margins were calculated based on prices and quantities during the wet season. No information is presented as to how these margins change with the dry season. Many observers of the marketing system believe that many marketers just get by during the wet season, and that marketing returns substantially increase during the dry season. Therefore,

TABLE 2

GROSS PER POUND MARGINS BETWEEN EX-VESSEL PRICE AT THE HARVEST SITE AND WHOLESALE PRICE TO RETAILER, FOR FIN-FISH, SAN SALVADOR, BY SPECIES CLASS[a]

Harvest Site	Absolute and Percentage Margin[b] in Colones[c] Per Pound							
	First Class		Second Class		Third Class		Commercial Mixed	
	Absolute	Perctg.	Absolute	Perctg.	Absolute	Perctg.	Absolute	Perctg.
Acajutla	0.12	11	0.09	13	0.16	26	*	*
La Libertad	0.24	22	0.19	27	0.20	33	*	*
La Herradura/ Jaltepeque	0.39	35	0.19	27	*	*	*	*
El Triunfo/ Jiquilisco	0.19	17	0.19	27	0.30	50	0.19	35
El Tamarindo	0.25	23	0.29	42	0.27	45	0.19	35
La Union	0.29	26	0.26	37	*	*	0.18	33

[a]The principal species which make up each class are presented in Appendix I.
[b]Percentage margin = absolute margin/selling price.
[c]One colon = $0.40 U.S. or $1 = 2.50 colones.

*This species class not reported at this site by merchants during time period of interviews.

even if we could qualitatively assess the performance during this season,there still remains the overall assessment for year-round performance.

With these limitations kept in mind, some comparisons can be made with the results at hand. Excluding those that go to Guatemala and those which handle non fin-fish products for the moment, non-integrated wholesalers appear to have the greatest return. Depending on the barriers to obtain a wholesaling stall in the market place, this may reflect location rent.

The primary buying-transporting arrangement reveals the lowest return. This group consists mainly of those which bring fish to market by basket using public transport. Therefore, they are unable to realize many of the scale economies found in private vehicle tranaporting. They pay a constant cost for each basket loaded onto the bus, and they are limited by the number of baskets they can manage in such a fashion. Also, their vertical arrangement means that a third market transaction will have to take place, and therefore, to be competitive, they will have to receive a lower price.

The firms that take produce to Guatemala realize the greatest return. This is probably due to the increased willingness of the consumer in Guatemala to pay for first class products. The cost figures for the firms which take non fin-fish products to Guatemala cannot be relied on greatly. Because of conversion problems in changing dozens and sacks of lobsters, oysters and bivalves to pounds, the quantities were weighted by value. Thus, overly high quantities likely resulted and consequently costs per pound were probably underestimated.

9.2 Shares of the Retail Price

One method of examining prices and margins is to look at the shares or percentages of the retail price that each sector receives. These shares are listed in Table 7. Fishermen's and wholesale merchant's shares are listed according to the harvest area, and are also listed as an average, by quality class. Retailer's share is listed as an average within a quality class only.

Fishermen's share of the retail price varied according to location. The average share of the retail price was 65, 46, 44, and 44 percent for the first class, second class, third class, and commercial mixed class, respectively. An average fishermen's share for the U.S. market is 41 percent as reported by Penn (1974).

The wholesale merchant's average share of the retail price was 19, 19, 28, and 24 percent, for the same classes. The retailer's share of the consumer dollar (colon) was 16, 33, 28, and 32 percent, respectively.

CONCLUSIONS AND RECOMMENDATIONS

10 Conclusions

10.1 Market Structure

There is evidence that there is strong oligopsony market power at the primary buyer level for fin-fish in the harvest areas of La Herradura and El Triunfo. Oligopsony power of a lesser degree exists in the ports of Acajutla, El Tamarindo and La Union. The reason that oligopsony power is less in these latter harvest areas is due to co-operatives and some individual fishermen having verticaly integrated into marketing activities. A monopsony primary buyer purchases fresh fin-fish from the Salvadorean islands in the Gulf of Fonseca.

The information system of communicating prices and other market information to the fishermen serves to accentuate and oligopsony power. Because the buyers are in contact with the regional market where produce from all the harvest areas are sold, they are better informed about supply and demand

TABLE 3

PERCENTAGE SHARES OF RETAIL[a] PRICE FOR FISHERMEN, WHOLESALE MERCHANTS, AND RETAILERS, BY HARVEST AREA AND QUALITY CLASS

	Quality Class			
	First	Second	Third	Commercial Mixed
	%			
Fishermen				
Acajutla	75	58	53	n.a.
La Libertad	65	46	48	n.a.
La Herradura	54	46	n.a.	n.a.
El Triunfo	69	46	36	44
El Tamarindo	65	39	40	44
La Union	62	42	n.a.	45
Average	65	46	44	44
Wholesale Merchants				
Acajutla	09	09	19	n.a.
La Libertad	19	18	24	n.a.
La Herradura	30	18	n.a.	n.a.
El Triunfo	15	18	36	24
El Tamarindo	19	28	33	24
La Union	22	25	n.a.	23
Average	19	19	28	24
Retailers				
Average	16	33	28	32

[a]Retail price adjusted downward for eviscerated whole fish equivalent price. Conversions used: first class, 85% yield; second, 87%; third, 90%; commercial mixed, 87%. No fillets are included.

n.a. - This quality class not reported for this port during survey.

conditions. Because there is no other information system, the fishermen must rely onthe buyers to inform them of proper prices. In the case of only a few buyers, it would be easy for them to tacitly or formally decide not to bid up prices, since the fishermen have no way of knowning the true market value of their catch.

Vertical integration and vertical coordination are frequently used in the wholesale merchant sector. In the fin-fish market between the transporter and wholesaler, only 16 percent of all quality classes is transacted by non-integrated firms. Two is the common number of market transactions between the fishermen and retailer. If vertical integration has resulted in a more efficient operation, then certain entry barriers face the non-integrated firm who wishes to enter the market.

Empirical evidence supports the hypothesis that vertical integration provides cost savings. Sources of these efficiencies, be they a reduction in transaction costs or some other savings, however, could not be determined from the data.

Vertical coordination by means of reciprocal agreements was found to have two other affects. One is that a greater burden of risks of variation in supply is put upon firms who do not vertically coordinate at either the primary buying-fisherman level or at the wholesaling-retailing level. Reciprocal agreements reduce uncertainty in obtaining or selling supply that other firms without such agreements must face.

Secondly, through the reciprocal agreements, vertical coordination was found to possibly create some entry barriers at the primary buying-fisherman level. The degree which vertical integration reduces risk and the size of this entry barrier could not be measured.

Estimating an average cost function for the industry revealed a decreasing cost industry. One source of these economies of scale were fuel costs. Other costs were found to be constant. Based on this finding, several firms within the industry are operating at less than minimum optimal size. However, there is evidence to indicate that other variables such as managerial capacity limits the size of a firm before reaching an optimal technical efficiency level.

This managerial capacity is limited by the scarce factor of trustworthy personnel; the upper bound usually determined by family members that can work in key positions. It sets an upper limit to horizontal and vertical growth. Therefore, the most efficient size for each firm may be less than the size indicated on the estimated average cost function which does not include this additional scarce factor.

Barriers are low for entering the business of purchasing artisanal landings or the Nicaraguan commercial by-catch and transporting this production by means of public transport. This entry barrier is greater in areas where vertical coordination and reciprocal agreements are used, such as El Tamarindo. Entry barriers into transporting production with a vehicle are more formidable. Capital requirements increase from ¢100-750 to ¢5000-7500. Entry barriers into purchasing the Salvadorean commercial by-catch are the greatest. Equipment and other fixed capital maintained by the contract buyers can be as much as ¢75,000. A limited number of available wholesaling stalls impedes entry into wholesaling in that market.

There is considerable seller concentration at the transporter and wholesaling levels.

10.2 Conduct and Performance

The exact manner in which price is determined in the imperfect market at the wholesale level cannot be identified. The model of price leadership by a dominant firm is proposed as one manner of partially explaining price in the lower-valued species market. This theory is proposed for this market since the contract buyers control over 54 percent of the commercial mixed quality

class and over 30 percent of the total fin-fish market.

Because of their recognized interdependence, it is suggested that a collusive theory best describes the way that price is set in the higher valued species market. In such a theory, the firms tacitly or formally agree to rules about price and no changes in the price, except according to the rules, may take place.

Positive net margins are found for most of the firms operating in the wholesale sector. This cannot be taken as conclusive evidence that firms are operating inefficiently or that abnormal profits are being made. An opportunity cost of managment was not included in the cost data and no provision was made for risk. Also, there remains the question of the right opportunity cost for capital. A 12 percent rate was used.

11 Recommendations

It is recommended that cooperatives be encouraged to continue in their efforts to create seller concentration to counter buyer concentration in the ports. They should develop their marketing programs to enable them to preclude any collusive efforts on the part of the buyers. However, marketing requires proper skills and management and cooperatives are bound by the same scarce factor of trustworthy personnel as are private firms. Therefore, marketing education programs should be implemented by the government to aid the cooperatives in management of their marketing activities.

More in-depth studies should be made about the wet and dry seasonal variations. Information should be gathered concerning the differences in fishing effort, catch, species mix, and cost of harvesting between seasons. Also, demand studies should be undertaken to determine why demand shifts so noticeably between seasons and to investigate the possibilities of sustaining this increased demand year-round.

Studies of price elasticity of fish products and cross elasticity between quality classes and other substitutes should be made.

Information systems which better inform the fishermen about the relative conditions of the market should be established. This, however, cannot be accomplished until basic information gathering and monitoring systems have been established in the wholesale market. Similarly, information about the relative conditions in each harvest area should be made available in the central wholesale market.

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APPENDIX I

THE PRINCIPAL SPECIES WHICH MAKE UP THE QUALITY CLASSES

English Name	Scientific Name	Spanish Name
----------First Class Species----------		
Snook	Centropomidae	Robalo
Snapper	Litianidae	Pargo, Boca Colorado
Grouper	Serrinidae	Mero
Croaker, Curvina	Sciaenidae	Corvina
----------Second Class Species----------		
Shark, Hammerheads, Roquiems, Blue Shark	Sphyrnidae Carcharhinidae Prionace glauca	Tiburon
Flounder	Bothidae	Lenguado
Mullet	Mugilidae	Liza, Chimbera
Grunts	Pomadasyidae	Ruco, Cuin Americano
Sole	Soleidae	Caito
----------Third Class Species----------		
Catfish	Ariidae	Bagre
Jack	Carangidae	Jurel
Mackerel	Scombridae	Macarela
Eel	Anguillidae	Anguila
Mojarras	Gerreidae	Mojarra

CHAPTER 21: FRESH FISH RETAIL MARKETING IN COSTA RICA

BY Bruce Epler and H. Lampe

This chapter analyzes the services, profitability, determinants of profitability and potential contributions of the Costa Rican fresh fish retailing sector in fisheries development. The population studied was comprised of the various fresh fish retailers operating in Costa Rica's populated central valley. All data were collected through personal interviews conducted from June through November, 1976. The structure of the retail marketing sector is evaluated by examining conditions of entry, product differentiation, economies of scale and seller concentration. This analysis reveals that the market structure of the fresh fish retailing sector is conducive to promoting competition and consequently is serving the public well. Profits in the industry were found to be closely aligned with the costs incurred in providing retail services.

I. The Retail Marketing Sector

Forty-four fish retailers were identified in Costa Rica's Central Valley (Table 1)[1]. With the exception of two outlets all of these firms were traditional pescaderias (retail outlets which sell fish only). A census of all forty-four firms was attempted using structural survey. Thirty-five firms cooperated in this effort. The nine firms not responding were observed. It does not appear that their operations, sizes or characteristics differ significantly from the firms interviewed.

Twenty-nine of the firms were located in San Jose. Twenty-two of these firms were found within a three-block area in downtown San Jose. Similar concentrations were common in other cities included in this study. Eleven firms operated in the larger suburban cities in Alejuela, Heredia and Cartago. The remaining four firms were located in new markets in smaller towns within 50 kilometers of San Jose.

Thirty-five of the firms identified were located in large central markets which may house over 100 small shops. These markets sell a wide variety of food and non-food items. Most of the markets are municipally owned. Supermarkets are becoming more prevalent but the majority of the populous still shops in the traditional market areas, possibly because these markets are well serviced by public busses.

A. The Firm

Physical characteristics of a pescaderia vary according to the type of clientele the firm caters to, its location and size. The physical sizes of a pescaderia range from five to 220 square meters. The average size firm is 28 square meters. Authorities in the municipally owned markets stated that outlets (tramos) were not allowed to be greater than 60 square meters and that an individual could not own more than one outlet in each market. These regulations do not appear to apply in privately owned markets.

The amount of total storage capacity per firm ranges from 136 kilograms to 4,500 kilograms. The average is roughly 1,300 kilograms. The amount of storage capacity is a general indication of the firm's economic size. For

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[1]The Costa Rican Department of Marine Fisheries has continued to collect information on fish retailing and has located ten additional pescaderias. Eight of these lie outside the area covered by this study.

TABLE 1

Number of Fresh Fish Retail Outlets in the Central Valley of Costa Rica (July 1976)

LOCATION	NO. OF PESCADERIAS	CITY TOTAL
Mercado Central (municipal)	8	
Mercado Del Carnes	7	
Mercado Bourbon and Vicinity	7	
Mercado Coca Cola (municipal)	2	
Vicinity of Mercado de Mayero	2	
Plaza Viquez (municipal)	2	
Others	1	
San Jose		29
Guadelupe		2
Mercado Central (municipal)	3	
Other	1	
Cartago		4
Mercado Central (municipal)	2	
Heredia		3
Mercado Central (municipal)	3	
Other	1	
Alejuela		3
Mercados Centrales (municipal)	3	
Grecia and Naranjo		3

Total number of pescaderias in municipal markets = 25

Source: Personal interviews.

example, firms in the busy San Jose central market area have greater storage capacities than firms in the less busy suburbs. Other types of equipment used by fresh fish retailers are cash registers, scales, ice makers, bicycles and cutting utensils. A few firms own trucks.

Fish retailers generally work six days a week. Retail outlets located in privately owned markets are open for a half day on Sundays. Public markets are closed on Sundays. Firms may close two or three days per month because of shortages in the supply of fish or for holidays. On the average, fish retailers are open ten hours a day. Friday and Saturdays are traditionally the busiest days of the week as people travel from rural towns to do their weekly shopping. Wednesday is the least active day of the week. The most active part of the day is in the mornings.

The number of people working in a firm ranges from one to seven. The average pescaderia employs three including the owner. Labor can generally be divided into two categories according to the type of function that is performed. These are employees who process fish and perform storage activities and those who do the selling, buying, and handling of the money. This division of labor does not exist in the small firms. Many pescaderias are owned and run by family members.

The oldest firm encountered has been in business for forty years. Twenty percent of the firms have been in business for 20 years or longer and 31% have started operations within the last two years. There is evidence that entry into and exit from the industry is frequent. The average owner had been in business for eight and a half years.

Nine of the retailers interviewed also acted as wholesalers. One of these firms sold to other pescaderias, two sold frozen packaged fish to supermarkets and a fourth exported most of its purchases. The remaining wholesale-retailers sold mainly to restaurants, hotels and bars.

Most of the wholesale-retailers delivered fish to their customers. The most common products sold by this group of firms are shrimp and fillets. Sixty percent of their total sales are attributed to wholesale activities.

Each of the wholesale-retailers extends credit to their regular customers. Repayment periods vary from one to two weeks. No interest is charged for the use of short term credit. Approximately 50% of wholesale sales are made on credit.

Other retailers include supermarkets and the Consejo National de Produccion. Supermarkets, with the exception of the "Mas Por Menos" chain and the "Super Dan", purchase frozen fish from one of two wholesalers in San Jose. The "Mas Por Menos" Company is vertically integrated. The company owns a landings-pier in Puntarenas and purchases fish directly from artisanal fishermen.

The Consejo Nacional de Producion (CNP) has several hundred outlets (expendios) located throughout the country. These outlets sell a wide variety of food products. Fish are stored in and sold from freezers. Prices are listed on the wall. The CNP purchases fish from the cooperative COOPEPES in Puntarenas and transports them to San Ramon, a city halfway to San Jose. The fish are quick frozen and packaged in plastic bags. Fish are then stored and delivered to CNP outlets once a week. The purpose of the CNP is to stabilize market prices. It does this by purchasing and storing fish when it is abundant and releasing it when supply is low.

B. Composition of the Retail Product Supply

The quantity of fish available for purchase by retailers varies from month to month and from week to week (Table 2, Figure 1). Landings by commercial fleets significantly influence supply. Weather patterns in the Gulf of Nicoya and changing biological conditions are additional factors influencing catch. During the interview period, a red tide prevented fishing for several days.

Supply also varies by the day of week. On the average, the greatest

quantity of fish, 23 percent of the total weekly supply, arrives in San Jose on Mondays. The days of the week with the least supply are Tuesdays and Wednesdays. Thirteen percent arrives on each of these days. Sixteen percent arrives on both Saturdays and Fridays and 19 percent on Thursdays.

The composition of weekly supply, defined as the percentage of the total weekly supply attributed to each species or commercial group, has been calculated from data collected on the performance survey (Table 3). The composition of the supply is important as it provides an indication of the product lines available to retailers.

The composition of weekly supply is as erratic as the volume of weekly supply. For example, during one of the interview weeks, first class large Corvina constituted 11 percent of that week's supply and 25 percent the next week. Certain species are more prevalent during certain months of the year while others may disappear seasonally. The changing composition of supply infers that retailers must continuously change their product mix.

C. Retail Services

This section presents a brief description of the types of retail services performed by the retail sector (figure 3).

Each morning between the hours of 5:00 and 8:00, retailers arrive at the Mercado Central in San Jose. Trucks, which have driven from Puntarenas the night before, are parked along both sides of the street. Normally about eight trucks are to be found. Retailers walk up and down the street speaking with each transportista to ask prices and the types of species he has for sale. Retailers inspect the fish for quality. As soon as the retailer has decided on the quantity and species he plans to buy that day, an agreement is reached with the transportista. There appears to be little price haggling.

Fish are rarely delivered to the suburbs by transportistas so surburban fish retailers must make their purchases in San Jose and transport the fish to their pescaderias. Many of these retailers own trucks while others rent one to transport fish to their pescaderias.

There are over 100 species of fish passing through Costa Rica's markets in the course of a year. A commercial classification system is used to group the various species (Table 4). This, in theory, facilitates the flow of fish at each marketing level by grouping various species into commercial price classes. The effectiveness of this classification system is dubious as it does not appear to be enforced at each marketing level. The cost of sorting at each level may be prohibitive. It does not pay a transportista to sort a few Corvina from 1,000 kilograms of fish, but it does pay the retailer. The classification system may become better coordinated if total supply increases. Sufficient quantities of each species would then be available thus making it worthwhile to separate them.

If fish are not sold on a given day, they are placed in plastic bags and put into storage. Storage allows retailers to plan for generally changing market conditions. It also enables them to compensate for daily changes in supply and demand so they are able to meet consumer demands at relatively stable prices. This in turn increases price stability and demand at lower marketing levels. Fresh fish retailers use large insulated ice boxes (neveras), refrigerators and freezers for storing their products.

The average firm has roughly 1300 kilograms of total storage capacity. The smallest storage capacity for a firm is 136 kilograms while the largest has 4540 kilograms. Thirty-six percent of the total storage capacity for the 35 firms interviewed is attributed to freezers, 47% to ice boxes, 11% to wall in coolers and 6% to refrigerators. An insignificant amount of storage may occur in meat coolers. The total storage capacity for the firms interviewed is 47,000 kilograms. Sixty three percent of the total storage capacity for all firms is located in San Jose. The average storage capacity for firms in San Jose is 1480 kilograms versus 1220 kilograms for the average firm in the surburbs.

TABLE 2

MONTHLY FISH LANDINGS ALONG THE PACIFIC COAST
Two Year Averages 1969-1974

Months	1969-70	1971-72	1973-74
	----------metric tons----------		
January	115	124	196
February	112	137	174
March	165	179	236
April	140	154	230
May	133	140	265
June	133	157	225
July	121	138	228
August	112	136	257
September	104	115	136
October	106	121	225
November	112	161	203
December	141	178	261
Total	1,494	1,746	2,686

Source: Department of Marine Fisheries, Costa Rica. Excludes sardines, tuna, and shrimp.

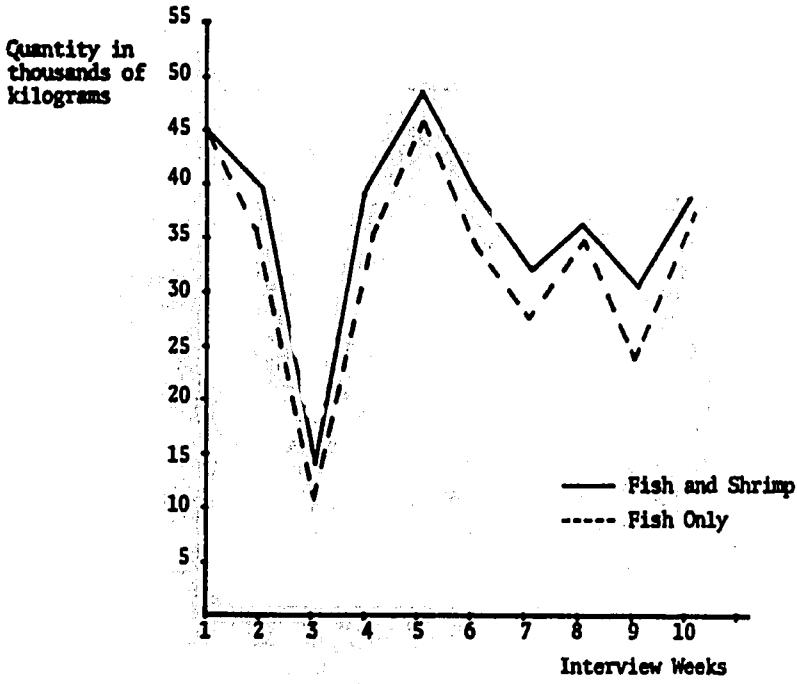

Figure 1 --Total estimated weekly quantities of fish purchased by fresh fish retailers (July 2 through October 10, 1976).

Source: Personal interviews.

TABLE 3

PRODUCT COMPOSITION BY SPECIES
(July-Oct. 10, 1976)

Species	Total Sample Quantities in Kilograms	Composition of Weekly Supply of Fisheries Products
White Shrimp	343	.006
Medium Shrimp	925	.017
Titi Shrimp	2,595	.048
Corvina Reina	423	.008
Corvina Grande	6,599	.122
Corvina Pequena	3,671	.068
Corvina Agria	3,878	.072
Primera Pequena	1,050	.019
Mackerel	911	.017
Durado	2,997	.055
Segunda	10,323	.191
Clasificado	3,182	.059
Cazon or Bolilo	5,430	.100
Cola	6,895	.127
Jurel	740	.014
Posta Blanca	1,638	.030
Posta Negra		
Pargo Grande	102	.002
Pargo Pequena	1,807	.033
Robalo Grande	125	.002
Others	541	.001
Total Sampling*	54,174	100%

*Average for 10 weeks.

Source: Personal interviews.

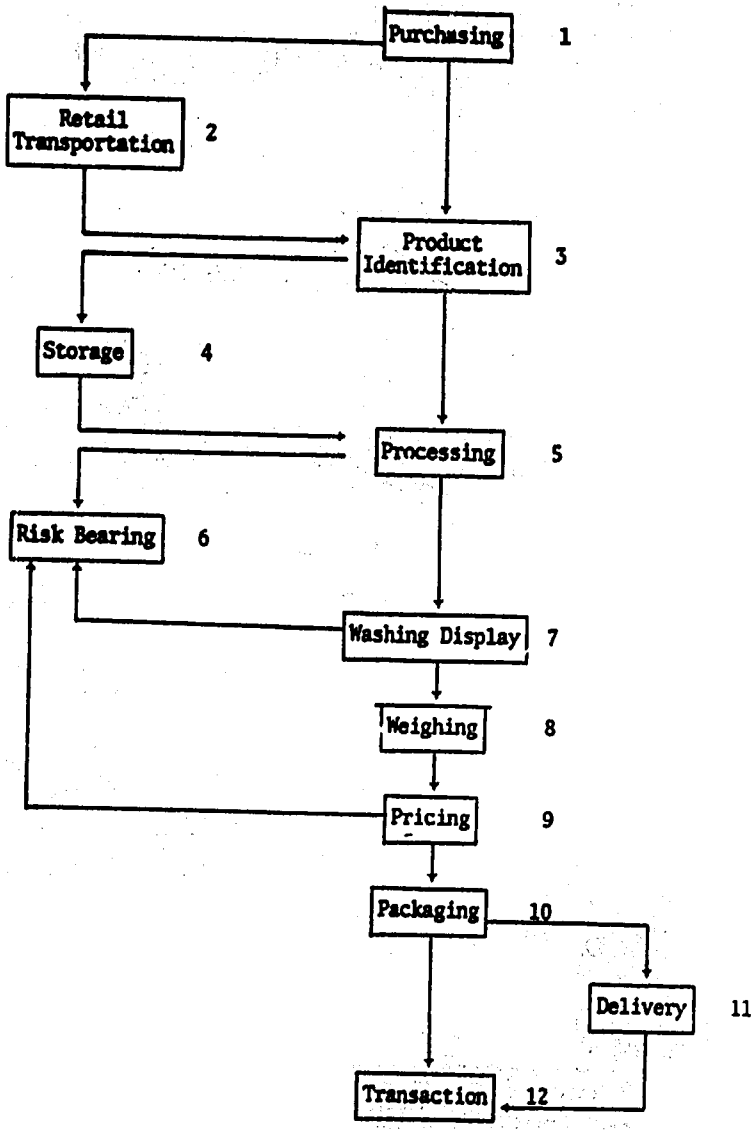

Figure 2. --Flow of retail services

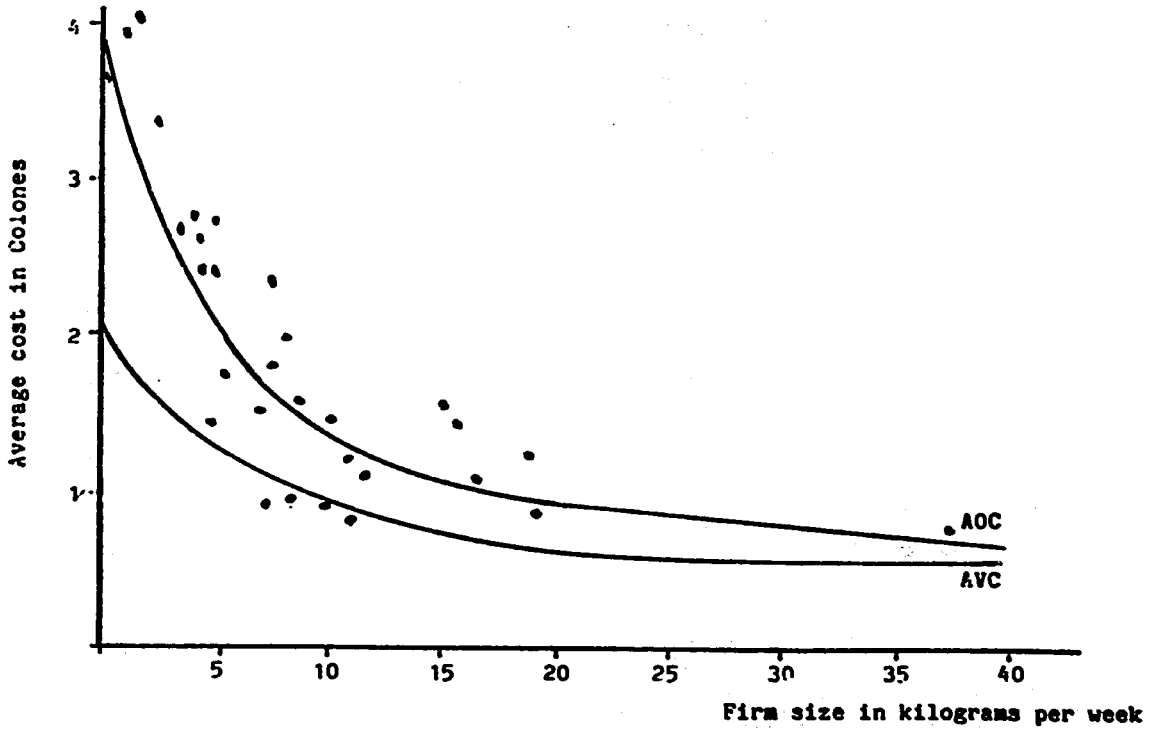

Figure 3 Economies of scale

TABLE 4

THE COMMERCIAL CLASSIFICATION SYSTEM IN COSTA RICA
(Principal Species)

Species	Common Names	Market Class
Cynoscion squamipinnis	corvina aguada	1° pequena only
Cynoscion albus	corvina reina, chola	1° grande or pequena
Cynoscion stolzmanni	corvina coliamarilla	1° grande or pequena
Cynoscion phoxocephalus	corvina picuda	1° pequena only
Centropomus undecimalis	robalo, gualaje	1° grande or pequena
Centropomus unionensis	mano piedra	1° pequena or chatarra
Lutjanus jordani	pargo rojo	1° pequana
Lutjanus colorado	pargo rojo	1° pequena
Lutjanus guttatus	pargo de la mancha	1° pequena, cola or clasificado
Lutjanus novemfasciatus	pargo negro	1° pequena or chatarra
Lutjanus argentiventris	pargo rojo, coliamarillo	1° pequena or chatarra
Lutjanus aratus	pargo jilguero	1° pequena or chatarra
Haplopagrus guntheri	pargo roquero	
Micropogon altipinnis	corvina agria	cola, agria, chatarra
Ophioscion spp.	corvina china	chatarra
Paralonchurus dumerlii	corvina cinchada	chatarra
Menticirrhus sp.	corvina zorra	clasificado, chatarra
Anisotremus pacificus	vieja	chatarra
Anisotremus dovii	vieja	chatarra
Scomberomorus maculatus	macarela	clasificato, cola
Haemulon leuciscus	roncador	chatarra
Rhizoprionodon longurio	tiburon bahia	cazon/bolillo
Carcharinus porosus	tiburon aleta negra	cazon/bolillo
Sphyrna spp.	cornuda, martillo	cazon/bolillo
Arius spp.	cuminate	cola
Bagre spp.	bagre	cola

The market classes primera (1°) grande and primera pequena include many of the same species. To be classified as primera grande the fish must weigh 2.3 kilograms or more. If sharks weigh 9 kilograms or less they are classified as cazon/bolillo.

Source: Depto. de Pesca Maritima, Puntarenas, Costa Rica

Retailers purchase eviscerated fish, fish which has had its gills removed and which has been gutted, for resale. Shark and a few other species are purchased as postas which are large sections of skinned fish usually weighing nine kilograms or more. The eviscerated fish is then processed into either fillets or steaks (chuletas). Some are sold in the same form as they are purchased. Most of the fillets are cut from the more expensive species or commercial groups. The yields on fillets are about 42 percent so a bit more than a kilogram of eviscerated fish is required to obtain one pound of fillets. This percentage varies slightly according to size and species. Steaks are sections of the fish formed by making vertical slices through the fish and its back bone. Each slice is about an inch thick. The yield on steaks is about 66 percent. One and a half pounds of fish is needed to obtain a pound of steaks. On larger fish, the upper portion of the body may; be cut into steaks and lower portion filleted. Large posta is cut, trimmed and sold in smaller pieces as posta. The yield on posta varies from 70 to 80 percent. Losses are attributed to trimming and shrinkage.

Each morning counters and windows are washed. Large blocks of ice, weighing 100 pounds, are purchased and chiseled into blocks about two inches thick. These are placed on the counter in front of a window. This is then covered with white, waxy paper. Fish to be put on display is washed and damaged areas are cut away. It is then neatly stacked on the waxy paper. Each product group is displayed in a separate pile with an identification marker and price nearby. This action familiarizes consumers with the various fish products and allows inspection for quality.

Once the customer has decided on the product and amount he desires, it is weighed. Weighing establishes a uniform measurement which is a basic necessity for efficient marketing. This standardization simplifies price comparison and the assembly process by permitting the grouping of similar species early in the marketing process.

Retail prices are either listed on the widow or communiated verbally. Prices are fixed for the day. There is no price haggling and prices do not decline toward the end of the day. Prices may vary among retail outlets even when these outlets are located in the same market and are selling the same product. These variations may be attributed to differences in quality. On occasion, retailers put fish on sale to attract new customers, reduce overstocking or to avoid spoilage.

Once the sale has been agreed upon, the product is removed from the scale and packaged. Fresh fish retailers in Costa Rica first wrap the fish in a piece of white, waxy papaer similar to that used in U.S. deliatessens, and then again in newspaper. Many retailers then place this neatly folded package in a plastic bag, so that it can be easily stored in the customer's basket.

Several pescaderias provide delivery service to their established customers. This is more common among wholesalers than retailers. Youths are hired to perform this service. The fish are placed in baskets attached to their bicycles and delivered at no charge.

A trasaction is the termination of the marketing system or the moment when the consumer takes possession or the product. It is at this point that the system has fulfilled its purpos It has successfully identified demand and stimulated production to meet this demand.

II. Market Structure

One of the prerequisites for the formulation of a constructive fisheries development program is the capacity to relate existing market structure to market performance. The structure of the market influences the character and intensity of the competition within that market. It influences, and is in turn influenced by market performance and conduct. This is clearly supported by price theory which distinguishes different types of markets and industries on the basis of their structure and provides some definite hypothesis

concerning the association of market structure to performance. Specifically, it suggests that the size of the profit to cost ratio increases as the structure of an industry deviates from that of atomistic competition.

Dimensions of market structure which are commonly idetified as influencing performance are: conditions of entry; the extent of product differentiation; economies of scale; and seller concentration. This chapter will utilize three representative firms identifying and analyzing the above mentioned components of the existing retail market in Costa Rica. The performance and efficiency of the representative firms are evaluated later in this chapter. The three firms were selected for the following reasons:

1) the owners were cooperative, thus reliable information could be obtained;

2) the firms are of different sizes so each is operating on a different region of the industry's average cost curve;

3) the location of each firm reflects the different environments in which fish retailers operate; and

4) each firm handles a different product mix.

A. Conditions of Entry

Conditions of entry refer to the relative ease or difficulty that new firms encounter in entering an industry. If barriers are high, existing firms have the opportunity to increase their profit positions by expanding to meet market needs and securing prices over their competitive price level without inducing entry. Conditions of entry can best be understood by describing each of the representative firms and the circumstances under which each started in business.

Firm #7 is located in the busy San Jose Central Market. The shop is entered directly from the street, employs two plus the owner, has approximately 1,000 kilograms of storage capacity and has been in operation for four years. The estimated average weekly quantity purchased[3] is 721 kilograms and average total weekly revenue is estimated at ¢7,290.00.[4] When the owner started in business he paid the municipality two months' rent in advance plus a small fee for a retail license. The previous owner was paid for the physial facilities and for the "Derecho de Llave" (right of kev).[5]

Once the existing floor space and physical facilities had been purchased, the premises had to be reconstructed to suit specifications for selling fish. Principal reconstrution costs were the installation of electricity and the construction of shelves and a dispaly area. The owner paid 50,000 or the original facility and remodeling and ¢1,865 in advance for two months' rent. The original purchase price of the "Derecho de Llave" is not known, but the owner claims that its present value is ¢250,000. The replacement value of equipment currently owned by the firm is approximately ¢32,000 (Table 5). The owner speculated that the firm is presently worth in excess of ¢353,000 (Table 6).

Firm #21 is located in San Jose, two blocks from the central market, in the privately owned Mercado Bourbon. The owner has been in business for 24 years and presently has three employees. Weekly purchases are about 1,800 kilograms and weekly sales 8,200. There are 1,600 kilograms of storage capacity and one ice maker. The owner estimated that the investment 15 years ago when operations were moved to their present location, was approximately ¢70,000, which included the cost of the equipment. ¢10,000 colones more was paid for the "Derecho de Llave." No estimates were given of the present value

TABLE 5

PRICES OF EQUIPMENT USED BY FRESH FISH RETAILERS

Type of Equipment	Capacity	Untaxed Value	Tax 8%	Sales Price
	cu.ft.	----------colones----------		
Freezer	7	4,675	374	5,050
Freezer	10	6,850	548	7,400
Freezer	13	7,475	598	8,073
Freezer	19	10,875	875	11,750
Freezer	31	11,225	898	12,123
Freezer	31	11,500	870	12,420
Second hand icemaker	225 lbs/day	10,000		10,000
Flaked icemaker	300 lbs/day	16,204	1,296	17,500
Glass meat cooler		20,648	1,652	22,300
Clock scale				4,150

TABLE 6

NET WORTH OF SELECTED FIRMS

	#38	#7	#21
	----------colones----------		
Facility purchase price	5,144[a]	79,743[a]	30,000[b]
Construction and remodeling costs	71,589[a]		30,000[b]
Replacement value of equipment	21,775[c]	35,350[c]	18,300[c]
Net worth (physical)	98,478	112,093	98,300
Value of the "Derecho de Llave"	37,840[a,b]	250,000[b]	d
Replacement value of the firm	136,318	362,093	

[a]Prices have been inflated to reflect their real value using the consumer price index; source, The International Monetary Fund, mid to low income group.

[b]The present value for these items was estimated by the owners.

[c]The replacement value of equipment is from prices gathered from equipment dealers in Costa Rica.

[d]The present value of the "Derecho de Llave" is not known (the owner paid ¢10,000 for it 15 years ago).

of the "Derecho de Llave" or the firm's preset value. If the owner were to replace his shop today, his initial investment would be approximately ¢80,000 plus the present value of the "Derecho de Llave." The replacement value of the equipment is estimated at ¢18,300.

The third firm, #38, is located in Heredia, a city about 20 kilometers from San Jose. At the time the survey was conducted the firm had been in existence for six months and employed two plus the owner. Weekly purchases were 400 kilograms. The cost of equipment was about ¢21,775. The owner paid about 5,000 for the original facility, ¢70,000 for the remodeling, and ¢37,000 for the "Derecho de Llave." The owner's total investment in the firm was said to be over ¢120,000.

In summary, the potential retailer rents the space from the municipality, and pays the previous owner for the facility and the "Derecho de Llave." The value of the "Derecho de Llave" varies acording to location. In addition, the new owner pays the costs of remodeling and purchasing equipment.

The above figures are intended to provide insight into the types of costs and amounts that must be invested to purchase an existing firm or start a new operation. The figures are not the actual amounts of money that a potential fish retailer must contribute out of his own pocket to start a new business. Operations may begin with very little equipment and be expanded gradually. Also, loans are available from the Banco Central de Costa Rica and credit for the purchase of equipment is extended by equipment retailers (Table 7).

At the time of the study, loans for the development of small businesses were ot available, but they do exist. The maximum that could be borrowed was 150,000. Repayment periods range from five to te years depending on the type of loan and collateral. The banks request that the borrower have enough collateral to cover 60 percent of the loan. Interest rates range from 12 to 16 percent depending on the amount of collateral and risk.

B. Product Differentiation

Product differentiation refers to the extent to which customers differentiate, distinguish, or have specific preferences among the competing outputs of various sellers in an industry. The distribution of buyer preference is important as it allows sellers to systematically obtain different shares of the market which influences firm size and efficiency. The degree of product differentiation is also an indication of the seller's ability to exert control over the prices of products he sells.

All of the outputs in the fish retailing industry are at least close substitutes but they are not perfect substitutes. This is clearly demonstrated by existence of a complex pricing structure within the industry. Retailers are able to distinguish their operations by catering to specific income groups and consumer tastes. The types of consumers that a firm caters to determines the species and prices of products it sells. Firms generally have from three to eight species or commercial groups for sale on a given day. The manner in which the firm selets the species and cuts of products it sells (the product mix) influences the firm's operation, costs, total revenue and profits. The composition of the product mixes for each of the three representative firms is presented in Table 8.

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[3]Estimates of average weekly quantities purchased and average weekly revenues are derived below.

[4]Prices, reveues and costs are presented as Colones: 8.54 = one U.S. dollar.

[5]The "Derecho de Llave" is similar to "goodwill."

TABLE 7

CREDIT TERMS FOR RETAIL EQUIPMENT

Type of Equipment	Repayment Period	Price Using Credit	Tax	Total Price	Monthly Payment
	- months -	colones			
20 cubic ft. Freezer	12	6,121	431.20	6,552	504
	18	6,484	431.20	6,916	364
	24	6,846	431.20	7,278	291
31 cubic ft. Freezer	12	13,820	937.60	14,794	1,138
	18	14,635	937.60	15,609	822
	24	15,456	937.60	16,430	657

Source: Koberg Co., San Jose, Costa Rica.

TABLE 8

THE PRODUCT MIX FOR SELECTED FIRMS

Type/Firm	#38	#7	#21
	%		
Large Shrimp			
Medium Shrimp	8	9	
Small Shrimp		6	
Corvina Grande	20	2	4
Corvina Reina			
Corvina Pequena		8	
Corvina Agria	8		5
Primera Pequena			2
Macarela		14	
Dorado	24		
Segunda	19	14	42
Clacificado	17	6	7
Cazon or Bolillo			6
Cola		41	31
Jurel			3
Posta Blanca	4		
Posta Negra			
Pargo Grande			
Other			
Total	100	100	100

Source: Personal interviews, June-October 10, 1976.

Differences in product mixes are more revealing when the average selling prices for the various products sold by each firm are weighted according to their importance in the product mix. The weighted average selling price for the jth firm ($\bar{p}j$) is calculated as:

$$P_j = \sum_{k=1}^{20} PC_k \cdot p^*_{jk}$$

where PC_k is the perentage of average weekly puchases by the jth firm attributed to species K, and P^*_{ij} is the weighted average selling prices of the kth species charged by the jth firm P^*_{ij} is calculated as follows:

$$\bar{P}_{ij} = \sum_{L=1}^{3} Q_{jkl} / \sum_{K=1}^{20} Q_{jk} \cdot P_{jkl}$$

where L is the cut in which each species is sold: fillets, steaks and/or eviscerated (L=1,2,3). The weighted average selling price per firm takes into account that: 1) the final quantities of each species and the quantities of each cut sold by each firm are not known; 2) the individual retailers may sell identical produts at different prices; 3) prices must be adjusted to whole weight equivalents; and 4) product lines differ among firms.

The weighted average selling price per kilogram was ¢10.90 for firm #38 and ¢10.10 for firm #7 and ¢5.60 for firm #21. Seventy percent of the fish and shrimp handled by firm #38 was priced at ¢7.55 or higher per kilogram, 45 percent of the products handled by firm #7 sold for ¢7.55 or more per kilogram and only 18 percent of the products handled by firm #21 sold for 7.55 or more per kilogram. Seventy-five percent of the products handled by firm #21 were priced at ¢5.50 or less per kilogram.

Retailers engage in multi-product marketing of particular fish products because these products an be efficiently sold to the same customer groups and because these groups can be most economically reached through a single market embracing diverse products.

Retailers also influence consumer preferences to purchase from specific retail outlets by providing different degrees and types of service. Credit ad delivery are two examples. Product freshness is another consideration influencing consumer preference to shop at specific retail outlets. Most retailers try to carry the freshest product possible but the degree of freshness is to a large part dependent on supply. If the fish or shrimp offered by wholesalers is not fresh or of good quality, retailers cannot sell a wholesome product. When supply or consumer demand is low, retailers may be forced to hold fish for longer periods of time than they desire. Product freshness, the width and composition of the produt mix, the types of retail services provided, the firm's reputation, the owner's personality and location are all factors influencing customer preference, firm size and the firm's ability to exert some control over its prices.

C. Firm Size

Before the question of seller concentration and economies of scale can be adressed, it is necessary to derive some measure of each firm's size.

Firm size will be measured by (1) estimating the average weekly quantities purchased[6] by each firm in the sample and (2) by estimating each firm's average weekly revenue during the periods sampled. Shrimp is included when estimating firm size because it is reasonable to assume that firms handling shrimp would attempt to maintain their size by purchasing and selling greater quantities of high priced fish if shrimp were not available. Including shrimp

in firm size also facilitatea the estimation of economies of scale. It would be difficult to separate out only those costs which are associated with the retailing of shrimp.

The average weekly quantity purchased by the jth firm FS_j is calculated by multiplying the estimated frequency of weekly purchases for the jth firm (Fj) by the average quantity purchased by the jth firm (Q_j) such that

$$FS_j = F_j \cdot \bar{Q}_j \ .$$

The estimated frequency of weekly purchases is calculated as follows:

$$F_j = \sum_{j=1}^{29} Pd_j \sum_{j=1}^{29} I_j \ 6$$

where Pd is the number of days on which the jth firm reported having made a purchase, I is the number of days on which the jth firm was interviewed, and 6 is the maximum number of days in the week on which firms are able to purchase fish.

The average quantity purchased by the jth firm $\bar{Q}_j$, is calculated as

$$\bar{Q} = \sum_{j=1}^{29} Q^*_{j,k} \sum_{j=1}^{29} Pd_j$$

where Q^*_j, is the total number of kilograms of each species recorded as having been purchased by the jth firm.

The estimates of firm size derived above and those obtained directly from the owners on the structural questionnaire were correlated with cost data to determine which set of figures appeared to be most reasonable. Estimated firm size proved to be more highly correlated with cost and will be used in this study. It is not argued that these estimates are completely accurate but they appear to be the best available, can be correlated with costs and provide a cross-sectional view of the industry for a period of time.

Firm size may also be measured in terms of average weekly revenue. Average weekly revenue for the jth firm (TRj) is estimated as

$$TRj = FSj \cdot \bar{P}j$$

where FSj is calculated as above and $\bar{P}j$ is the weighted average selling price for the jth firm as calculated earlier in this chapter.

Firm size measured both in terms of average weekly quantities puchased and average weekly revenues are presented and discussed in the section on economies of scale.

A detailed description of firm size and its significance to market structure and performance is presented in the following sections.

D. Economies of Scale

Economies of scale are defined as reductions in cost per unit of products manufactured and sold associated with the operation of large as compared to small production, distribution and merchandising entities (Sherer, 1974).

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[6]The quantity of output which is normally used in estimatng firm size cannot be calculated as data on the amount of fish processed by each firm is not available.

Economies of scale, given that they exist, significantly affect market structure and performance by influencing seller concentration and firm size through efficiency. In any industry, the output of the optimally sized firm, that which operates at the lowest average cost, will determine the degree of seller concentration needed for reasonable efficiency. If a firm needs only to supply a negligible fraction of industry output, economies of scale present no deterrent to entry. If a firm must add significantly to industry output to be reasonably efficient, economies of scale retard entry. In this situation existing firms can raise prices above the competitive level without attracting entry. Entry by new firms would put downward pressure on existing prices. Entry at a smaller scale would leave the entrant at a significant cost disadvantage.

A statistical approach is used to determine whether economies of scale exist. To facilitate analysis, total cost is separated into operating and purchasing costs. Operating costs are those costs over which the individual firm has a large degree of control (e.g., labor and storage costs). Purchasing costs are the costs of purchasing fish and shrimp. Purchasing costs are not controlled by individual firms. They reflect the collective actions of all fish retailers.

Attempts to correlate average total cost with average weekly quantity purchased per firm yielded no satisfactory results. This can be explained by the fact that the weighted average purchasing cost per firm, which accounts for approximately 80 percent of the industry's total cost, is not consistent among the various sized firms. Products sold by fresh fish retailers in Costa Rica are not homogeneous, so the magnitude of purchasing cost is more a function of the composition of the product mix than the quantity purchased. The inclusion of purchasing cost reflects differences in the costs of product mixes and not differences in the average cost. Therefore, we study operating and purchasing costs since product lines are not homogeneous across firms.

The statistical technique used in testing the hypothesis that economies of scale exist in fresh fish retailing utilizes cross-sectional cost data collected on the structural questionnaire for 29 firms. Each firm's operating cost was divided by its estimated average weekly quantity purchased to obtain average operating cost (AOC). Average operating costs were then correlated with estimated average weekly quantities purchased (FS) using ordinary least squares (OLS).

The regression equation was attempted using natural log and a quadratic in its structural form. The log form

$$\text{Log (AOC)} = \underset{(7.58)}{3.91} - \underset{(-6.57)}{.52} \text{ Log} \qquad R^2 = .61$$

yielded the best results. Examination of Figure 4 reveals that over the range of firms interviewed, none appears to have reached or surpassed minimal optimal size (i.e., the point where average cost for the industry is at its minimum). Because of this, the average operating cost curve is not the familiar U shaped curve.

The above equation shows that economies of scale are potentially significant in influencing the structure and performance of the Costa Rican fresh fish retailing industry. As firms increase in size from purchasing 100 to 1,000 kilograms of fish per week, average operating cost decreases from ¢3.60 to ¢1.33 per kilogram. This cost decreases most rapidly as firm size approaches 500 kilograms per week. Expansion from 100 to 500 kilograms per week results in a 44 percent reduction in average operating cost. Between 500 and 1,000 kilograms per week, average operating cost drops by 33.5 percent. As firms handle 1,000 kilograms or more per week, this cost continues to decrease but at a decreasing rate. Expansion in firm size from 100 to 1,000 kilograms results in a ¢2.27 reduction in cost whereas expansion from 1,000 to 2,000 kilograms only results in a ¢.34 cost reduction. Thirty-four

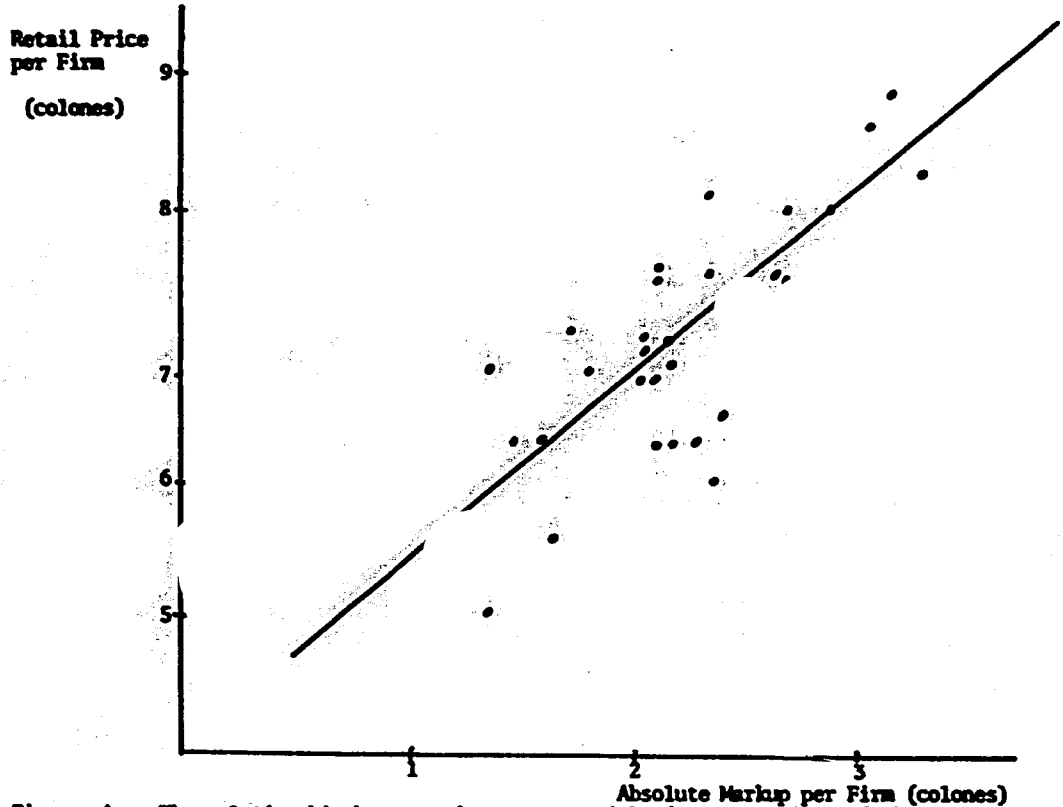

Figure 4. --The relationship between the average weighted retail price and absolute markup per firm.

percent of the firms sampled handle 500 or less kilograms per week; 76 percent were smaller than 1,000 kilograms and 96 percent were smaller than 2,000 kilograms. The largest firm which handled 3,800 kilograms per week had an average operating cost of ¢.72.

Economies of scale can be further analyzed by separating operating cost into its component costs: variable cost and fixed cost. Variable cost includes the costs of ice, electicity, packaging, labor and retail transportation. The owners' salaries are not included as estimates of their opportunity costs are not available. Components of fixed cost are rent, depreciation, utensils, and the operating license.

The correlation of average variable cost (AVC) and firm size is best expressed by using the form

$$\text{Log (AVC)} = \underset{(3.00)}{2.16} - \underset{(-2.89)}{.31} \text{ Log (FS)} \qquad R^2 = .24$$

Examination of Figure 4 reveals that average variable cost, indicated by the dotted line, decreases as firm size increases. The magnitude of this decrease is less than that for average internal cost. Average fixed cost, the area between the two curves, decreases at a greater rate and over a wider range before starting to level out than does average variable cost. This indicates that reductions in fixed cost are greater than corresponding reductions in variable cost. Firms do not have to proportionately increase fixed cost as they expand.

Explanations for the reduction in average operating cost are:

1) retail transportation cost does not increase with quantity purchased;
2) specialization increases the efficiency of labor;
3) greater quantities increase the efficiency of ice and electricity used in storage;
4) larger firms maintain proportionately less storage capacity; and
5) average fixed cost is inversely related to firm size.

Comparison of the costs of principal species purchased by various sized firms reveals that larger firms do have a stronger bargaining position which is reflected in their paying less than smaller firms for the same product. If these savings could be incorporated into the average operating cost curve, economies of scale would be greater. Larger firms also receive preferential treatment when the supply of fish is low.

One cannot, on the basis of the above analysis, conclude that firms in this industry are not competitive or efficient merely on the basis that they are not of optimal size. Stigler (1958) addresses the question of optimal size by the so called "Survivor Test" in which he states that an efficient firm size "is one that meets any and all problems the entrepeneur actually faces: strained labor relations, rapid innovation, government regulation, unstable foreign markets, and what, not."

E. Seller Concentration

Concentration refers to the ownership or control of a large portion of some aggregate of economic resources or activity, either by a small portion of the units which own or control the aggregate or by a small absolute number of such units (Bain, 1959, p. 89).

Seller concentration can be measured in several ways but it is most pertinent to measure the size of each firm by either the value of its sales in relation to the value of sales by the industry or by the proportion of total industry output attributable to each firm. The degree of seller concentration, when so measured, provides insight into the distribution of economic power and is therefore an indication of the character and intensity of competition within an industry.

Before estimating seller concentration, adjustments must be made as each of the firms in the sample cannot be considered as separate economic enterprises. The pairs of firms numbered 17 and 18, 41 and 43, and 42 and 45 are owned by the same persons and will be considered as three firms. Estimates of firms sizes and seller concentration are presented in Table 9.

When measured in terms of quantities purchased, seller concentration (CQ) is calculated as follows: CQ = FS/TP, where TP is the estimated total purchases by the industry and is calculated as

$$TP = \sum_{i=1}^{10} \sum_{j=1}^{29} \sum_{k-1}^{20} Q_{ijk} \cdot 1/FS,$$

with S the percentage of firms interviewed in the industry.[7] Seller concentration, when measured in this manner, reveals that 20 percent of the firms account for 43 percent of the industry's purchases.

Bain (1967) states that an oligopoly situation may exist when 20 percent of the firms control one-third or more of total industry output. When weekly revenue per firm was used as a measure (CTR),[8] seller concentration is identical to the concentration ratios obtained when using quantities purchased. No difference was found in concentration when the sale of fish alone was analyzed. In all three cases, the largest 10 percent of the firms control one-third of the market. The smallest 10 percent control less than 3 percent of the market.

When contemplating the nature of competition within an industry, one must realize the character of competition is to a large part determined by the degree of concentration within each of the many individual markets, market centers and towns where fish is sold. The location of competing firms is, therefore, an important consideration influencing firm size and concentration. In all except two instances, two or more fresh fish retailers are found within a few yards of each other. As many as eight may be found in a single market. In the San Jose market district, 22 pescaderias are located within a three-square block area.

Examination of seller concentration in San Jose reveals that one firm controls 40 percent of that city's market. In Cartago, where four fish sellers are located, one firm accounted for 60 percent of the fish sales. Similar concentrations were common in other towns included in the sample.

The degree of product differentiation is another dimension to be considered when examining seller concentration and competition. Individual firms have been able to secure different segments of the market by catering to specific types of clientele. The degree to which retailers compete among themselves, therefore, varies according to the similarity of the product mixes.

Superiority by certain firms in marketing their products, the ability of larger firms to provide similar or better products which meet consumer demand at lower or competitive prices, locational advantages, differences in capabilities and goals of management and the lack of capital by smaller firms with which to expand are further explanations for the differences in firm sizes.

F. Summary

This section has been concerned with describing the structure and organization of the fresh fish retailing industry in Costa Rica. Knowledge of

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[7]Twenty-nine of the 44 firms in the industry were sampled s = .66

TABLE 9

BREAKDOWN OF QUANTITIES PURCHASED AND CONCENTRATION

Firm #	Average Kilograms Purchased Weekly	Concentration	
17,18	5341	.137	
10,34	3556	.092	
21	1758	.045	
30	1480	.039	
42,45	1350	.035	(.312)
41,43	1250	.032	
9	1014	.026	
40	987	.025	
2	945	.025	(.43)
22	896	.023	
13	865	.022	
11	816	.021	
42	786	.020	
28	752	.020	
44	729	.019	
7	721	.019	
33	712	.019	
37	699	.018	
36	690	.018	
27	600	.016	
39	580	.015	
29	575	.015	
41	560	.015	
43	500	.013	
45	500	.013	
6	452	.012	
	424	.011	
38	402	.010	
4	345	.009	
23	342	.009	
3	316	.008	
32	270	.007	
12	216	.006	
19	205	.005	
15	268	.004	

Estimated total industry quantity = 38,830 kilos.

the retail structure will enhance our ability to evaluate and interpret retail performance. The most significant features revealed in the analysis are that significant economies of scale exist and that seller concentration is high. Thirty-one percent of the industry's purchases and sales are attributed to the four largest firms.

High seller concentration and economies of scale appear to be a typical feature of the marketing structure in developing countries (Mueller, 1959, p.

$$ITR = \sum_{j=1}^{29} TFj \cdot 1/S.$$

417). Studies in Jamaica, India, West Africa and Puerto Rico suggest that food wholesaling and retailing are carried on under conditions best described as monopolistically competitive. There are several plausible explanations for this. First, the size of the market in developing countries is generally small in comparison to similar markets in the United States. This, coupled with economies of scale, would indicate the existance of fewer firms than would be found in developed economies. Secondly, capital markets in developing countries are not highly organized so it may be difficult to acquire enough capital to set up an efficiently sized firm. It may be easier to acquire smaller loans which are used to set up smaller and less efficient operations. Thirdly, the relative newness of certain industries in developing economies further explains existing patterns of seller concentration.

Product differentiation was also found to be common place in developing countries. Typically, there are a large number of retailers selling differentiated products and services. Differentiation in these countries is encouraged by the relative immobility of sellers and buyers which exaggerates the locational advantage enjoyed by certain firms. Segmentation of the populations into economic or social castes, inadequate market information and where applicable, the reliance of buyers and sellers on credit increase the potential for product differentiation in developing countries.

High seller concentration, significant economies of scale and product differentiation indicate a reduction in competition in the fresh fish retailing industry in Costa Rica. On the other hand, the relative ease of entry, when measured in terms of capital requirements, would indicate a competitive structure. If profits or prices are excessive, entry into the industry would eventualy force them to a competitive level.

III. Market Performance

Market performance refers to the composite of end results in the dimensions of price, output, cost, product design and so fourth which enterprises arrive at in any market. The identification of economies of scale, conditions of entry, product differentiation and seller concentration presented earlier provided insight into the forces influencing market performance. This section will address market performance, and efficiency by evaluating the retail marketing margin.

Retail prices are determined by consumer demand and the supply of the market. In a competitive market individual retailers do not determine consumer demand or market supply, they merely discover prices based on their knowledge of what consumers are willing to pay, current supply, the prices of substitute products and prices charged by competitors.

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[8]CTR is calculated as TFj/IRF where IRF is defined as Total Revenue for the industry:

In Costa Rica, retail prices changed from day to day. The frequency and magnitude of these changes depend on (1) the frequency and magnitude of shifts in supply and demand and (2) the relative elasticities of the supply and demand functions. The greater the inelasticity of demand and supply, the greater the degree of price change. Imperfect knowledge of supply and demand, variations in the prices of substitute products, differences in locations and quality considerations all contribute to price variations, so retail prices are in reality only approximately of equilibrium prices.

The above argument does not imply that cost considerations do not influence retail prices. A seller's decision to incur costs is based on his belief that potential buyers will be willing to pay prices that are at least sufficient to cover his costs and provide some return for his labor. His perception of the market as well as his costs influence his willingness to pay. If a retailer believes that the retail price he could obtain is too low or that wholesale prices are too high to cover his costs, he will not purchase that product. The costs incurred in providing marketing services therefore influence supply. Prices at both the retail and wholesale levels are in the long run directly influenced by the cost of retailing.

Price wars are common, especially in San Jose's central market. One retailer is believed to establish his selling prices by undercutting the prices of his local competitors by ¢1.00 per kilogram on fillets and by lesser amounts on less expensive fish. Price wars occur in "fits and starts" but do not appear to result in the destruction of any of the firms involved. Such wars create peridic downward pressures on the retail margin and prices.

The reason for this description of retail prices and costs has been to demonstrate that retailers in a competitive industry do not set a retail price by calculating the desired return and adding it to the cost incurred. Retail prices are not determined by the individual's costs but rather by the costs incurred by the industry and the prices charged by competitors. Retail prices increase in response to a change in costs only when the cost increase are experienced by the whole industry.

Each morning retailers make purchases outside the central market. If a retailer makes a purchase and later discovers that he is unable to sell the product at a desired margin he will be forced to lower his price. He will take this into account and pay less for his next purchase or exercise the option of not buying until wholesale prices fall. Demand at the wholesale level therefore consists of consumer demand minus a schedule of the retail margins. If the retail margin is a flat absolute amount, the derived wholesale demand schedule has the same elasticities as the consumer demand curve. If the retail margin is calculated as a percentage mark-up over wholesale prices, the elasticities of demand are greater for corresponding quantities at the wholesale level. The nature and size of the retail margin, therefore, influences wholesale prices.

The supply curve to the retail market, which is derived from the fishermen's supply curve by adding the appropriate wholesale margin, indicates the various quantities of fish that wholesalers are willing and able to supply at various prices. The costs of providing wholesale services are included in this schedule. Wholesale prices are established at the intersection of the retail demand and wholesale supply curves.

Fluctuations in wholesale prices are caused by the same factors that influence retail price changes. Additional considerations influencing prices at this level are terms of sale, time of day, differences in quality and the size of the sale.

In summary, prices at each marketing level are continuously adjusting to account for changes in demand, supply and marketing costs. These price changes direct the production, distribution and consumption of fish.

B. Retail Margins

Retail fish marketing in Costa Rica involves the handling of many species or commercial groups, each of which has a unique price structure, composes a different percentage of each firm's product mix and may be sold in three cuts. When attempting to identify and evaluate retail margins, one must weight margins for individual products according to their relative importance in the firm's product mix. Weighting takes account of not only differences in each firm's price and margins but also differences in the relative volumes of high and low priced products sold. Evaluation of the margins for the selected firms will be more revealing if the reader has knowledge of the economic importance of the various species and cuts sold by the industry.

Retail margins differ among individual species and cuts. The size of the margin is a function of the species' retail price, its purchasing cost, the prices of close substitutes and the cut in which the product is sold. The structure questionnaire made inquiries into how retail margins for individual fish products are determined. Retailers were given hypothetical retail prices for specified species and cuts and asked the maximum they would purchase that species for if they were to sell it for the price given. For example, retailers responded that if they were to sell corvina grande fillets for ¢17.65 per kilogram, the maximum they would purchase eviscerated corvina grande for is ¢7.15. If a 43 percent yield is assumed and heads are sold for ¢2.20 per kilogram, the absolute markup is ¢1.70. The percentage markup is 24 percent. Ten percent of the consumer dollar spent on corvina fillets is retained by the retail sector. When asked the maximum they would pay to purchase chatarra, if they were to sell it for ¢3.30 per kilogram, the average response was ¢2.10. The absolute and percentage markups for chatarra are ¢1.20 and 58 percent. Thirty-seven percent of the consumer dollar spent on chatarra remains in the retail sector.

In order to determine the economic significance of processing, weighted average retail margins for fillets, steaks adn eviscerated fish of all species have been calculated (Table 10). The composition of the supply of fish offered for sale to consumers was found to be 48 percent fillets, 12 percent steaks and 40 percent eviscerated. The absolute markup for fillets is ¢1.70. The percentage markup is 13 percent, and 24 percent of the consumer dollar spent on fillets is retained by the retail sector. Markups on the other two cuts are higher. The absolute retail markups are ¢3.50 per kilograms on steaks and ¢2.40 on eviscerated fish. The percentage markup on steaks is about double the percentage markup on fillets.

Wholesale and retail prices collected on the performance survey have been used to calculate retail margins for individual species and cuts. For those species which are processed into fillets and steaks, retail prices have been adjusted to eviscerated weight equivalents to compensate for differences in processing yield. Additional adjustments were made in retail prices if by-products accrue during processing. The eviscerated weight equivalent prices for fillets and steaks from corvina reina, corvina grande and corvina agria have been increased, as heads from these species are sold for ¢2.20 per kilogram.[9] The differences between their adjusted retail value and their wholesale cost are the retail margins for these species. Information on retail margins and markups by species is presented in Table 11.

Analysis of retail margins for individual products using data collected on both the performance and structural questionnaire resulted in similar conclusions. The size of the absolute markup increases as retail prices

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[9]Heads are assumed to represent 25 percent of the weight of eviscerated fish.

TABLE 10

RETAIL MARGINS BY CUT
(All Species)

Cuts	Weighted Average Whole Weight Selling Value Per Kilogram	Weighted Average Purchase Price Per Kilogram	Absolute Markup (Marketing Margin)	Percentage Markup	Percentage of the Consumer Dollar Going to Retailing
Fillets	¢6.95	¢5.26	¢1.70	32	24
Steaks	¢8.90	¢5.42	¢3.48	64	39
Whole	¢6.57	¢4.16	¢2.41	58	37

TABLE 11

RETAIL MARGINS BY SPECIES

Species	Weighted Average Whole Weight Selling Value Per Kilogram	Weighted Average Purchase Price Per Kilogram	Absolute Markup (Marketing Margin)	Percentage Markup	Percentage of the Consumer Dollar Going to Retailing
Large Shrimp	¢70.26	¢59.90	¢10.30	17	15
Medium Shrimp	¢44.63	¢34.04	¢10.59	31	24
Small Shrimp	¢18.10	¢12.86	¢5.24	41	29
Corvina Reina	¢11.47	¢7.99	¢3.48	44	30
Corvina Grande	¢10.80	¢8.62	¢2.18	25	20
Corvina Pequeña	¢9.06	¢6.39	¢2.67	42	29
Corvina Agria	¢8.29	¢4.46	¢3.83	86	46
Primera Pequeña	¢8.52	¢6.58	¢1.94	29	23
Macarela	¢7.72	¢4.76	¢2.96	62	38
Dorado	¢8.73	¢4.93	¢3.80	77	43
Segunda	¢4.34	¢2.46	¢1.88	76	43
Clacificado	¢7.55	¢4.86	¢2.69	55	36
Cazon o Bolillo	¢6.01	¢5.36	¢ .65	12	11
Cola	¢5.50	¢4.93	¢ .57	12	10
Jurel	¢4.33	¢2.68	¢1.65	62	38
Posta Blanca	¢7.78	¢4.24	¢3.54	83	45
Posta Negra	--	--	--	--	--
Pargo Grande	¢9.28	¢6.83	¢2.54	36	27
Pargo Pequeña	¢6.53	¢4.93	¢1.60	32	24
Robalo Grande	¢8.70	¢8.08	¢ .62	8	7
Others	¢8.45	¢4.74	¢3.71	78	44
Weighted for all Species	¢8.88	¢6.25	¢2.62	42	30

increase while the percentage markup decreases as retail prices increase. The percentage of consumer dollar going to retailing also decreases as retail prices increase. Part of this can be explained by the fact that a larger proportion of the more expensive fish is processed and sold as fillets, which have lower percentage markups.

The relation between the price and cost of a product varies in a multi-product firm. Retailers may choose to price each product by itself or to price the product mix as a whole. In either instance, the retail margin differs for each product. There is not a single margin, even for individual products, which retailers use in determining their selling price. Retailers change their margins from day to day because they attempt to maintain stable retail prices. Consequently daily changes in wholesale prices would make the use of a fixed margin difficult. Each firm appears to have a host of customary margins which is used in determining retail prices. Each margin is the result of past competitive experience, genuine decision making and knowledge of consumer demand.

Weighted average selling prices and purchase prices for the various product mixes along with information on retail margins for each firm included in the performance survey are presented in Table 12. The percentage markups for individual firms range from 24 to 73 percent. The mean percentage markup per firm is about 45 percent. No correlation was found when the percentage markup was plotted against weighted average selling price per firm or firm size. Absolute markups per firm range between ¢1.40 and ¢.4.40. Correlation of absolute markups per firm with weighted average selling prices per firm shows that the absolute markup increases by approximately ¢.70 for each colone that retail prices increases (Figure 5).

The weighted average selling volume and purchase price for all species and cuts handled by the industry are ¢8.88 and ¢6.26, respectively. The weighted average absolute markup for the industry is ¢2.62. The weighted average percentage markup is 42 percent, and 30 percent of the consumer dollar spent on fish is retained by the retail sector.

Retail prices and margins are an indication of marketing performance only when the costs of providing retail services are considered. The cost of fresh fish retailing to consumers in Costa Rica can only be evaluated by examining the costs of resources used in retailing and profits retained by industry. Breaking down the margin is a small step toward appraising it because the figures tell little about the feasibility of reducing marketing costs or about the efficiency with which these resources are used. This study will assume that firms, subject to the constraints imposed upon them by their size, utilize resources efficiently. Fresh fish retailers compete among themselves and with other industries so the prices they pay for inputs must be competitive. Also, the profit motivation encourages the efficient use of these resources. Therefore, if the cost of retailing is excessive, this will be reflected by excessive returns to management and capital.

Before addressing the question of retail performance, the following discussion will familiarize the reader with the types and costs of resources used in fresh fish retailing (refer to Table 13).

Labor. Fish retailing is a service and as might be expected is rather labor intensive. Labor is involved in performing every service provided by retailers. The number of employees per firm ranges from one to seven. The average salary is ¢185.00 per week. In addition to salaries, most retailers pay social security which is equal to 13.5 percent of each employee's salary. There are economies of scale associated with the increased employment of

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[10]Average labor cost is understated as it does not include any return to management.

TABLE 12

RETAIL MARGINS BY FIRM

Firm Identification Number	Weighted Average Whole Weight Selling Value Per Kilogram	Weighted Average Purchase Price Per Kilogram	Absolute Markup (Marketing Margin)	Percentage Markup	Percentage of the Consumer Dollar Going to Retailing
1	¢20.10	¢15.13	¢4.97	33	25
2	¢11.07	¢8.20	¢2.87	35	26
3	¢12.93	¢9.70	¢3.23	33	25
4	¢8.55	¢5.92	¢2.63	44	31
6	¢8.03	¢5.61	¢2.42	43	30
7	¢10.11	¢7.92	¢2.19	28	22
9	¢9.92	¢6.95	¢2.97	43	30
10	¢7.49	¢4.50	¢2.99	66	40
12	¢7.19	¢4.56	¢2.63	58	37
13	¢9.56	¢6.57	¢2.99	45	31
14	¢5.04	¢3.64	¢1.40	38	28
15	¢8.26	¢5.53	¢2.73	49	33
17	¢25.85	¢20.87	¢4.98	24	19
18	¢7.17	¢5.44	¢1.73	32	24
19	¢6.30	¢4.05	¢2.25	56	36
21	¢5.63	¢4.05	¢1.58	39	28
22	¢9.04	¢6.69	¢2.35	35	26
23	¢7.38	¢5.17	¢2.21	43	30
25	¢7.46	¢5.36	¢2.10	39	28
28	¢7.80	¢5.53	¢2.27	41	29
29	¢7.75	¢5.80	¢1.95	34	25
30	¢8.90	¢6.46	¢2.44	38	27
32	¢6.25	¢4.12	¢2.09	51	34
33	¢9.81	¢5.82	¢3.99	69	41
34	¢9.33	¢5.73	¢3.60	63	39
36	¢7.05	¢4.95	¢2.48	42	30
37	¢16.61	¢12.02	¢4.59	38	28
38	¢10.90	¢7.55	¢3.35	44	31
40	¢7.97	¢5.03	¢2.94	59	37
42	¢6.93	¢4.80	¢2.13	44	31
44	¢8.67	¢6.20	¢2.47	40	28

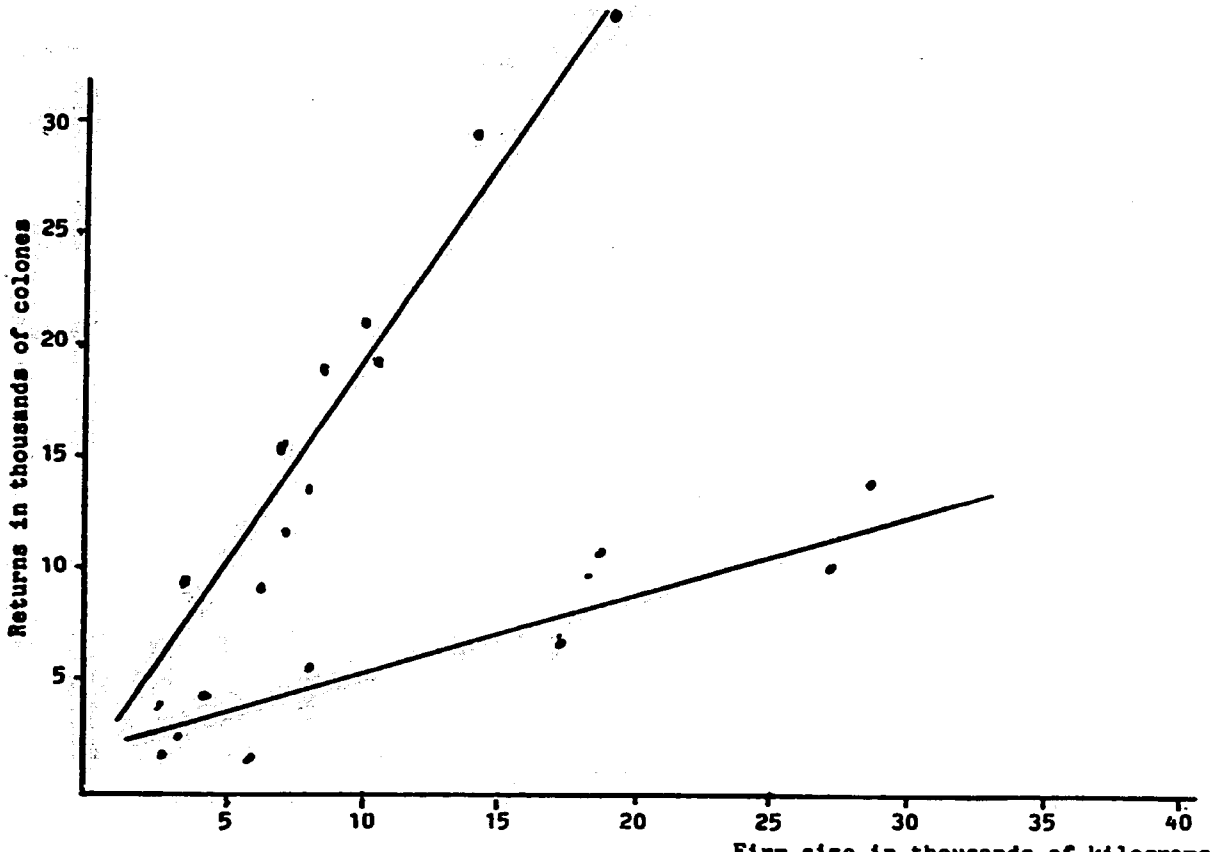

Figure 5. Relationship between returns per firm and firm size and product mix

TABLE 13

EQUIPMENT AND INPUTS USED IN PROVIDING RETAIL SERVICES
(Excluding Working Capital)

Retail Services	Equipment and Inputs																		
	Labor	Plastic Boxes	White Paper	Newspaper	Plastic Bags	Freezers	Refrigerators	Ice Boxes	Walk-in Coolers	Scales	Utensils	Ice	Electricity	Waste	Trucks	Dollies	Bicycles	Water	Cash Register	Ice Maker
Sorting and Culling	X																			
Porterage	X															X				
Weighing	X									X										
Purchasing	X	X																		
Retail Transportation	X											X			X					
Product Identification	X																			
Wrapping for Storage	X				X															
Storage	X					X	X	X	X			X	X							
Washing	X																	X		
Processing	X										X			X						
Pricing	X																			
Display	X											X								
Weighing	X										X									
Packaging	X		X	X	X															
Delivery	X														X		X			
Final Transaction	X																			

labor. Examination of Table 14 shows that the average cost of labor per kilogram of fish for the smaller representative firm was ¢1.11, as compared with an average labor cost of ¢.42 for the largest firm.[10] For the three firms, labor costs account for 32 percent of the retail margin and 8.6 percent of the consumer dollar. The increase in productivity is attributed to specialization of labor by larger firms.

Storage. Storage is the second largest cost component in the retail margin, accounting for approximately 13 percent of the retail gross margin and slightly over 3 percent of the consumer dollar. Storage costs include the cost of ice, which is used in ice boxes and to preserve fish while on display, the cost of electricity used to power mechanical storage equipment and depreciation.[20] Ice accounts for 44 percent of total storage costs, electricity 24 perent, and depreciation 21 percent. Average storage costs decrease for larger firms. Economies of scale are associated with increased storage, as equipment efficiency increases with greater utilization, and equipment with larger capacities can be purchased at a less than proportionate increase in their costs.

Packaging. Packaging materials consist of newspaper, white waxy paper, similar to paper used in delicatessens in the United States, and plastic bags. The average cost of wrapping a kilogram is approximately ¢.14. Packaging costs consume about 2 percent of the consumer dollar and 7 percent of the gross retail margin (Tables 15 and 16).

Rent. The cost of rent is dependent on the physical size of the firm and its location. The average rent paid by firms in San Jose's market district is ¢730.00 versus ¢430.00 per month by other firms. Higher rents in the city more than compensate for transportation costs paid by firms in the suburbs. Thirteen percent of the gross retail margin and 3 percent of the consumer dollar go into rent.

Maintenance. Maintenance can be separated into two categories, facility and equipment maintenance. Facility maintenance involves such things as remodeling and repainting the shop. The cost of facility maintenance varies greatly. The amount spent is left to the owners' descretion. Weekly maintenance costs for the selected firms ranged from ¢25.00 to ¢65.00 per week. Facility maintenance accounts for 65 percent of total maintenance cost. Average maintenance cost is less for larger firms.

Retail Transportation. Retail transportation costs are only paid by those firms not located in the central market district of San Jose. This cost is assumed to be a function of distance and frequency of purchase, not the quantity purchased. For firms providing this service, the average transportation cost is ¢175.00 per week. This represents 5 percent of their retail margin.

Other Costs. Cutting utensils, licenses to operate and telephone costs are included in this category. Firms generally possess three large knives for cutting and trimming fish. Each costs about ¢100.00 per month. Operating licenses, which are renewed with the local municipality every two to three months, cost about ¢25.00 per month.

Returns. Returns are the residual obtained by subtracting the cost components identified above from the value of the retail margin. The value of the retail margin is equal to total sales minus purchasing costs. Returns include profits or losses accruing from retail operations, returns to net worth and the owner's opportunity cost. When returns per firm were plotted against firm size, measured in terms of average weekly quantity purchased, two trends emerged. Firms of similar size earn different returns (Figure 6). In each instance, returns increase with firm sizes. The difference in the trenda is explained by the fact that firms carrying a more expensive product mix can earn greater per unit returns.

TABLE 14

BREAKDOWN OF THE ABSOLUTE RETAIL MARGINS FOR SELECTED FIRMS

	Firms		
	#38	#7	#21
Weighted Average Retail Price/Firm	¢10.90	¢10.11	¢5.65
Weighted Average Purchase Price/Firm	¢ 7.55	¢ 7.92	¢4.05
Absolute Margin Retail Costs/Kilogram	¢ 3.35	¢ 2.19	¢1.60
Labor	¢ 1.11	¢ .77	¢ .42
Storage	¢ .35	¢ .32	¢ .23
Packaging	¢ .14	¢ .14	¢ .14
Rent	¢ .21	¢ .32	¢ .24
Maintenance	¢ .31	¢ .09	¢ .04
Retail Transportation	¢ .37		
Other Costs	¢ .18	¢ .15	¢ .08
Returns	¢ .68	¢ .40	¢ .46

TABLE 15

BREAKDOWN OF THE RETAIL MARGINS FOR SELECTED FIRMS

	Firms		
	#38	#7	#21
	%		
Retail Margin	100	100	100
Retail Costs - Labor	38	35	26
Storage	11	15	14
Packaging	4	16	9
Rent	6	15	15
Maintenance	9	4	2
Retail Transportation	11		
Other Costs	6	7	6
Gross Returns	20	18	28

[20]Depreciation is calculated as 10 percent per annum on all storage equipment.

TABLE 16

BREAKDOWN OF THE CONSUMER DOLLAR FOR SELECTED FIRMS

	Firms		
	#38	#7	#21
	%		
Retail Price			
Retail Margin Components	100	100	100
Labor	10	8	7
Storage	3	4	4
Packaging	1	2	3
Rent	2	3	4
Maintenance	4	1	1
Retail Transportation	3		
Other Costs	2	1	1
Return	6	4	8
Total Retail Margin	31	22	38
Wholesale Price	69	78	72

C. Retail Performance

This section will evaluate retail performance by examining returns for the selected firms. It is argued that if the system is not operating efficiently, then "returns to management" must be excessive.

Attempts to obtain estimates of opportunity costs were unsucessful, so firm profits or losses cannot be separated from the owner's salaries. Consequently return to net worth cannot be used as measure of profitability. Emphasis is therefore placed on "return to management" as a measure of retail performance. Return to management is obtained by subtracting return to net worth from returns, as defined above. The rate of return to net worth is the rate that could be earned in a savings account, 6-3/4 percent. This rate does not include any risk incentive.

Net worth is defined as the present market value of equipment and the retail outlet. The present values of the "derecho de llave" have been excluded for the following reasons. First, accurate estimates of their present value are not available for all firms, and second, the "derecho de llave" appreciates at an unknown rate. Its value and rate of appreciation are related to the physical and economic size of the firm as well as its location. The rate of appreciation appears to be large enough to justify purchase of the derecho as an investment. This may explain the presence of absentee owners in the industry. If the "derecho de llave" were included and interest accrued to its present value, return to capital would be underestimated.

Before addressing the question of profitability, the retail margins for the three firms are discussed. The breakdown of each firm's margin confirms that economies of scale have a significant impact on reducing costs. Internal costs per kilo are ¢2.67, ¢1.79 and ¢1.60 per firm, in order of increasing size. The greatest savings are realized in labor, storage, maintenance and other costs. Rent and packaging costs do not decrease as firm size increases.

Per unit returns do not increase with firm size. They are a function of both the product mix and economies of scale. This is clearly demonstrated by comparing the average weighted retail margins, costs and returns for firms numbered 38 and 7. The difference in the size of each firm's margin, ¢3.35 versus ¢2.19, more than offsets the lower average cost enjoyed by the larger firms. Profitability therefore reflects the ability of management in selecting a product mix which will maximize profits subject to constraints imposed by local demand and competition.

Weekly returns during the interview period for the thre firms were ¢275.00, ¢288.00 and ¢829.00. If a 6-3/4 percent interest rate is assumed the approximately 50 percent of returns go to net worth. For the largest firm, the return to net worth is 15 percent. On the average, about 2 percent of the consumer dollar is retained as returns to net worth. The owners' salaries for the two smallest firms are ¢145.00, which is approximately the going weekly salary for employees working in pescaderias. The fresh fish retailing industry in Costa Rica is sensitive to the rate of return to net worth. For instance, with a 14 percent rate of return, the mean interest on loans given to small businesses by the Banco Central de Costa Rica, there are no returns to the managers of the smaller firms. The return to management for the larger firm drops form ¢701.00 to ¢564.00.

IV. Conclusions and Recommendations

Efforts to promote development have been concentrated largely at the production end. Economic and social goals are not usually achieved by this one sector approach as it has not properly coordinated demand and supply. Development efforts must therefore be coordinated at each level in the producer to consumer chain.

One of the areas of development which deserves more consideration is

marketing. An efficient marketing system can create incentives to increase fisheries production while simultaneously creating and satisfying the demand for increased production. Initiatives to increase landings should be accompanied by an evaluation of the marketing system to insure that it is capable of efficiently accommodating increases in production.

The general objective of this study has been to provide understanding of the conduct and performance of the fresh fish retailing sector in Costa Rica. This understanding should have clarified existing and potential contributions of the retail sector in the overall objective of artisanal fisheries development. The specific objectives of this study have been:

1) to look at retail performance by evaluating retail margins and costs; and
2) to address the issue of market conduct by explaining the nature of the marketing margin

The most apparent shortcoming of this study was its inability to accurately identify firm size. Attempts to identify firm size by use of structural questionnaire proved of little use. Estimates of size derived from data collected by the performance survey are similarly suspect. Fluctuations in supply, the absence of data identifying the extent of processing in each firm and biases resulting from the sampling scheme all contributed to errors in identifying firm size. The absence of information on quantities of fish held in reserve further complicated attempts to measure size.

The seasonality of supply is an additional consideration influencing firm size. The months during which data were collected for this thesis are historically the months with the largest catches. Average weekly total revenues and returns are therefore overstated. During the remaining months, seller concentration can be expected to be higher than the estimations presented in this study.

Given the time and resources available for this study, it was not possible to identify the consumer demand curve, the retail "derived" demand curve or the wholesale and retail supply curves. Lack of a sufficient number of price and quantity observations at the wholesale level, poor information concerning changes in the quantities of fish sold to consumers as fillets, steaks and eviscerated, the absence of data on retail reserves, heterogeneous, product mixes and the absence of knowledge as to which species are more nearly substitutes are all problems that would have to be resolved before those demands could be estimated.

Regardless of its shortcomings, the general analysis and conclusions derived in this study are applicable. Competition in the Costa Rican fresh fish retailing industry is an effective force limiting the opportunities of private firms to promote their own self interest at the expense of the public. Entry is relatively easy and less than optimally sized firms can enter the industry and compete. This stems primarily from the fact the incumbents can select a product mix which partially offsets the comparative advantage that results from existing economies of scale. The industry appears to be responsible and flexible. This responsiveness grows primarily from the relative freedom in which new management and capital enter the industry.

Seller concentration is relatively high but does not appear to threaten the nature of competition within the industry. Increased efficiency associated with large scale operations creates a downward pressure on retail margins and prices. Economies of scale do not present a major deterrent to entry. Skilled entrepreneurs can easily enter the industry and select a product mix which enables them to compete with larger firms that realize lower per unit costs.

Even with larger economies of scale, the industry can be expected to remain competitive. Variations in the width and types of product mixes create differential pressures for price competition among retailers. The diversity of product lines, differences in management's objectives, strategies, and

quality and quantities of fish supplied to retailers make it impossible for larger firms to set price, even for particular products, which would satisfy all retailers.

An additional consideration which deters any attempts to maintain a stable balance of power within the industry is service competition. One firm began operations in June from a very poor location in San Jose's market district and by October was selling nearly 1000 kilograms of fish and shrimp per week. This rapid growth is attributed to the owner's initiative in using family members to reach new markets by delivering fish at no additional charge. The owner extended credit freely to new wholesale customers and was thus successful in securing an increasing larger proportion of the wholesale market.

The above conclusions do suggest that performance in the fresh fish retailing industry can be improved. This marketing system is not static. It has evolved over time and is closely associated with overall conditions in the country as well as its stage of development. Economic growth will demand that this sector increase its efficiency, thus providing price incentive to increase production while creating and satisfying the demand for increased production.

General welfare can be increased by government efforts to assist the industry, particularly in the area of providing better information. The Costa Rican Department of Marine Fisheries could print a daily sheet which lists the volumes, composition and prices of fish products landed in Puntarenas and sold wholesale in San Jose. This type of service will further competition and, as it accumulates, assist interested individuals in identifying any anomalie(s) that may occur in this market.

An important area of government participation which would stimulate market development is that of legislation designed to establish guidelines or standards for product quality. It is obvious that man chooses his food by appearance and taste, so a system of quality control would protect the consumer and increase demand.

Most fresh fish retailers are housed in public markets so projects dealing with modernizatin can assist the industry. Market officials, employed by the government decide on the number, locations, physical size and locations of fresh fish retail outlets. The government is therefore in a position to influence market structure and ultimately performance.

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CHAPTER 22 CHEMICAL ANALYSIS, SENSORY EVALUATION AND STUDIES OF ALTERNATIVES IN THE HANDLING, PRESERVATION AND UTILIZATION OF FISH IN GUATEMALA AND COSTA RICA

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Following the survey on the "State of the Art of Fish, Fish Preservation and Usage in Guatemala and Costa Rica," a series of investigations was planned for both countries. These may be enumerated as follows:

1) Proximate analysis of some common species of edible fish in Guatemala.
2) Analysis for insecticide residues in the species analyzed (Guatemala).
3) Chemical analysis of common species of fish in Costa Rica.
4) The use of a chemical and physical method for assessing fish quality (Costa Rica). Hypoxanthine test. Torrymeter test.
5) Sensory evaluation of common species of fish eaten in Costa Rica.
6) Correlation between chemical and sensory methods.
7) A study of alternatives in the handling of fresh fish.
8) Salting and drying of fish.
9) Overall summary and recommendations.

I. Proximate Analysis of Guatemala Fish

These analyses were done at the Central American Institute for Investigation and Industrial Technology (Instituto Centroamericano de Investigacion y Technologia Industrial, ICAITI), which, as previously indicated, served as one of the cooperating arms of the project in Central America. Eight species of fish were analyzed for their contents of moisture (humedad), fat (grasa), protein (proteina), and non-protein nitrogen (nitrogeno no proteico). All determinations were done in duplicate according to the procedures outlined by the A.O.A.C. The results of the analyses are summarized in Table 1.

II. Analysis for Insecticidal Residues in Guatemalan Fish

A considerable amount of insecticidal spray is used to combat diseases of cotton and other cultivated plants in Guatemala. Inevitably, some of these insecticides enter streams and/or estuarine waters from which fish are harvested. Any effort to improve the nutritional status of developing nations must consider very seriously not only the protein content of the recommended food or diet but also the wholesomeness and safety of such commodities. For these reasons, it was thought necessary to analyze commonly consumed species of fish for their content of DDT and Dieldrin. The results are summarized in Table 1.

III. Proximate Analysis of Fish in Costa Rica

Any process advanced for the preservation of fish will depend heavily on their composition. Fat content, in particular, is known to be an important parameter. Methods used for the preservation of fish from temperate waters may not be directly applicable because the species and, therefore, the composition of the fish may be different. As was done in Guatemala, therefore, analyses for moisture, protein, fat, non-protein nitrogen were done. The iodine index was done here also. Nine types of fish commonly eaten in Costa Rica were analyzed in quadruplicate. The results are summarized in Table 2.

An analysis of Table 2 leads to the following conclusions

TABLE 1. Analysis of Fish in Guatemala

Species	Moisture %	Protein (Nx6.25) %	N.P.N. %	Fat %	pp'DDE ppm	pp'DDD ppm	pp'DDT' ppm	Dieldrin ppm
Black bass 1/12/78	78.45	19.31	0.35	0.89	0.05	0.01	0.04	---
Black bass 23/3/79	81.09	18.82	0.27	0.21	---	---	---	---
Crappie 1/12/78	68.64	27.58	0.40	1.22	0.09	0.01	0.06	0.01
Crappie 23/3/79	80.70	17.22	0.25	0.39	---	---	---	---
Guapote 7/12/78	79.66	19.45	0.31	0.97	0.15	0.04	0.06	0.02
Blue gill 4/12/78	75.99	21.34	0.31	1.56	0.02	0.01	0.02	---
Blue gill 23/3/79	79.71	20.49	0.26	0.80	---	---	---	---
Guapote 29/3/79	76.33	21.19	0.32	1.38	---	---	---	---
Lisa 29/11/78	76.98	21.46	0.01	1.07	0.04	0.03	0.08	---
Lisa 4/4/79	76.98	20.85	0.33	0.96	---	---	---	---
Mojarra 7/12/78	66.37	26.21	0.59	4.39	0.10	0.19	0.09	---
Mojarra 29/3/79 amatitlan	75.37	21.95	0.31	2.03	---	---	---	---
Mojarra (Riodulce) 6/dic/	65.33	31.21	0.50	2.58	0.04	0.01	0.05	---
Mojarra (Riodulce) 21/3/79	77.90	21.76	0.34	0.66	---	---	---	---
Pupos enteros 7/12/78	73.24	17.14	0.25	4.44	0.05	0.013	0.04	0.02
Pupos grandes (secosy salados) NaCl=13.75%	18.17	41.65	---	7.25	---	---	---	---
Pupos pequenos (secosy salados) NaCl=15.69%	19.24	40.64	---	8.33	---	---	---	---
Sierra 29/11/78	75.46	21.09	0.37	1.67	0.65	0.06	0.47	0.14
Sierra (San Jose) 7/12/78	74.60	22.96	0.01	2.92	1.23	0.16	1.25	0.14
Sierra April/4/79	74.14	21.43	0.53	2.93	---	---	---	---

TABLE 2. Analytical Data of Fish in Costa Rica

Analysis	Sample #1-July	#2-Oct.	#3-Jan.	#4-April	Average
a. Corvina agria					
% moisture	77.6	79.9	77.4	77.8	78.2
% protein	20.2	22.5	20.2	23.0	21.5
% fat	1.0	0.7	2.2	1.8	1.4
Non-protein nitrogen	0.24	0.34	0.34	0.3	.31
Iodine index	103.7	---	70.	71.3	81.7
b. Corvina aguada					
% moisture	79.6	77.5	80.6	80.0	79.4
% protein	17.5	19.1	18.9	18.7	18.6
% fat	0.5	2.5	0.8	1.0	1.2
Non-protein nitrogen	0.21	0.24	0.3	0.3	.26
Iodine index	---	83.9	62.	90.1	78.7
c. Corvina cinchada					
% moisture	78.7	79.4	78.8	78.6	78.9
% protein	20.7	19.1	21.5	21.3	20.7
% fat	0.3	0.8	0.9	1.4	.85
Non-protein nitrogen	0.3	0.32	0.39	0.3	.33
Iodine index	---	---	58.	77.	67.5
d. Corvina china					
% moisture	78.0	80.3	79.1	77.6	78.8
% protein	20.8	19.0	19.5	20.7	20.
% fat	0.1	0.4	0.8	1.3	.65
Non-protein nitrogen	0.29	0.34	0.31	0.4	.34
Iodine index	---	---	121.	64.8	92.9
e. Macarela					
% moisture	78.7	77.1	75.3	73.3	76.1
% protein	20.2	20.8	20.9	20.7	20.7
% fat	0.4	1.7	3.9	4.2	2.6
Non-protein nitrogen	0.34	0.47	0.42	0.4	.41
Iodine index	---	107.8	66.	54.	75.9
f. Tiburon					
% moisture	75.6	77.3	75.4	74.3	75.7
% protein	22.1	22.4	24.9	26.0	23.9
% fat	0.6	0.7	1.2	1.1	.9
Non-protein nitrogen	1.03	1.44	0.92	1.3	1.17
Iodine index	---	---	74.	52.7	63.4

Table 2, continued

Analysis	Sample #1-July	#2-Oct.	#3-Jan.	#4-April	Average
g. Jurel					
% moisture	74.9	76.4	75.5	77.4	76.1
% protein	19.9	23.1	21.2	22.9	21.8
% fat	2.3	1.1	3.1	1.5	2.0
Non-protein nitrogen	0.33	0.32	0.38	0.4	.36
Iodine index	95.8	110.0	66.	83.2	88.8
h. Cuminate colorado					
% moisture	79.3*	80.1	80.1	78.9	79.6
% protein	20.3*	18.2	17.5	19.3	18.8
% fat	0.4*	0.6	1.0	1.2	.8
Non-protein nitrogen	0.31*	0.32	0.27	0.30	.30
Iodine index	---	---	87.	62.3	74.65
i. Bagre					
% moisture	79.3*	78.5	78.5	80.0	79.1
% protein	20.3*	19.3	20.4	23.0	20.8
% fat	0.4*	1.1	1.4	1.5	1.1
Non-protein nitrogen	0.31*	0.41	0.30	0.3	.33
Iodine index	---	110.2	88.	70.5	89.6

1) In Corvina aguada, the percent of protein remained constant throughout the various seasons. However, fat content varied greatly being lowest between July to October and highest between January to April. In July, the iodine index was comparatively higher, but, in the absence of data for the month of October, no conclusion can be drawn with respect to this value for ther period July-October. Between January to April, the value was relatively constant.
2) Regardless of the species, there was no great variation in the protein content.

IV. Sensory Evaluation of Fish in Costa Rica

As compared to Costa Rica, the consumption of fish in Guatemala can be considered to be relatively low. The decision was made, therefore, to limit work in Guatemala to cursory analyses only.

The large amount of fish caught in Costa Rica, the possibility of promoting wider consumption by the rural population, the protential use of species which are not being fully utilized now and the need to assess the efficacy of any preservative method advanced, dictated that sensory evaluations be done on the species of interest.

In order to proceed with this aspect of the investigation, it was necessary to train a panel of Judges. The details on this are described below. Samples of the score sheets used and of the different types of odors or scents (olores) which may be detectable are attached.

The ultimate judgement as to the quality of fish is made by the human senses. Fish are of the highest quality for eating purposes immediately after death. This is reflected in their appearance, odor and flavor. As time passes, quality decreases at a rate dependent on both external and internal factors. External factors include temperature, fishing method, care in handling, presence of degradative bacteria and thoroughness of evisceration. Internal factors include the species of fish, physical condition, and presence of digestive enzymes in the gut. The primary test of how these various factors influence fish quality, or its "freshness," is that of sensory evaluation, preferably by a trained panel.

Two thesis projects begun to complement work initiated at the University of Costa Rica, required the sensory evaluation of fish. One thesis, conducted by Hannia Jemenez, concerned the correlation between various methods of determining fish freshness. The other thesis conducted by Cira Zuniga, measured the effect of two variables in fish handling. The first variable was the type of ice (flake vs. chipped block ice) and the second variable the time the fish was left without ice (0 vs. 5 hours). The following is a description of the panel training and procedure used in sensory evaluation of Corvina aguada in this work.

Panel training. Thirteen people, employees of CITA, twelve males and one female, expressed interest and willingness to participate in a trained panel to evaluate fish quality for two thesis projects.

An initial session was held February 9, 1979 to explain the general purposes of the research and outline what the panelists' contribution would be. The requirements in time and training were discussed. Five Corvina reinas, the only Corvina available on that date, were examined. These fish had received different treatments in an attempt to simulate varying time of fish in ice. Two had not been removed from the ice, one had been held one hour at room temperature and returned to the ice, one was held five hours at room temperature and returned to the ice and a fifth had been kept overnight at ambient temperature.

After the prospective panelists left, a practice session was held to determine how the fish should be prepared for evaluation of the raw and cooked muscle. One fillet of each fish was removed and skinned; the skinned fillet was then cut into cubes of approximately 1 1/2 cm to a side. The pieces from

five fish were combined, mixed and 20-30 grams placed in a plastic wrap for the raw sample and in aluminum foil for the cooked sample. Mixing the fish helped compensate for the inherent variability between individual fish within the same treatment. Cooking time was tested at 3, 6 and 9 minutes. Four minutes were then tested and found to be the optimum, though less fresh samples seemed to be slightly overdone. It was then determined that the hot packets of fish should be allowed about five minutes to cool enough so as to be tasted comfortably.

Corvina aguada was purchased in Puntarenas on March 4, 1979. Four were well iced and very fresh. Several more were purchased from another vendor. These fish were being kept at the bottom of an ice chest with no ice; their eyes were sunken and they were obviously not as fresh as those obtained earlier. These fish were used for a training session on March 5th to develop terms useful in describing the fish. Panelists were asked to list characteristics of the fish; its general appearance, raw odor and cooked odor and flavor. The first session evaluating the whole fish was held beginning at 7:30 a.m. as the panelists arrived for work. Thirteen people participated. The first five fish were the fresher ones, the second five were less fresh in appearance. The panelists generally were unable to describe the fish without using the words "fresh" or "good." Few used terms that were more descriptive. After the earlier session, the fish were filleted and prepared as previously described. Panelists were scheduled at 10:30, 11:00 and 11:30 a.m. for the second panel session.

A meeting at 2:00 p.m. was then held to discuss the results of the earlier tests and to evaluate 20 odorants. The panelists were asked to smell various items in opaque white plastic bowls covered with perforated aluminum foil. They were then asked to indicate what the bowls contained (or smelled like) and to note if this odor had any connection with the odor of fish. These odorants were taken from a list of characteristics used to evaluate freshness of flounder (Appendix A). The odorants and results follow, as well as score sheets and results (A-1).

A second training session was held on March 9 using the remaining fish left after evaluation on March 5 and a second set of fresher fish purchased March 8 from the central market in San Jose. The panelists were again asked to note characteristics describing the samples. A list of possible terms was provided. Nine references were evaluated at 2 p.m. Score sheets, terms and results are shown in Appendix A-2.

A third training session was held on March 15 using a score sheet with category scales for the various parameters. Terms were adapted and translated from Connell (1975) and from a "flatfish scoresheet" (Appendix A). In the afternoon, a discussion was held with the majority of the panelists participating. The scores each panelist assigned the two fish (the same fish as on March 9), were noted on the blackboard and wide variations between panelists showed the need for more training. A few members seemed to be judging overly harshly, perhaps because they had not seen a really poor sample as yet. It was decided to take appearance of the flesh from the general aspect sheet and add it to the evaluation of the raw samples in the second daily session.

A fourth training session was held on March 22 with fish purchased previously and a fifth session on March 27. Five fish were evaluated by each panelist. An analysis of various was done on the results. The panel was able to differentiate the two groups of fish. Score sheets, results and analyses for the third, fourth and fifth sessions are shown in Appendix A-3. In the fourth and fifth sessions, each panelist evaluated five fish. Two were the fresher samples from Puntarenas and three the "less fresh" samples from the market in San Jose. The order was the same for all panelists.

On April 6, a final training session was conducted with 31 items and 10 panelists. The panelists were asked to describe the odor and indicate if it had any relation to the fish they had evaluated previously. The items were

then ranked on order of the number of panelists who said that item was a characteristic of fish. The list is in Appendix A-4.

The first two experimental runs. The first session to evaluate *Corvina aguada* captured the night of May 29/30, 1979, was held on May 31, 1979 (a Thursday) with eight of the nine remaining panelists present (eight males and one female). The fish were evaluated by the panelists on the following Mondays and Thursdays (June 4, 7, 11, 14) ending on June 18 for the handling study and on June 21 for the methods correlation study.

The panel area is located on one end of a building next to the library of CITA and facing a quiet residential street. Five booths, connected by pass-throughs to the serving area permit the panelists to concentrate without outside distractions. Charcoal-filtered distilled water was available for rinsing the mouth between samples of cooked fish. Temperature of the panel area was not controlled since ambient temperature varies little. Light was provided by 150 watt reflector bulbs. An inlet of air was needed in the booth area but a fan vented to the outside did keep air moving enough so that the fish odor was removed between the panel sessons of early and late morning.

In the morning (7:30-8:15 a.m.), each panelist evaluated the general appearance and odor of three whole fish. Each fish was placed on a white plastic tray covered with white freezer wrap and identified with a three-digit number. The side from which the microbiology sample was taken was face down on the tray and the open belly facing away from the panelist. The order of service was at random.

After this evaluation was completed, half of each of the five fish of each treatment (two for the handling study and one for the methods correlation study) was skinned and filleted and the fillet cut into cubes of approximately 1 1/2 cm to a side. Immediately after preparation the cubes were placed in a pyrex casserole sitting in ice. The contents of each casserole (one for each treatment) were mixed and 20-gram samples were taken and wrapped in plastic for the raw sample or aluminum foil for the cooked sample. This was completely by approximately 9:20 a.m.

During the first experimental run, all panelists at one time period received the same order for the raw samples and the same order for the cooked samples (different than the raw samples). Across the entire run the order was partially balanced (i.e., all of the six possible orders of presentation for the three samples were used an equal number of times, if the presentation was balanced). During the second run, each panelist received the samples in different orders and the order for each session was, therefore, partially balanced (both first and second panels).

Sample trays were prepared with six white plastic saucers identified by random three-digit numbers, three saucers in the front for the raw samples and three saucers in the second row for the cooked samples. Before each session, the raw samples were removed from the refrigerator approximately 15 minutes prior to the hour and placed on the corresponding dishes. Five to seven minutes to the hour, the cooked sample packets were placed in simmering water and cooked for four minutes. They were then drained and placed on the corresponding saucers. The trays with the score sheet were then placed in the booths.

Panelists were scheduled to arrive at 10:00 and 10:30 a.m. They were not as prompt as would be desired and thus the samples were not at the same temperature for all evaluations. In addition, all panelists were not present at all sessions due to travel, illness and vacations.

The second run was identical to the first except for the sample order. The second run began on Thursday, June 28, and was completed on July 16, for a total of six sessions each Monday and Thursday (June 28, July 2, 5, 9, 12 and 16).

Sources of error. The temperature of the samples was not controlled as rigidly as would have been desirable. In the first session with whole fish, the temperature of the fish varied between 12° and 20°C. The cooked sample

was steaming for some and cool for those who arrived 10 to 20 minutes late.

There was an obvious influence of appearance and odor of the fish evaluated in the early panel of whole fish on samples of cubed fillet tested in the second panel. One concrete example occurred on the last day of the first run. Two panelists were absent from the first panel and thus did not see the fish prepared for the second. Their scores for cooked odor and flavor were higher than the scores of the other panelists for the fish of the methods correlation study. It evidently was of better eating quality than its outer appearance indicated.

Another problem was that the panelists knew how long the fish had been held since capture. We indicated that we would be introducing other fish unannounced and this may have helped somewhat in eliminating part of the bias. After one session, one panelist was convinced that we had done just that--put in a fresh sample among the older ones.

The types of scale used in this work is that commonly used for fish. However, it is not the most adequate one conceivable. It is actually an attempt to compress much information into one scale. Each grade level has several descriptive terms which one hopes would cover the major characteristics of the fish at a given quality level. The problem is that the fish may exhibit characteristics in a more complex manner and one fish may have odors found in several grades. The panelist is then frustrated since there is no way to use this system to record his actual impressions. He has to decide which are the more important aspects and ignore the rest. Each panelist may come to different conclusions. The most promising way of evaluating these complex changes would be to measure all characteristics individually and allow a computer to chart the changes across time. This would be an adaptation of Harper's et al. (1968) method using 44 odors as a basis for evaluating a complex aroma. Each is measured on a 5 point scale. Thus, terms useful in describing fish would be developed, the panel trained to recognize these and evaluate their intensity in fish.

For this study, the panelists were selected for their interest in the fish project. So few people were willing to be on this panel that it proved impossible to do a rigorous screening and eliminate those insensitive to the various changes in fish or unable to reproduce their ratings. This would be desirable.

V. Chemical and Physical Assessment of Fish Quality and Correlation Studies

To facilitate the rapid assessment of fish quality it is desirable to have one or more easily executed tests.

Among the chemical tests, the hypoxanthine test is one of the most widely used for assessing fish quality.

Physical methods for the determination of fish quality are, up to the present time, less popular and less reflective of the actual quality of fish. The best known method is the Torrymeter test which is based on the dielectric properties of the sample.

Although preliminary work was done at the administration site of the grant (Rhode Island), the results served mainly to establish methodology helpful for actual work on tropical species in Costa Rica. Therefore, in Costa Rica, the hypoxanthine test and measurements with the Torry meter were repeated on a species of tropical fish.

A study on the correlation between chemical, sensory and instrumental methods was done, also. These are all described and summarized below.

The exploitation of marine resources is increasing in Costa Rica with both economic and nutritional results. As a consequence, fresh fish consumption is also increasing. A great variety of methods exists to determine the freshness of fish. However, most studies completed to date have dealt with species

different from those commonly found in tropical waters. Thus, there is a need to find methods applicable to our commercially important species.

The species selected for study in this work was the Corvina aguada (Cynoscium squamipinnis). This species is found in surface waters and is obtained in good quantity throughout the entire year. Fishermen and consumers consider it a fish of prime quality.

The fishing site where Corvina aguada was found (for this study) was in the province of Puntarenas, Gulf of Nicoya, at the north coast of Caballo Island.

Freshness was determined using the analysis for hypoxanthine as the chemical method, scoring by a trained panel as the sensory method, Torry meter measurements as the instrumental method and total plate count as the microbiological method. Samples were taken twice per week, Mondays and Thursdays, until the panelists decided analysis should not be continued due to the disagreeable state of the samples.

Methodology employed. From experience, fishermen know that there are two tides per month in which Corvina aguada is most plentiful. These tides are related to lunar movement. It has been demonstrated that to obtain the largest quantities of aguada, the optimum tides are between 9 and 9.5 feet with the casting of the net between 16:00 and 16:30 when the tide begins to go out. Before fixing the date for the trip to the port of Puntarenas, the tides were analyzed by consulting a table of tides that is distributed to the fishermen. Once the date was set, equipment was made ready and transportation was arranged.

The first date set was May 5. However, the trip was not completed due to an accient en route. For health reasons the trip was postponed until May 29.

Due to the tardiness of the fishermen, we set out for the Gulf of Nicoya at 17:00. The net was first cast at 18:30. The net used was a gill net with a mesh area of 3.5 inches, a width of 210 inches and a length of 500 meters. Water depth was approximately 12 meters and sea temperature at the bottom was 82°F and at the surface 80°F.

The net began to be pulled in at 22:30 and due to the limited space in the boat the fish could not be eviscerated immediately, as had been hoped, but two hours later after the net had been cast out the second time. To eviscerate the fish, a cut was made from the gills to the anus. The viscera were then pulled out by hand and the fish washed with sea water. They were then placed in styrofoam ice chests with flake ice. Since the capture in the two castings of the net was not sufficient, it was necessary to purchase fish from another launch, its treatment in evisceration and storage unknown. (When purchased, the fish had been eviscerated and were on ice.) The evisceration was incomplete making it necessary to finish at the receiving site, washing afterwards with potable water.

The return to the port was on May 30 at 10:00. The fish were transported to CITA, remaining in the same styrofoam ice chests as before. They were packed in flake ice, some made at CITA and the rest by the National Production Advisory Board in Puntarenas.

The second run was on June 26. The procedure followed was similar to that described above with times varying as follows:

Departure from San Jose	10:00
Arrival in Puntarenas	12:00
Departure for the Gulf of Nicoya	15:00
First casting of the net	16:30
Net brought in beginning	20:30
Net brought in ending	23:00
Fish put on ice	2:30

Since enough fish were caught for the study, it was not necessary to purchase additional fish. Water depth was the same as before. Water temperature was

not taken since the thermometer was not available.

Sampling. Upon arrival at CITA, the fish were transferred to plastic fish boxes, six fish were placed in each box and the fish, as well as the boxes, numbered. These were stored in a cold room at a temperature that varied between 4 and 5 degrees. To facilitate sampling, the cold room was used only for the fish in this study.

On the day of analysis, it was necessary to complete three samplings beginning at 5:30. First, 16 fish were taken at random for the Torry meter measurements. The meter was placed near the gill flap in the dorsal area and the measurement made. The second sampling was of 5 of these 16 fish. This sampling was also done at random. These were the 5 fish that would be evaluated by the sensory panel and by chemical analysis. The other 11 fish were returned to the boxes. For the panel, the 5 fish were analyzed individually (for general aspect and together for the raw and cooked pieces). For chemical analysis, a third random sampling was made to select two fish that would be analyzed individually in addition to the mixture of five.

The sample of five fish was prepared and at 7:30 was taken to the sensory testing area; the general aspect was graded first and later pieces of raw and cooked muscle.

Then samples were taken for chemical analysis. The two first that were sampled individual for analysis were used. Twenty-five grams were removed from each fish. For the mixture of five fish, five grams of each were removed.

Procedure followed for hypoxanthine analysis

Reference: N.R. Jones, J. Murray and (in part) Mrs. E.I. Livingston and C.K. Murray. 1964. Rapid estimation of hypoxanthine concentrations as indices of the freshness of chill-stored fish. J. Sci. Food Agricul., 15:763-774.

1. Weigh a 25 gram sample of fish.
2. Add 50 ml of $HClO_4$ (0.6 N.)
3. Homogenize 1-2 minutes, using an electric blender.
4. Filter over filter paper using suction.
5. Take 25 ml of supernatant.
6. Neutralize with 30% KOH to pH 6.5-7.0 using a magnetic agitator.
7. Add distilled water to complete 37.5 ml.
8. Refrigerate to precipitate $KClO_4$.
9. Filter through filter paper.
10. Take 0.5 ml of supernatant.
11. Add 2.0 ml of distilled water.
12. Add 2.0 ml of phosphate buffer 0.25 M, pH 7.6
13. Add 0.5 ml of xanthine oxidase solution, 0.032 IU.
14. Place in water bath at 37°C for 30 minutes.
15. Read in spectrophotometer at 290 nm.
16. Compare the absorbance value obtained with the standard curve.

Note: When the absorbance was very high, as in the last days of sampling, it was found best to take 0.25 ml of the sample to get a better reading on the graph and then multiply the result by two.

Preparation of the hypoxanthine standard curve.

A standard curve was prepared with levels of 20 µg to 100 µg of hypoxanthine (Hx). "µg" = micrograms.

No.	Standard Solution Hx, (ml)	Hx (μm)	H_2O (ml)	Buffer (ml)	Enzyme Solution (ml)
+	---	---	2.5	2.0	0.5
1	0.1	20	2.4	2.0	0.5
2	0.2	40	2.3	2.0	0.5
3	0.3	60	2.2	2.0	0.5
4	0.4	80	2.1	2.0	0.5
5	0.5	100	2.0	2.0	0.5
++	0.5 ml of unknown sample		2.5	2.0	---

Where + and ++ are blanks to correct the absorbance; + enzyme blank, ++ hypoxanthine blank.
Measurements were made using a Pye Unicam SP6 spectrophotometer.

Comments. The results obtained with the Torrymeter demonstrate that the mean of 16 measurements in general decreases as the number of days in storage increases. However, for every reading obtained during the same sampling day, one can observe the great variation existing between one fish and another. With the purpose of finding reasons for this variability, weights of the fish were recorded for the second run and it can be seen that the weight of the fish is not related to the reading obtained. The weights are included for reference.

In the results from the chemical test a great increase (in hypoxanthine content) is observed across time. However, there was also a great difference in values between individual fish and the mixture of five. It is, therefore, advisable to study this phenomenon on greater detail.

As far as storage techniques are concerned, they are quite good. The plastic fish boxes are served well. The only change made was to make four small holes in the bottom for drainage. The boxes with ice keep a considerable time.

Results and Discussion. Results of analysis of variance of "treatment vs. session" for the handling study show that sessions were significantly different in all cases. Treatments were significantly different in three of the six sensory parameters tested--general aspect (whole fish) odor, raw muscle color and cooked muscle odor, as well as for the Torrymeter data. Using Duncan's multiple range test, each mean was compared with every other mean to find which treatments were those significantly different at the 5% level of probability (Amerine, Pangborn and Roessler, 1965).

> The shortest significant range, R_p, for comparing the largest and smallest of p mean scores is given by $Q_p S_{\bar{x}}$, with (n-1) (k-1) degrees of freedom, where the appropriate value of Q_p can be obtained from Table G in the Appendix. The standard error of any mean score, $s_{\bar{x}}$, can be calculated from $s_{\bar{x}}$ = error variance/k.

From Table G, Q_p = 3.01 (p=2); 3.16 (p=3); 3.25 (p=4) with a probability of 5%.

General Aspect Odor (whole fish)

$s_{\bar{x}} = 0.1807$ $R_p = 0.54$ (p=2); 0.56 (p=3); 0.58 (p=4)

TABLE 3.

HYPOXANTHINE DATA

First Run

Date		Sample Absorb.	Enzyme Blank Absorb.	Hypox. Blank Absorb.	Real Absorb.	Value Graph (μm)	μmoles/ g fish
May 31	A	0.439	0.123	0.091	0.225	24.5	1.11
	B	0.544	0.123	0.127	0.294	32.0	1.44
	C	0.452	"	0.101	0.228	24.7	1.11
June 4	A	0.389	"	0.126	0.140	15.5	0.70
	B	0.379	"	0.124	0.142	15.4	0.70
	C	0.479	"	0.103	0.248	26.5	1.20
June 11	A	0.356	"	0.063	0.170	18.6	0.84
	B	0.398	"	0.157	0.118	12.7	0.57
	C	0.534	"	0.104	0.307	33.5	1.51
June 7	A	0.540	"	0.100	0.317	35.5	1.60
	B	0.366	"	0.048	0.195	22.1	1.00
	C	0.556	"	0.058	0.375	40.0	1.80
June 14	A	0.280	0.125	0.024	0.131*	14.5	1.31
	B	0.415	0.125	0.034	0.256*	28.5	2.57
	C	0.522	"	0.044	0.353*	38.2	3.44
June 18	A	0.420	"	0.049	0.246*	26.4	2.38
	B	0.641	"	0.049	0.467*	51.0	4.59
	C	0.667	"	0.123	0.419*	45.5	4.10

Where A and B are individual fish; C is a mixture of 5 fish.

*These results were obtained with 0.25 ml of sample.

TABLE 4.
HYPOXANTHINE DATA

Second Run

Date		Sample Absorb.	Enzyme Blank Absorb.	Hypox. Blank Absorb.	Real Absorb.	Value Graph (μm)	μmoles/ g fish
June 28	A	0.362	0.125	0.062	0.175	19.3	0.77
	B	0.470	"	0.092	0.253	27.5	1.10
	C	0.364	"	0.079	0.160	17.5	0.70
July 2	A	0.404	"	0.116	0.163	18.5	0.74
	B	0.563	"	0.100	0.338	37.0	1.48
	C	0.548	"	0.142	0.281	30.5	1.22
July 5	A	0.492	0.126	0.098	0.268	29.3	1.19
	B	0.688	"	0.122	0.440	47.5	1.90
	C	0.710	"	0.151	0.433	46.5	1.86
July 9	A	0.477	"	0.058	0.293	32.0	2.88
	B	0.541	"	0.071	0.344	37.5	3.38
	C	0.507	"	0.058	0.323	35.1	3.16
July 12	A	0.530	"	0.049	0.355	37.6	3.38
	B	0.516	"	0.035	0.355	37.6	3.38
	C	0.442	"	0.039	0.277	30.5	2.73
July 16	A	0.910	"	0.081	0.703	76.1	6.85
	B	0.694	"	0.079	0.489	53.7	4.83
	C	0.498	"	0.054	0.318	35.0	3.15

Where A and B are individual fish; C is a mixture of 5 fish.

TABLE 5.
TORRYMETER DATA

First Run

May 31, 1979		June 4, 1979		June 7, 1979	
#Box - #Fish	Reading	#Box - #Fish	Reading	#Box - #Fish	Reading
2-1	8	1-3	11	2-1	1
5-5	1	5-1	6	**10-3	2
** 4-1	10	* 2-4	9	* 5-2	11
* 5-3	11	10-1	2	**10-6	0
*10-4	12	2-5	11	7-2	1
** 6-2	13	1-6	0	** 3-5	2
* 8-3	7	* 6-3	11	5-6	2
7-3	7	7-4	1	*5-4	10
10-3	7	10-5	5	3-3	10
8-5	8	** 6-1	6	8-6	9
10-2	10	4-2	10	3-4	5
2-5	9	** 2-6	11	9-2	0
2-3	9	6-5	1	7-3	1
9-5	5	9-2	2	10-1	4
8-1	8	3-6	9	1-1	1
3-1	8	* 2-2	10	4-5	13
$\bar{X}$	8.3		6.6		4.5
sd	2.8		4.2		4.5

June 11, 1979		June 14, 1979		June 18, 1979	
#Box - #Fish	Reading	#Box - #Fish	Reading	#Box - #Fish	Reading
4-2	6	* 7-2	1	** ---	0
** 4-6	9	10-1	0	* ---	6
* 9-3	6	4-3	9	---	1
* 2-3	7	4-5	1	* ---	8
** 7-6	5	4-2	6	---	0
** 4-4	9	** 6-6	9	* ---	3
9-2	0	9-2	0	---	2
10-1	0	3-3	8	---	4
10-2	6	** 5-4	1	** ---	5
7-5	3	* 9-6	6	---	
8-1	8	* 1-3	8	---	
8-2	6	2-1	5	---	
9-1	0	3-1	4	---	
8-3	0	1-2	5	---	
3-1	4	3-2	9	---	
3-4	2	7-5	9	---	
$\bar{X}$	4.4		5.1		3.2
sd	3.2		3.5		2.8

*Fish taken in the second sampling.
**Fish taken in the third sampling.

TABLE 6.

TORRYMETER DATA

Second Run

June 28, 1979			July 2, 1979			July 5, 1979		
Weight	Box-Fish	Reading	Weight	Box-Fish	Reading	Weight	Box-Fish	Reading
654 g	* 3-2	10	1210 g	* 5-2	6	750 g	* 8-5	0
771	** 4-6	14	970	** 7-4	5	1590	** 6-4	10
1017	** 8-2	14	805	* 3-4	3	803	** 2-3	3
1195	* 2-4	8	667	* 6-1	7	742	* 1-2	6
493	* 1-5	4	750	** 8-5	5	539	* 4-4	14
514	4-4	15	742	1-2	8	958	8-3	3
784	3-5	3	944	2-6	9	544	6-5	9
640	7-2	12	701	4-2	7	683	2-2	0
803	2-3	9	795	3-1	9	571	1-1	4
837	6-3	4	632	7-5	9	701	4-2	4
758	5-5	8	988	5-3	10	944	2-6	5
805	3-4	10	544	6-5	11	1192	7-3	6
750	8-5	6	958	8-3	5	707	7-6	5
683	2-2	4	670	1-6	8	795	3-1	9
571	1-1	10	803	2-3	6	714	5-1	11
513	6-6	12	514	4-4	13	988	5-3	10
	$\bar{X}$	8.9			7.6			6.2
	sd	3.9			2.6			4.0

July 9, 1979			July 12, 1979			July 16, 1979		
Weight	Box-Fish	Reading	Weight	Box-Fish	Reading	Weight	Box-Fish	Reading
988 g	** 5-3	8	514 g	* 4-4	11	670 g	** 1-6	0
795	** 3-1	8	640	** 7-2	4	509	* 3-3	1
958	* 8-3	0	836	* 6-3	0	491	* 8-1	4
513	* 6-6	8	784	** 3-5	6	583	5-6	0
701	* 4-2	5	571	* 1-1	0	683	2-2	0
686	1-4	7	670	1-6	0	758	5-5	0
683	2-2	0	491	8-1	6	944	2-6	0
836	6-3	1	509	3-3	2	556	7-1	2
556	7-1	3	583	5-6	1	671	4-1	0
632	7-5	4	683	2-2	0	707	7-6	1
514	4-4	11	944	2-6	0	1192	7-3	0
491	8-1	10	556	7-1	0	544	6-5	0
784	3-5	9	758	5-5	0	743	* 3-6	3
509	3-3	5	707	7-6	2	549	6-2	1
714	5-1	8	544	6-5	1	714	5-1	2
583	5-6	4	1192	7-3	1	518	** 4-5	0
	$\bar{X}$	5.7			2.1			0.9
	sd	3.5			3.1			1.3

*Fish taken in the second sampling.
**Fish taken in the third sampling.

TABLE 7.

CORRELATIONS STUDY

Sensory Evaluation Results

Whole Fish--General Aspects

	Appearance							Odor						
	I	II	III	IV	V	VI	VII	I	II	III	IV	V	VI	VII
A	5	4	4	2	2	2	2	10	9	7	4	3	2	2
B	5	4.5	4.5	3.5	3	2.5	2	10	10	9.5	7.5	4.5	4	3.5
C	5	4	3	-	3	-	1	8	7	4	-	4	-	2
D	5	4	4	5	4	3	2	9	9	8	10	9	6	4
E	5	-	4	3.5	2.5	-	2	10	-	8	7	4	-	2
F	5	4	4	3	-	2	1	10	9	8	3	-	2	0
G	-	5	4.5	4.5	3	2	2	-	10	9.5	10	6.5	4	2
$\bar{X}$	5.0	4.3	4.0	3.6	2.9	2.3	1.7	9.5	9.0	7.7	6.9	5.2	3.6	2.2
D	0	0.4	0.5	1.1	0.7	0.4	0.5	0.8	1.1	1.9	2.9	2.2	3.1	1.3

Raw meat

	Color							Texture						
A	8	7	7	8	3	4	2	5	3	3	3	3	4	3
B	10	9.5	8	7	7	3.5	2	5	4.5	3.5	3.5	3	3	2
C	8	8	-	8	7	-	2	4	3	-	4	4	-	
D	9	8	8	9	8	7	7	4	3	4	3	4	3	3
E	10	9	8	8	8	-	2	5	3	4	3	3	-	1
F	9	9	8	-	-	1	2	4.5	5	4	-	-	1	2
G	-	10	8.5	7	7	4	5	-	5	4	3.5	3	2	3
$\bar{X}$	9.0	8.6	7.9	7.8	6.7	3.9	3.1	4.6	3.8	3.8	3.3	3.3	2.6	2.1
D	0.9	1.0	0.5	0.8	1.9	2.1	2.0	0.5	1.0	0.4	0.4	0.5	1.1	0.9

Cooked meat

	Color							Odor						
A	5	3	3	3	4	3	4	9	7	8	6	6	4	
B	5	5	4	4	4	2.5	3	10	10	8	6.5	6	3	
C	4	4	-	4	4	-	2	7	8	-	6	6	-	
D	4	3	4	5	4	3	4	7	9	9	8	7	8	5
E	5	5	5	4	3	-	4	10	9	7	7	7	-	4
F	4	5	5	-	-	4	4	10	9	8	-	-	2	2
G	-	5	4	4	3	2	3	-	10	8	9	7	7	3
$\bar{X}$	4.5	4.3	4.2	4.0	3.7	2.9	3.4	8.8	8.9	8.0	7.1	6.5	4.8	2.4
D	0.5	1.3	0.8	0.6	0.5	0.8	0.8	1.5	1.1	0.6	1.2	0.5	2.6	1.6

Cooked meat

	Flavor						
A	9	7	8	7	6	3	1
B	10	10	8.5	8	5.5	3	1
C	7	8	-	3	5	-	1
D	6	9	10	9	7	9	1
E	10	10	8	8	4	-	2
F	10	10	6	-	-	1	1
G	-	9	8	10	7	6	2
$\bar{X}$	8.7	9.0	8.1	7.5	5.8	5.3	1.3
D	1.8	1.12	1.2	2.4	1.2	2.9	0.5

TABLE 6.

HYPOXANTHINE DATA

Third Run

Date	#	Sample Absorb.	Enzyme Blank Absorb.	Hypox. Absorb.	Real Absorb.	Value Graph (μg)	Volume Extract (cc)	Hypox. μmoles/ g fish	Average & s.d.
Aug. 27	1	0.583	0.127	0.114	0.342	37.1	55	1.80	
	2	0.464	"	0.080	0.257	28.1	47	1.16	
	3	0.751	"	0.089	0.535	57.3	53	2.68	$\bar{x}$=1.61
	4	0.500	"	0.078	0.295	32.1	37	1.05	sd=0.66
	5	0.457	"	0.072	0.258	28.2	54	1.34	
Aug. 30	1	0.538	0.127	0.077	0.334	36.2	55	1.76	
	2	0.401	"	0.085	0.189	20.9	55	1.01	
	3	0.512	"	0.079	0.306	33.2	45	1.32	$\bar{x}$=1.26
	4	0.503	"	0.103	0.273	29.8	53	1.39	sd=0.36
	5	0.413	"	0.104	0.182	20.2	46	0.82	
Sept. 3	1	0.509	0.147	0.094	0.268	29.3	55	1.42	
	2	0.542	"	0.098	0.297	32.3	58	1.65	
	3	0.621	"	0.098	0.376	40.6	58	2.08	$\bar{x}$=1.70
	4	0.502	"	0.071	0.284	30.9	58	1.57	sd=0.25
	5	0.626	"	0.113	0.366	39.6	51	1.78	
Sept. 6	1	0.447	0.151	0.103	0.193	21.3	57	1.07	
	2	0.632	"	0.080	0.401	43.3	57	2.18	
	3	0.491	"	0.084	0.256	28.0	60	1.48	$\bar{x}$=1.95
	4	0.755	"	0.120	0.484	52.0	58	2.66	sd=0.65
	5	0.656	"	0.087	0.418	45.1	59	2.35	
Sept. 10	1	0.607	0.138	0.081	0.388	41.9	59	2.18	
	2	0.676	"	0.086	0.452	48.6	53	2.27	
	3	0.798	"	0.090	0.570	61.1	57	3.07	$\bar{x}$=2.71
	4	0.785	"	0.102	0.545	58.4	59	3.04	sd=0.44
	5	0.763	"	0.090	0.535	57.4	59	2.99	
Sept. 13	1	0.685	0.150	0.079	0.456	49.1	58	2.51	
	2	0.754	"	0.085	0.519	55.7	58	2.85	
	3	0.619	"	0.091	0.378	40.8	57	2.05	$\bar{x}$=2.46
	4	0.650	"	0.089	0.411	44.3	58	2.27	sd=0.31
	5	0.734	"	0.101	0.483	51.9	58	2.63	
Sept. 17	1	0.896	0.146	0.108	0.642	68.6	50	3.02	
	2	0.730	"	0.105	0.479	51.5	57	2.59	
	3	0.862	"	0.110	0.606	64.8	57	3.26	$\bar{x}$=2.94
	4	0.769	"	0.093	0.530	56.8	58	2.90	sd=0.24
	5	0.783	"	0.095	0.542	58.1	58	2.95	
Sept. 20	1	0.931	0.149	0.113	0.669	71.4	55	3.46	
	2	0.903	"	0.098	0.656	70.1	60	3.71	
	3	0.777	"	0.074	0.554	59.4	61	3.19	$\bar{x}$=3.41
	4	0.809	"	0.083	0.577	61.8	60	3.27	sd=0.28
	5	0.836	"	0.081	0.606	64.8	62	3.54	

TABLE 9.
TORRYMETER DATA

Third Run

August 27, 1979		August 30, 1979		September 3, 1979	
#Box - #Fish	Reading	#Box - #Fish	Reading	#Box - #Fish	Reading
* 2-4	13	** 9-6	12	** 1-1	11
** 4-4	10	** 7-1	12	** 9-3	12
* 4-1	10	* 8-4	12	* 3-5	3
* 6-2	10	* 9-1	11	* 3-3	10
** 7-3	11	* 6-5	9	* 6-3	9
9-5	9	1-1	12	2-1	7
2-2	11	3-5	3	4-2	5
1-5	7	2-6	10	7-4	4
5-6	10	4-2	5	5-5	9
3-1	12	7-1	2	6-3	8
1-4	12	1-3	10	4-6	8
3-3	11	3-4	8	1-5	2
8-1	11	2-6	12	7-1	6
5-4	12	9-3	12	8-2	1
7-5	6	8-5	9	3-4	5
6-1	10	6-6	9	2-2	6
X	10.3		9.3		6.6
sd	1.8		3.3		3.2

September 6, 1979		September 10, 1979	----------
#Box - #Fish	Reading	#Box - #Fish Reading	----------
* 4-6	7	Readings were	
* 7-1	8	abnormal, many	
** 2-5	11	over 10 and it	
* 8-1	7	was not possible	
** 9-2	11	to repeat the	
1-4	10	same readings on	
7-6	4	the same fish.	
6-1	6		
5-6	4		
5-2	4		
8-6	7		
2-6	5		
2-1	5		
1-5	0		
3-6	10		
6-6	6		
X	6.6		
sd	3.0		

*Fish taken in the second sampling.
**Fish taken in the third sampling.

ICO (6.33)	.73+	.21	.06	-
IC5 (6.27)	.67+	.15	-	-
IICO (6.12)	.52	-		
IIC5 (5.60)	-			

Thus IIC5 (chipped block ice used after 5 hours at ambient temperature) fish has a lower odor score for the whole fish than ICO and IC5 fish (the samples stored in flake ice).

Raw Muscle Color

$s_{\bar{x}} = 0.1422$ $R_p = 0.43$ (p=2); 0.45 (p=3); 0.46 (p=4)

ICO (3.85)	.57+	.55+	.05	-
IC5 (3.80)	.52+	.15	-	
IICO (3.30)	.02	-		
IIC5 (3.28)	-			

This indicates that the samples put on ice immediately after being eviscerated had better color than samples held for 5 hours at ambient temperatures. The type of ice had no effect.

Cooked Muscle Odor

$s_{\bar{x}} = 0.1924$ $R_p = 0.58$ (p=2); 0.61 (p=3); 0.63 (p=4)

IICO (7.53)	.91+	.76+	.38	-
IIC5 (7.15)	.53	.38	-	
ICO (6.77)	.15	-		
IC5 (6.62)	-			

The sample stored on chipped block ice immediately after being eviscerated had better cooked odor than the fish held in flake ice, no matter what its treatment. The fish stored in chipped block ice after 5 hours at ambient temperature was not significantly differentiated from the fish stored in flake ice after 5 hours. There was no difference between IIC5, ICO and IC5. The reason for the higher cooked muscle odor scores of the block ice fish are unknown. It may be that the panel scored this higher in the second run (when block ice was used) for some reason. The scores in this parameter are slightly higher in the second run for the methods correlation study as well.

Torrymeter Data

$s_{\bar{x}} = 0.1924$ $R_p = 0.58$ (p=2); 0.61 (p=3); 0.63 (p=4)

IICO (7.53)	.91+	.76+	.38	-
IIC5 (7.15)	.53	.38	-	
ICO (6.77)	.15			
IC5 (6.62)	-			

The sample stored on chipped block ice immediately after being eviscerated has better cooked odor than the fish held in flake ice, no matter what its treatment. The fish stored in chipped block ice after 5 hours at ambient

temperature was not significantly differentiated from the fish stored in flake ice after 5 hours. There was no difference between IIC5, ICO and IC5. The reason for the higher cooked muscle odor scores of the block ice fish are unknown. It may be that the panel scored this higher in the second run (when block ice was used) for some reason. The scores in this parameter are slightly higher in the second run for the methods correlation study as well.

Torrymeter Data

$S_{\bar{x}}$ = R_p = 1.34 (p=2); 1.40 (p=3); 1.44 (p=4) 5% prob. +
R_p = 1.85 ("); 1.93 ("); 1.98 (") 1% prob. ++

ICO (4.90)	4.27++	2.90++	2.28++	-
IICO (3.62)	2.99++	1.62+	-	
IC5 (2.00)	1.37+	-		
IIC5 (0.63)	-			

At the 5% level of probability, the dielectric constant indicates that the two best means of storing fish are to put them on ice immediately after evisceration, and flake ice is better than chipped block ice. If one has to wait for 5 hours after evisceration before icing, again, flake ice is better than chipped block ice. At the 1% probability level, the differences are a bit blurred. Again, the best means to store fish is with flake ice and immediate icing. Immediate icing with chipped block ice is the next best but this is equal to flake ice with a 5 hour wait, though better than chipped block ice with a 5 hour wait. The fish with a 5 hour delay before icing is not differentiated, whether or not flake or block ice is used. If the linear regression coefficient of the means of the Torrymeter data (in increasing order) is calculated vs. the means of Raw Muscle Color (in increasing order), the correlation is found to be 0.94. Color would appear to change in the same way that the dielectric constant does.

In the method correlation study, the first run and the second run show differences in significance of correlation of sensory with Torrymeter data. This is probably due to the greater variability in the fish of the first run. Not all fish were captured in the same area and treated the same since it was necessary to buy fish from another fisherman. The fish purchased were being held in chipped block ice rather than the flake ice used for the other fish. Torrymeter measurements on corvina aguada appear to be strongly affected by handling--the type of ice and the time left at ambient temperature. It is interesting to note that the Torrymeter measurements in the first run were not correlated with the sensory measurements while the hypoxanthine measurements were. This would seem to indicate that the Torrymeter is more sensitive to variations in handling than the sensory quality would warrant while the hypoxanthine content would appear to be a better indicator of sensory quality. Correlations were better when the average of two fish measurements were used rather than the mixture of five fish. The difference in sampling size may be the contributing factor, however, since only 5 grams from each fish were used in the mixture while 25 grams were used from each fish for the individual analyses. A different sampling technique will be used in the next runs, so that a truer value will be obtained--that of taking a 25 gram sample from the homogenized fish half rather than excising out 25 grams.

When the correlation coefficient between Torrymeter data and sensory data for the handling study are analyzed, one can see that holding at ambient temperatures affects the dielectric constant more than it affects sensory quality. Torrymeter data and sensory data are significantly correlated only for the fish put in ice immediately after being eviscerted. (Only raw muscle color was correlated for the 5 hour flake ice treatments [IC5].) The Torrymeter appears good as a quality indicator for corvina aguada only if the fish is well iced immediately after being eviscerated. At ambient tempera-

tures, readings decline faster than sensory quality, so that the Torrymeter registers zero long before the fish is beyond panel evaluation.

The various sensory parameters appear equally effective in measuring loss of fish quality with days on ice. Only three showed significant differentiation in the handling study however. It is likely that these measurements were not made independently of one another since the panelists were aware that the raw and cooked samples came from the fish seen earlier in the morning. Also, the samples were placed on the same tray and evaluated at one sitting.

VI. A Study of Alternatives in the Handling of Fresh Fish

Objective: To test alteratives in the handling of fish under totally controlled conditions and to determine which method will help to prevent rapid deterioration of the product in the fresh state.

Variables studied:
1. Type of ice.
   a. Flake ice.
   b. Chipped block ice.
2. Time of icing.
   a. Zero hours.
   b. Five hours.

Analyses done:
1. Sensory (Taste panel)
   a. Evaluation of the general aspect.
   b. Odor and color of the raw fish and odor and flavor of the cooked fish.
2. Instrumental analysis. Use of the Torry meter

Species studied: Corvina aguada (Cynoscium squamipinnis)

Introduction. To study alternatives in the handling of the fish a comparison was made between methods used by the fishermen and improved conditions possible in research with controlled variables.

To duplicate conditions normally used by the fishermen, chipped block ice was used and icing was done after holding the fish on deck five hours after eviscerating. The fishermen prefer block ice because it melts more slowly. However, often there is not enough ice in the boat and the fish is iced only upon arriving at the principal receiving point, the port of Puntarenas, after approximately five hours.

As a better treatment, flake ice was used and icing was done immediately after gutting all fish (zero hours). These are considered the optimum conditions for the preservation of fish because flake ice covers the fish more and removes heat more rapidly. In addition, it does not damage the fish as does chipped block ice where sharp points pierce the skin.

Sensory and instrumental analyses were done to evaluate differences in the progressive deterioration that the fish suffer. These investigations were designed to indicate which of the two conditions is actually the better.

Obtaining the fish for study. As stated previously under the correlation study, fishermen know from experience that there are two tides per month in which corvina aguada is most plentiful. All preparations for catching the fish were as outlined before. The fish was transferred to a large insulated chest covered with fiber glass with a division in the center, whose length was 130 cm, depth 86 cm and height 85 cm with a wall thickness of 8 cm. The chest was designed especially to maintain fish during transport the fish to CITA.

The second run was on June 26 and the procedures followed were similar to those described above. The fish analyzed during the first run was iced with flake ice made by an ice machine in CITA (and by flake ice from the National Production Advisory Board in Puntarenas). The fish analyzed in the second run were iced with chipped block ice, chipped with an ice pick. The pieces resulting were of variable size and shape. Block ice was purchased in

TABLE 10.

Two-way Analysis of Variance (Treatment vs. Session) for Data from the Entire Panel--Handling Study

General Aspect	Souce of Variation	Deg. Free.	Sum of Squares	Mean Square	F Calc.	Probability
Appearance:	Total	23	25.05			
	Sessions	5	23.59	4.72	76.53	4×10^{-10}
	Treatments	3	0.54	0.18	2.91	0.069
	Error	15	0.93	0.06		
Odor:	Total	23	150.02			
	Sessions	5	145.19	29.04	152.94	2×10^{-12}
	Treatments	3	1.99	0.66	3.48	0.042
	Error	15	2.94	0.20		
Raw Muscle						
Odor:	Total	23	107.19			
	Sessions	5	94.46	18.89	30.80	2.2×10^{-7}
	Treatments	3	3.52	1.17	1.91	0.171
	Error					
Color:	Total	23	14.18			
	Sessions	5	10.64	5.64	17.54	8.6×10^{-6}
	Treatments	3	1.72	0.57	4.71	0.016
	Error	15	1.82	0.12		
Cooked Muscle						
Odor:	Total	23	73.05			
	Sessions	5	66.68	13.34	60.04	2.2×10^{-9}
	Treatments	3	3.04	1.01	4.57	0.018
	Error	15	3.33	0.22		
Flavor:	Total	23	130.20			
	Sessions	5	116.98	23.40	40.24	3.6×10^{-8}
	Treatments	3	4.50	1.50	2.58	0.092
	Error	15	8.72	0.58		
Torrymeter	Total	23	176.27			
	Sessions	5	96.02	19.20	16.20	1.4×10^{-5}
	Treatments	3	62.46	20.82	17.56	3.6×10^{-5}
	Error	15	17.79	1.19		

TABLE 11.

Means and Variance (using entire panel) of Sensory Results for the Handling Study

General Aspect		ICO	IC5	IICO	IIC5
Appearance:	$\bar{X}$	3.15	2.85	3.18	3.23
	s^2	1.04	0.90	1.24	0.90
Odor:	$\bar{X}$	6.12	5.60	6.33	6.27
	s^2	6.35	5.89	6.62	5.80
Raw Muscle					
Odor:	$\bar{X}$	6.80	6.38	7.08	6.08
	s^2	4.69	3.95	3.60	5.03
Color:	$\bar{X}$	3.85	3.30	3.80	3.28
	s^2	0.35	0.49	0.50	0.74
Cooked Muscle					
Odor:	$\bar{X}$	6.77	6.62	7.53	7.15
	s^2	2.83	2.67	2.47	3.70
Flavor:	$\bar{X}$	6.27	6.08	7.18	6.78
	s^2	5.90	5.48	3.99	5.57

TABLE 12.

CORRELATION COEFFICIENTS -- METHODS CORRELATION STUDY

Torrymeter data vs. the various sensory parameters:						
FIRST RUN	General Aspect-Appear.	General Aspect-Odor	Raw Muscle Odor	Raw Muscle Color	Cooked Muscle Odor	Cooked Muscle Flavor
2-3 judges:	0.532	0.563	0.530	0.658	0.697	0.709
entire panel:	0.678	0.626	0.626	0.557	0.719	0.658
SECOND RUN						
2-3 judges:	0.975**	0.979**	0.870*	0.944**	0.962**	0.986**
entire panel:	0.986**	0.980**	0.923**	0.993**	0.974**	0.983**
Hypoxanthine data vs. the various sensory parameters:						
FIRST RUN	C(mix.) vs. GAA	C(mix.) vs. GAO	C(mix.) vs. RMO	C(mix.) vs. RMC	C(mix.) vs. CMO	C(mix.) vs. CMF
2-3 judges:	-0.956**	-0.969**	-0.787	-0.813*	-0.951**	-0.97 **
entire panel:	-0.977**	-0.975**	-0.974**	-0.909*	-0.990**	-0.995**
	A+B/2 vs. GAA	A+B/2 vs. GAO	A+B/2 vs. RMO	A+B/2 vs. RMC	A+B/2 vs. CMO	A+B/2 vs. CMF
2-3 judges:	-0.910*	-0.950**	-0.921**	-0.902*	-0.973**	-0.965**
entire panel:	-0.929**	-0.973**	-0.945**	-0.919**	-0.943**	-0.825*
SECOND RUN	C(mix.) vs. GAA	C(mix.) vs. GAO	C(mix.) vs. RMO	C(mix.) vs. RMC	C(mix.) vs. CMO	C(mix.) vs. CMF
2-3 judges:	-0.806*	-0.750	-0.775	-0.947**	-0.870*	-0.828*
entire panel:	-0.855*	-0.855*	-0.720	-0.925*	-0.779*	-0.781
	A+B/2 vs. GAA	A+B/2 vs. GAO	A+B/2 vs. RMO	A+B/2 vs. RMC	A+B/2 vs. CMO	A+B/2 vs. CMF
2-3 judges:	-0.929**	-0.927**	-0.959**	-0.871*	-0.992**	-0.965**
entire panel:	-0.937**	-0.967**	-0.955**	-0.923**	-0.961**	-0.947**

*Significant at the 5% level of probability.
**Significant at the 1% level of probability.
(Calculated using the t-statistic were $t_4 = \sqrt{4r^2/1-r^2}$)

TABLE 13.
CORRELATION COEFFICIENTS -- HANDLING STUDY

Torrymeter data vs. the various sensory parameters: (entire panel)

FIRST RUN	General Aspect-Appear.	General Aspect-Odor	Raw Muscle Odor	Raw Muscle Color	Cooked Muscle Odor	Cooked Muscle Flavor
ICO	0.894*	0.917*	0.820*	0.926**	0.883*	0.829*
IC5	0.780	0.687	0.767	0.897*	0.736	0.713
IICO	0.939**	0.932**	0.830*	0.809*	0.881*	0.846*
IIC5	0.643	0.637	. . .			

*Significant at the 5% level of probability.
**Significant at the 1% level of probability.
(Calculated using the 5-statistic where $t_4 = \sqrt{4r^2/1-r^2}$)

Puntarenas the day of capture and that used subsequently was made at CITA in a cold room at -20°C. The term run indicates the time that transpires from the capture of the fish until it undergoes microbiological, sensory and Torry meter analysis.

Sample collection. On Mondays and Thursdays, analyses were made of sensory qualities, microbiological counts and dielectrial constants using the Torry meter. It was necessary to arrive at CITA at 5:00 a.m. to prepare the fish for analysis. The fish were removed from the chest where they had been placed in two layers of 15 fish each. Individual fish were taken from both layers and the various sides and center so that the sample would be as representative as possible. Five fish were removed from fish of each icing treatment and placed on previously numbered trays. A reading based on the Torry meter reading was made, attempting to ensure that the area where it was placed was free of ice and slime so that the reading would be correct. For this reading, it was necessary to test 11 more fish in addition to the 5 mentioned. These 11 were then returned to their respective places and again covered with ice.

Use of the Torrymeter:*

a. To take individual measurements, place the dial on "1."
b. Place the base of the instrument on the surface parallel to the lateral line of the fish.
c. Press the button to take the reading.
d. The reading appears in the instrument display.
e. Erase this reading pressing the appropriate button.
f. Rinse the base of the Torrymeter with distilled water.
g. Proceed in the same manner for the following fish.
h. To obtain a meaningful average, it is necessary to work with at least 16 fish.

Discussion. The Torrymeter readings are a good index for determining the freshness of fish, since the dielectric properties of the skin and muscle are altered during its deterioration with the degradation of tissue components. This can be seen very well in the data obtained, where the average of the readings decreased as the fish got older. It is also important to note that the difference between the type of ice used to maintain the fish is quite obvious. For the first run where flake ice was used, the average of the Torrymeter readings remained higher than for the second run with chipped block ice. One can therefore conclude that the use of flake ice was effective in maintaining higher quality of the fish for a longer time.

VII. Salting and Drying of Fish.

Part of the Cooperative Agreement between CITA and URI involves a project to develop and/or improve low cost fish preservation techniques. Its primary objective is to improve the traditional methods of the artisanal fisherman of Costa Rica. It is hoped that the fisherman with little capital will be able to increase the useful life of his catch, decrease his losses and thus increase his income.

Since Costa Rican fishermen are already familiar with it, the technique of salting and drying was selected for initial study. Some of them already are accustomed to salted and dried fish at certain times of the year. However, hygenic conditions can be improved.

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*Torrymeter Fish Freshness Meter Operates Handbook. Torry Research Station, Aberdeen, Scotland, pp. 6-9; also refer to part II, Chapter 6.

TABLE 14. TORRYMETER DATA

First Run: Flake Ice						
-0 hours- No	Day 1 May 31	Day 2 June 4	Day 3 June 7	Day 4 June 11	Day 5 June 14	Day 6 June 18
1	11	11	4	2	10	0
2	8	0	5	7	5	0
3	11	11	9	0	3	0
4	11	9	6	7	0	0
5	11	10	5	3	3	4
6	11	11	2	5	5	0
7	11	10	6	5	1	4
8	11	11	7	0	8	0
9	11	9	7	1	0	0
10	11	3	4	3	3	2
11	11	10	8	2	0	-
12	11	7	0	0	4	-
13	8	6	2	4	1	-
14	6	2	0	10	1	-
15	8	0	1	0	0	-
16	11	11	2	8	0	-
X	10.1	7.6	4.3	3.6	2.8	1.0
sd	1.6	4.1	2.8	3.2	3.0	1.7
-5 hours-						
1	5	2	0	0	3	2
2	7	0	0	4	2	0
3	6	4	3	0	1	0
4	5	0	0	0	0	0
5	5	1	2	0	0	1
6	1	6	0	6	0	5
7	4	1	1	0	1	0
8	9	3	2	0	0	0
9	8	7	2	5	2	0
10	2	0	5	0	0	0
11	0	2	2	0	0	-
12	6	0	0	0	5	-
13	5	1	3	1	1	-
14	9	5	0	2	0	-
15	6	3	4	0	0	-
16	5	1	2	3	0	-
X	5.2	2.2	1.6	1.3	0.9	0.8
sd	2.6	2.2	1.6	2.1	1.4	1.6

(X = mean; sd = standard deviation)

TABLE 15. TORRYMETER DATA

	Second Run: Chipped Block Ice					
-0 hours- No	Day 1 June 28	Day 2 July 2	Day 3 July 5	Day 4 July 9	Day 5 July 12	Day 6 July 16
1	14	0	0	5	0	0
2	6	3	5	0	7	4
3	12	5	4	4	2	0
4	5	8	3	3	5	0
5	4	5	6	5	1	0
6	11	6	4	2	2	0
7	4	3	8	1	2	0
8	11	4	0	3	2	1
9	8	6	1	0	0	0
10	5	0	8	2	0	5
11	6	8	7	2	1	0
12	10	2	0	0	2	2
13	5	9	0	4	3	1
14	6	4	0	4	1	1
15	11	5	14	0	0	0
16	9	11	0	3	0	0
X	7.9	4.9	3.8	2.4	1.8	0.9
sd	3.2	3.1	4.1	1.8	2.0	1.5
-5 hours-						
1	6	0	0	0	0	0
2	7	0	0	0	0	0
3	0	0	0	0	0	0
4	6	0	0	0	0	0
5	5	0	0	0	0	0
6	0	0	0	0	0	0
7	0	0	0	0	0	0
8	5	0	0	0	0	0
9	0	0	0	0	0	0
10	7	0	0	0	0	0
11	8	0	0	0	0	0
12	3	0	0	0	0	0
13	7	0	0	0	0	0
14	3	0	0	0	0	0
15	2	0	0	0	0	0
16	2	0	0	0	0	0
X	3.8	0	0	0	0	0
sd	2.9	0	0	0	0	0

(X = mean; sd = standard deviation)

TABLE 16.

HANDLING STUDY

Sensory Evaluation Results
Flake ice: 0 hours

Whole Fish--General Aspects

	Appearance							Odor						
	I	II	III	IV	V	VI	VII.	I	II	III	IV	V	VI	VII.
A	5	3	3	3	2	2	1	10	7	6	6	3	2	1
B	5	5	4.5	3	3	2.5	1	10	9.5	9	6	5.5	3.5	2
C	4	4.5	3	-	3	-	1	8	9	7	-	4	-	3
D	5	4	4	3	4	3	1	9	10	9	6	7	2	0
E	5	-	4	3	2.5	-	3	10	-	8	6	3	-	3
F	5	4	4	3	-	1	1	10	9	8	2	-	0	0
G	-	4.5	4.5	3.5	2.5	1.5	1.5	-	5.5	9	7	5	4	0
$\bar{X}$	4.8	4.2	3.9	3.1	2.8	2.0	1.4	9.5	9.0	8.0	5.5	4.6	2.3	1.3
D	0.4	0.7	0.6	0.2	0.7	0.8	0.7	0.8	1.0	1.2	1.8	1.6	1.6	1.4

Raw meat

	Odor							Texture						
A	8	7	7	7	4	3	1	5	3	4	3	3	4	3
B	10	10	8	7	5.5	3.5	2	4	5	4	4	2	3	2
C	9	8	-	7	6	-	3	5	3	-	3	3	-	1
D	8	8	8	8	9	8	4	4	3	3	3	4	4	1
E	10	9	8	7	4	-	2	5	3	3	3	3	-	1
F	10	8	10		-	3	3	5	4	4	-	-	3	2
G	-	9.5	8	9	6	6	2	-	5	4	4	2	3	2
$\bar{X}$	9.2	8.5	8.2	7.5	5.8	4.7	2.4	4.7	3.7	3.7	3.4	3.4	3.4	1.7
D	1.0	1.0	1.0	0.8	1.8	2.2	1.6	0.5	1.0	0.5	0.5	0.5	0.5	0.8

Cooked meat

	Color							Odor						
A	5	3	3	3	2	4	2	10	7	7	6	6	5	4
B	4	5	4	4	3	2.5	2	10	9.5	8.5	7	5	3	2
C	5	3	-	3	4	-	4	8	9	-	6	7	-	1
D	4	4	4	4	4	3	2	8	9	8	9	5	4	3
E	5	4	4	4	2.5	-	2	10	9	8	7	2	-	3
F	5	4	4	-	-	4	4	10	9	8	-	-	4	1
G	-	4.5	4	4.5	2.5	3	2	-	10	9	7	6	5	4
$\bar{X}$	4.7	3.9	3.8	3.8	3.0	3.3	2.6	9.3	8.9	8.1	7.0	5.2	4.2	2.6
D	0.5	0.7	0.4	0.6	0.8	0.7	1.0	1.8	0.9	0.7	1.1	1.7	0.8	1.3

Cooked meat

	Flavor						
A	10	6	7	5	5	5	1
B	10	10	9	7	4	3	1
C	9	9	-	5	6.5	-	1
D	7	9	9	10	6	2	1
E	10	10	7	6	1	-	2
F	10	9	7	-	-	1	1
G	-	9	9	8	6	4	4
$\bar{X}$	9.3	8.9	8.0	6.8	4.8	3.0	1.6
D	1.2	1.3	1.1	1.9	2.0	1.6	1.1

TABLE 17.

HANDLING STUDY

Sensory Evaluation Results
Flake Ice: 5 hours

Whole Fish--General Aspects

	Appearance							Odor						
	I	II	III	IV	V	VI	VII	I	II	III	IV	V	VI	VII
A	5	4	4	3	2	1	1	10	9	6	5	3	1	1
B	5	5	4	3.5	2	2.5	1	10	9.5	9	6.5	3.5	3.5	2
C	5	3	3	-	1.5	-	1	9	7	6	-	3	-	1
D	4	4	4	3	3	4	1	7	9	9	7	3	3	0
E	5	-	3.5	3.5	2	-	1	10	-	8	7	2	-	0
F	5	4	4	3	-	1	1	10	9	8	2	-	0	0
G	-	4.5	4.5	4	3	1.5	1	-	9	9	8	6	3	1
$\bar{X}$	4.8	4.1	3.9	3.3	2.3	2.0	1.0	9.3	8.8	7.9	5.9	3.4	2.1	0.7
D	0.4	0.7	0.5	0.4	0.6	1.3	0	1.2	0.9	1.3	2.2	1.4	1.5	0.8

Raw meat

	Odor							Texture						
A	10	8	7	5	2	3	0	5	4	3	3	2	3	3
B	10	10	8.5	6	6	4	2	5	4	4	3.5	2.5	2	2
C	9	8	-	7	4	-	3	4	4	-	3	2	-	3
D	7	8	8	7	3	6	3	4	3	3	3	2	2	1
E	10	9	8	7	3	-	2	5	3	3	3	2	-	1
F	10	7	9	-	-	2	0	5	4	3	-	-	2	1
G	-	9.5	7.5	10	6	4	1	-	4	3.5	5	2	2	1
$\bar{X}$	9.3	8.5	8.0	7.0	4.0	3.8	2.0	4.7	3.7	3.3	3.4	2.1	2.2	1.7
D	1.2	1.0	0.7	1.7	1.7	1.5	1.5	0.5	0.5	0.4	0.8	0.2	0.4	1.0

Cooked meat

	Color							Odor						
A	5	4	3	2	3	3	2	9	8	7	6	4	4	3
B	5	5	4.5	3.	4	2.5	2	10	10	8	6.5	5.5	3	2
C	5	3	-	3	3	-	3	8	9	-	7	6	-	1
D	4	4	4	4	2	2	1	9	8	8	6	4	5	1
E	5	5	4	2.5	2	-	2	10	7	8	6	6	-	3
F	5	4	3	-	-	4	1	10	9	7	-	-	3	3
G	-	4.5	3.5	5	2.5	2	1	-	10	9	8	6	4	1
$\bar{X}$	4.8	4.2	3.7	3.3	2.8	2.6	1.7	9.3	8.7	7.8	6.6	5.3	3.8	2.0
D	0.4	0.7	0.6	1.1	0.8	0.9	0.8	0.8	1.1	0.8	0.8	1.0	0.8	1.0

Cooked meat

	Flavor						
A	9	9	6	6	4	2	2
B	10	9.5	9	7.5	4	3	1
C	9	8	-	7	5	-	1
D	9	8	10	7	4	2	1
E	10	10	6	6	4	-	1
F	10	9	7	-	-	1	1
G	-	10	9	9	6	4	1
$\bar{X}$	9.5	9.1	7.8	7.1	4.5	2.4	1.1
D	0.6	6.8	1.7	1.1	0.8	1.1	0.4

TABLE 18.

TORRYMETER DATA
Handling Study

Third Run: Flake Ice								
-0 hours- No	Day 1 Aug.27	Day 4 Aug.30	Day 8 Sept.3	Day 11 Sept.6	Day 15 Sept.10	Day 18 Sept.13	Day 22 Sept.17	Day 25 Sept.20
1	13	11	0	0	-	-	-	-
2	14	13	13	5	-	-	-	-
3	14	9	3	13	-	-	-	-
4	11	7	7	4	-	-	-	-
5	12	6	14	6	-	-	-	-
6	13	7	0	6	-	-	-	-
7	6	6	13	9	-	-	-	-
8	6	7	0	6	-	-	-	-
9	10	9	2	6	-	-	-	-
10	15	9	7	0	-	-	-	-
11	12	8	7	6	-	-	-	-
12	12	10	3	4	-	-	-	-
13	12	10	3	3	-	-	-	-
14	13	9	7	0	-	-	-	-
15	15	11	6	1	-	-	-	-
16	13	9	5	0	-	-	-	-
X	11.9	8.8	5.6	4.3	-	-	-	-
sd	2.7	1.9	4.6	3.7	-	-	-	-
-5 hours-								
1	1	1	2	3	-	-	-	-
2	4	2	1	1	-	-	-	-
3	3	0	0	5	-	-	-	-
4	0	1	0	4	-	-	-	-
5	9	3	1	3	-	-	-	-
6	4	3	3	0	-	-	-	-
7	12	1	0	1	-	-	-	-
8	2	5	6	0	-	-	-	-
9	8	6	0	0	-	-	-	-
10	0	1	0	1	-	-	-	-
11	7	5	0	0	-	-	-	-
12	8	2	0	1	-	-	-	-
13	4	8	6	0	-	-	-	-
14	1	9	3	0	-	-	-	-
15	6	5	4	2	-	-	-	-
16	7	5	0	1	-	-	-	-
X	4.6	3.6	1.6	1.4				
sd	3.3	2.7	2.2	1.6				

(X = mean; sd = standard deviation)

Several preliminary experiments were carried out in preparation for the rest of the study. The first step was to look for species besides shark that would be suitable for salting and drying. Shark is presently the only fish processed in this way by fishermen in Costa Rica. Sea catfish appears particularly promising. In addition, both sea catfish ("cola" or bagre and cuminate) and shark are readily available. Preliminary results confirmed the suitability of shark as raw material for this process and indicate that cola is also a good choice.

After species selection, the next step was a salt penetration study using these two fish cut into pieces of two different thicknesses and immersed in a saturated brine. Curves of salt content and water content were obtained over a period of time. These curves of initial salt penetration and salt saturation in the fish muscle were needed to calculate the time required to produce a product with a given salt content.

Salting in brine was chosen because it reduces salting time considerably. Since the diffusion of salt is quite rapid, bacterial and enzymic deterioration are minimized. In addition, insect contamination and oxidative rancidity are not a problem. When using brine, the speed of salt penetration into the muscle tissue is determined by the salt concentration, brine temperature, the type and purity of the salt used, the species of fish, the thickness and configuration of the fish, environmental conditions and agitation of the brine. Salt concentration is the most important factor (the time required is inversely proportional to the salt concentration). It was determined that 100 percent saturation is the concentration needed to minimize changes in the muscle tissue due to enzymic and bacterial action, especially considering the high temperatures at which artisanal salting is done. For this reason, all laboratory and field studies were planned with saturated brine.

It was planned to carry out a study on drying to immediately follow the salting trials. The drier to be used at this stage was being repaired at the time so that drying curves were not obtained. Work therefore continued in areas planned to be conducted subsequently to the controlled drying study. Experiments were carried out with a mechanical drier and with an experimental model of a solar drier, specifically designed and constructed for this study. Experiments with the mechanical drier determined the effect of different salting times on the external appearance of the finished product. After consulting the literature concerning salting and drying of fish, it was decided to produce salted-dried fish with a 28 to 30 percent salt content, dry weight, and 32 to 38 percent moisture. However, it appeared that products with this level of salt or a lower level did not have the desired appearance. The product traditionally consumed in Costa Rica is that with the characteristics of dried salted cod processed by means of strong salting. This product has a high salt content and an agreeable white appearance due to salt crystals on the fish surface. It is also a product with low water content (the grade of "extra hard"). It is assumed that higher levels of salt are required to give a product with these characteristics. In experiments with the mechanical drier, salt crystallization at the surface was observed but in an irregular, discontinuous manner producing a disagreeable appearance even in cases where the color was quite good. Salt quality may be the important factor here principally referring to its impurities and particle size.

The work completed so far with the experimental model of the solar drier consists basically in the determination of its efficiency in utilizing solar energy as compared to traditional drying, the direct exposure to the sun and wind. The results obtained to date, using only the drying chamber and chimney were not satisfactory.

The entire system has three parts: the drying chamber, the solar energy collector and the chimney. The drying chamber is crucial because the dehydrating process occurs in it and it must, therefore, have adequate conditions of temperature, relative humidity and air flow. The drying chamber

is a wooden box, whose interior is lined with black plastic and whose exterior is painted a dull black. This box is topped with a wooden frame across which is extended a double layer of plastic. The top layer is transparent to produce the greenhouse effect and the lower layer is black to absorb heat better. Two trays of metal mesh in a wooden frame inside the drying chamber support the salted fish to be dried. Tray dimensions are 120 x 60 cm.

The energy collector is of particular importance since it is in this section that the air entering the drying chamber is heated and this establishes the air flow throughout the system. The collector is a wooden box, its interior covered with a sheet of galvanized iron painted a dull black. Steel wool painted dull black covers the bottom of the unit. The top is a double layer of transparent plastic.

The chimney at the exit of the drying chamber is a simple galvanized wire structure covered with black plastic. Its function is to produce a pulling effect that increases air flow. When conducting experiments, thermocouples or thermometers are placed at important points such as the entrance of the collector, the entrance of the drying chamber and the entrance and exit of the chimney to observe temperature differences and to establish the effect of each section of the system. During experiments, the weights of salted fish samples in the solar drier are compared with those of other samples placed on an identical tray in the sun. These measurements of temperature and fish weight are made every hour.

In order to determine the efficiency of the system, the amount of solar radiation on the day in question is obtained from the Meteorological Station in Puntarenas (the main port on the Pacific, the site of the tests). This is compared with energy balances made using experiemental measurements.

At the conclusion of this work, it is hoped that we will be able to offer the artisan fisherman improvements in traditional salting procedures as well as a means of rapid drying that will minimize insect contamination and the cooking of the fish that results from direct action of the sun. With these improvements, the fishermen will be able to produce a product with increased hygenic and sensory quality in a shorter time and for only the cost of a small initial investment. Solar driers can be constructed from cheap and readily accessible materials.

VIII. Overall Summary and Recommendations

Proper development of the fishery industry can contribute much to the betterment of nutrition in developing countries. The possibilities for this in Guatemala and Costa Rica are not equal because of geographical differences and differences in food habits. Guatemala's catch of fish is limited by coastal restraints and the amount of fish consumed in this country is comparatively small. Part of this latter phenomenon may be due to the unavailability of fresh fish over many, many years. Any increase in the amount of available fresh fish is not conceivable in the immediate future. Even if this were to occur, transportation to and distribution within the interior, would be a formidable task. Increased fish consumption in this country would, therefore, be quite unlikely under the present conditions. If feasible, aquaculture could probably contribute to an augmentation of the source. It has been reported that some efforts have been and are being made along these lines.

Development of a habit of consuming fish in the fresh or preserved state would, most likely, have to be achieved, especially by the rural populace who are most in need of the protein. Should adequate supplies be available at some future date, methods of preservation, transportation and distribution would have to be developed so that the material will be available at the "target" areas. Salted fish is used in this country to some extent at certain times of the year and, perhaps, preservation of the product in this form,

could provide an initial "take off" point if the raw commodity ever becomes available. As in many other areas, proper handling to assure a product of good sanitary and nutritional quality is an important prerequisite in considering these possibilities for either the fresh or preserved product.

Costa Rica, on the other hand, is blessed with good coastal areas and conditions suitable for a large fishing industry. As a consequence, this country has a substantial catch and the consumption of fish here is relatively higher. Still, the availability of fish within the interior, rural areas is below the desired level which would help to eliminate niches of malnutrition. Transportation and distribution are apparently important handicaps here since there seems to be an abundance of fresh fish in the markets of San Jose, the capital. To achieve better and more far-flung distribution of fish, adequate preservation methods must be developed. Maintenance of high quality all along the line from the point of capture to the point of consumption is an important requisite. For fresh fish, handling immediately after capture, cleaning (gutting), washing and icing seem important areas where added emphasis should be placed in order to assure a supply of high qualtiy product. More adequate icing methods by fishermen and intermediates can be facilitated by simple educational and demonstrative means and, moreso, by the availability of ice and more suitable recepticles for holding the ice and the fish, especially aboard the fishing vessels. Government and industrial intervention in this area, if judiciously executed, could do much to accelerate improvement. At the same time, the fishermen and intermediates, if awakened to this deficiency, could probably be propelled to form "ice cooperatives" to ensure an adequate supply at a low cost. Government subsidy in such an adventure would be a significant national contribution.

In order to boost the consumption of protein from fish, the accelerated use of many species which are not now being used to the maximum should be encouraged. This would not only provide more protein, but would lead to an expansion of catching activities, providing more labor and more industry. Utilization of such species will depend heavily on their nature, local habits and the resources of the species.

The keeping quality of fish after capture could be aided by some means to prevent or retard spoilage on board. Since the scarcity of ice seems to be a serious problem, maybe use of sorbic acid (potassium sorbate) as a microbial inhibitor in the fish containers would help to hold down spoilage. Action here would, of course, be primarily superficial since enzymatic reactions within the tissues would still proceed. The efficacy of any such treatment would have to be established and any additive used would have to be approved for use in or on foods.

Assuming that fish arrive at the market place in good condition, the maintenance of high hygenic conditions within the market could be enhanced by setting up "model fish vending booths" within the market and have them tended by selected vendors with experience in the business. Once the operations of these models have become established, other vendors will wish to have similar facilities and the concept will, at least, have gained acceptance. This done, the entire current practices and facilities can be gradually modified to meet the required or desired levels of efficiency and hygenic specifications. Such a change-over should, preferably, be gradual and educational so as not to disrupt the business of any who cannot voluntarily afford modifications or who, because of tradition are reactive to "imposed" changes. Likewise, as much help and education as possible should be provided by government, industry and other interested groups.

Full utilization of many so-called "underutilized" species will depend heavily upon the development of fishery products and on the rapid evolution of methods to preserve fish in such tropical regions. Several possibilities have been identified already in Costa Rica. One outstanding example is the fish known as Crevalle Jack or jurel (Caranx hippos) which has red meat, and is like beef in color. The abundance of this fish in Costa Rican waters should

be investigated and its use in the preparation of fish products such as sausage, etc., fully investigated. Despite the preference of the populace for a whole fish and the alledged proneness to rancidity, the natural color points to candidacy of this fish for use in products which would otherwise be colored artifically. Preliminary work at CITA on its use in sausage was promising enough to warrant more detailed investigation. A resume of some experimental observations follows.

The fish with red meat, like beef in color, is jurel or Crevalle Jack (Caranx hippos). It is caught in the Pacific, outside the Gulf of Nicoya, but its abundance is not known nor are there statistical figures since it is not a species of importance here. It would be included under "chatarra" so that the amount caught and potential catch would also be unknown. Jurel is presently eaten fresh but it has little market--the fishermen tend to throw it away since it doesn't bring a very good price. People don't like the red color, preferring white fish. The flesh tends to become rancid quickly. It's potential for salted fish would not be good here since again, a white appearance is desired. Smoking might have more of a potential.

Last year (June 1978), Carlos Avalos of CITA tested this fish in sausage since its color would make it an ideal fish for this purpose. The formula used was as follows:

filler (yuca starch)	10%
jurel	65
ice	20
salt	2
sausage spice	0.5
curing salt	0.5
binder (Gomafo)	1.0
garlic	.25
hot pepper	.25
oregano	.25
sugar	.50

The resulting sausage had good flavor and odor, with no fishy taste. The texture was smooth and sticky, very moist. The color was excellent with a red exterior, quite agreeable, and the interior a pleasant pink. There were also some disagreeable yellow sections in the internal part of the sausage. The following day, the color, odor and flavor were the same. The casing was a bit wrinkled but still was of good appearance. The texture was very smooth, dissolved rapidly in the mouth, very moist.

Jurel is harder to fillet than shark because its skin is softer and it has bones. The meat is red in color with darker meat in the dorsal section. The proportion of darker meat is greater in jurel than in shark. This would decrease its yield (if these parts were not used). Jurel is a smaller fish than shark with bones. This implies a poorer yield and more work in filleting. The sausage made with shark had a better texture than that made with jurel, but the red meat of jurel is better for the development of good color.

It would be interesting to try making sausage with part pork and/or beef and part jurel. Perhaps it would be possible to improve the texture of the sausage with 100 percent jurel.

Salted and dried fish, as well as brined fish, will very likely contribute much to improving the dietary status of Costa Ricans. As noted previously under the section on "Salting and Drying," this method of fish preservation is not foreign to Costa Rican fishermen and some salted fish and fish products are eaten by the populace. In addition to the work done (or contemplated) and outlined in the above-mentioned section, some work has been done on jurel. A very brief summary follows:

Some work with salting and drying of jurel fillets was done. Dry salting

and salting in brine were tried. The jurel salted in brine one week was dried 69 hours at 30-37°C to a final water content of 37.5%. It had a strong rancid odor, an intense yellow color on the surface and a dark brown color in the interior. The flavor was that typical of salted cod, rancid but not disagreeable. The texture was very hard (eating it as is without desalting). Salt crystals covered the surface. A broth made with this jurel had an odor and flavor typical of salted cod. The flavor of the meat itself was very disagreeable--very bitter.

Perhaps the most encouraging signal for the role of fish and fishery products in the nutrition of Costa Ricans is the enthusiastic cooperation and encouragement given by government agencies, industry and other groups. CITA, a dedicated group involved in Food Science and Technology is destined to be a national leader in all such developments. An English translation by the URI associate of a summary of a fish preservation study by Mr. Carlos Avalos is included below.

> There exists a great interest to develop fishery products at the national level. The fish processing industry in Costa Rica produces only canned tuna and sardines, a small quantity of frozen fish and an insignificant amount of salted-dried fish. The rest of the fish caught is consumed as fresh fish.

An emphasis in the national Program of Feeding and Nutrition (Programa de Alimentacion y Nutricion, PAN) is that of using marine products in the menu administered by the Program due to the high nutritive value of these products. Limiting factors are the small variety of products available and their high cost.

The project for developing low-cost fish preservation techniques described above, not only aims to provide concrete solutions to the problems confronting the small-scale fisherman, but also to offer alternative fishery products as components diversifying and fortifying the PAN menu. The introduction of these new products will not only benefit the program itself but will also benefit the processor. PAN now serves 442,200 children in schools (Comedores Estudiantiles, CE) and 40,3000 children in education and nutrition centers (Centros de Educacion y Nutricion, CEN). In addition, [illegible]y habits in fish consumption will be developed since all beneficiaries are young children (2-12 years).

Because of the importance of this project, its programmed stages will be completed even though they will extend beyond the CITA-URI agreement period. Process improvement will continue in the pilot plant, this consisting of a drying study utilizing a drier with controlled temperature, relative humidity and air velocity to obtain the drying curves required to find out how moisture is given up by the different species. Work will continue to develop a product with an appearance adequate for the eventual commercialization of the product. It will also be necessary to include storage studies to determine the effect of salt and moisture content on shelf life and sensory tests to determine the acceptability and functionality of the product as used in student dining halls. The field tests with the solar drier will continue with modifications in design if necessary. All work will be accompanied by an economic study.

APPENDIX A

FLAT-FISH SCORE SHEET

Raw

General Appearance

Mark

5 Eyes full, bright or very slightly cloudy; gills bright red or very deep pink, with slight clear slime; slime on body clear to slightly milky. Muscle blocks apparent (M.B.A.)

4 Eyes slightly sunk, some opacity; gills pale pink, bleached, with thick opaque slime; slime on body thick and opaque; edge of gill cover slightly bleached and pinking in regions on underside of body. (M.B.A.)

3 Eyes sunk and opaque; gills bleached with thick grey or brown slime; slime on body yellow and watery; bleaching on back, particularly in head region and gill cover, pinking on underside. (M.B.A.)

2 Eyes completely sunk or bloated and opaque; gills very bleached with dirty grey or brown-yellow slime; slime on body watery with yellow bacterial discoloration; marked bleaching and pinking on body. (M.B. no so apparant.)

1 Eyes totally callapsed; gills badly bleached and badly discolored with bacterial slime; body slime watery or scarce with marked bacterial discoloration, in head region, particularly. Gill cover very bleached, and marked pinking on the underside. (M.B. slightly apparent.)

Flesh, including the Body Cavity

5 Translucent with blue or pink tinge. Dark purple blood in backbone.

4 Loss of translucency; bluish or pinkish white; slightly waxy. Backbone still purple.

3 Waxy, slight yellowing, slight discoloration of body cavity. Backbone still well colored (red-blue or purple.)

2 Some opacity, yellow or brownish discoloration extending in from fin rays. Discoloration of body and reddening on backbone.

1 Marked opacity, yellow or brown discoloration and marked reddening on backbone.

0 Marked discoloration, particularly in body cavity. Blood almost completely diffused in backbone.

Texture

5 Firm, smooth and slimy.

4 Loss of slime but no marked grittiness.

2 Grittiness towards the tail.

1 Marked general grittiness.

Raw Odors

10 Fresh oil, metallic, roses, fresh-cut grass ("lawn-mower").

9 Metallic, oily, earthy, peppery.

8 Oily, seaweedy, aromatic.

7 Oily, citric, musty, mousey.

6 Oily, bready, biscuity, malty, cut-flower stems.

5 Sour beer, slight rancidity, painty, cod-liver oil.

4 Muddy, grassy, meaty, satle vegetables, "old-boots", fruity, sweaty, lower fatty acids.

3 Rotten cabbages, sour sink, wet matches, rotten meat, rancid butter.

2 Byre-like, singed hair, ammonia.

1 H_2S, strong ammonia, sulphides.

0 Faecal, nauseating, indole.

Cooked Odors

10 Meaty, onlony, fresh salt butter or margarine, Worcester sauce, slight caramel.

9 Oily, slightly aromatic, slightly peppery, boiled clothes.

8 Curry, still oily, peppery, damp clothes, "baked" smell.

7 Caramel, boiled potatoes, musty, butterscotch.

6 Metallic, slightly sour, acrid, slightly sweaty, boiled string.

5 Sour bread, lower fatty acids, rancid butter, singed milk, smoky.

4 Slight amines, slight ammonia, sour beer, spoiled cheese.

3 Ammonia, very sour, slightly faecal.

2 Strong ammonia and amines, faecal.

1 Very strong ammonia, strongly faecal, putrid cheese.

Texture

5 Firm and dry.

4 Crumbly, short and firm.

3 Soft but dry.

2 Soft and moist.

1 Very soft, sloppy.

Cooked Flavor

10 Meaty, very slightly bitter, shellfish, slightly garlic flavored.

9 Oily, rather herring-like, metallic, but still meaty.

8 Curry, seasoned meat, oniony, spicy, peppery, canned meat.

7 Neutral flavor, only slightly sweet and meaty.

6 Slightly rancid, slightly sour, slightly bitter.

5 Rancid oil, rancid butter, fish meal.

4 Bitter, "woody," sour, little flavor.

3 Very bitter, rotten fruit.

2 Very bitter and very sour.

1 Nauseating: difficult to taste.

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APPENDIX A-1

Score Sheet Used in Training Panel
March 5, 1979

PESCADO

OLOR CRUDO, OLOR Y SABOR COCINADO

Nombre _____ Fecha _____

Serie _____

Las muestras que se le presentan deben ser analizadas por usted. Describa las principales caracteristicas que observe en el olor crudo, olor y sabor cocinado.

Olor crudo

Numero de muestras	Comentario
1. _____	_____
2. _____	_____
3. _____	_____

Olor y sabor cocinado

1. _____	_____
2. _____	_____
3. _____	_____

APPENDIX A-2

Score Sheet Used in Training Panel
March 9, 1979

PESCADO

ASPECTO GENERAL

Nombre _____ Fecha _____

Serie _____

Las muestras que se le presentan deben ser analizadas por usted. Describa las principales caracteristicas que observe en lo referente al estado de frescura (aspecto general), tratando de emplear terminos que expliquen el porque es "bueno," fresco o menos fresco.

Numero de muestra	Comentarios
1. _____	_____
2. _____	_____
3. _____	_____

OLOR CRUDO, OLOR Y SABOR COCINADO

Las muestras que se le presentan deben ser analizadas por usted. Describa las principales caracteristicas que observe en el olor crudo, olor y sabor cacinado, tratando de emplear terminos que expliquen el porque es "bueno," fresco o menos fresco.

Olor crudo	
1. _____	_____

Numero de muestras	Comentario
2. _____	_____
3. _____	_____

Olor y sabor cocinado:

1. _____	_____
2. _____	_____
3. _____	_____

APPENDIX A-3

PESCADO

ASPECTO GENERAL

Nombre_____ Fecha_____

Serie _____

Para cada muestra que se le presenta, evalue el aspecto general, usando las escalas en la hoja adjunta, para la apariencia y papa el olor de la superficie del pescado (no el olor por adentro o de las cavidades).

Numero de muestra	Puntaje Apariencia	Puntaje Olor
_____	_____	_____
_____	_____	_____
_____	_____	_____

Comentario:_____

_____

_____

_____

OLOR Y COLOR DE LA CARNE CRUDA

Para la muestra que se le presenta de carne cruda, evalue su olor y color, usando las escalas de la hoja adjunta.

Numero de muestra	Puntaje Olor	Puntaje Color
_____	_____	_____
_____	_____	_____
_____	_____	_____

OLOR Y SABOR DE LA CARNE COCIDA

Para la muestra que se le presenta de carne cocida, evalue su olor y sabor, usando las escalas de la hoja adjunta.

Numero de muestra	Puntaje Olor	Puntaje Sabor
_____	_____	_____
_____	_____	_____
_____	_____	_____

Comentario:_____

_____

_____

CHAPTER 23 ASSESSMENT OF THE FRESHNESS OF FISH

BY D. Kazantzis, S.M. Constantidines, C.O. Chichester, and T.C. Lee

Fish, because of its high nutritive value, is a very suitable substrate for indigenous as well as extraneous microoorganisms. In addition, the tissues (flesh) contain many enzymes which, under appropriate conditions, can degrade proteins, lipids and carbohydrates, with the production of malodors and even toxins. When fish is gutted after capture, the microbial flora of the gut may contaminate the commodity, which, if not promptly and adequately washed and stored, will deteriorate rapidly.

Freshness is an important attribute of fish and has a great influence on the market acceptability, edibility and public health rating of this important high protein food. In view of this, experiments were designed to assess the freshness of certain well-known commonly eaten species of fish.

Since the project was designed to be a bi-phasic one, with a research assistant (Mr. D. Kazantzis) at the University of Rhode Island, working in consort with the resident research associate in Central America (Ms. Linda Nutley), preliminary experiments were done at the University of Rhode Island using local species of fish. However, since fish from tropical waters are different from those in the waters of the temperate zone, the said experiments were later repeated in Central America, using the species which are eaten in greatest quantity and most frequently by the local populace. Species selection was done with the aid of the University of Rhode Island's team working on stock assessment in Costa Rica and of local fisheries experts.

Probatory experiments were carried out using six species of saltwater fish. These experiments were undertaken to:

1) Test published methods of standardized adaptable methods for applicability in the determination of protein, non-protein nitrogen, lipids, moisture, ash, and other components of fish at various intervals after capture.

2) To get acquainted with and assess the use of the Torrymeter in determining the freshness of fish. This compact and relatively new piece of equipment is being widely promoted for use in the rapid determination of the freshness of fish.

3) To assess the microbiological value of fish after storage on ice for extended periods.

4) To observe any possible correlation between the Torrymeter readings, the chemical tests and microbiological counts in evaluating the freshness of fish.

Procedure

Fish were obtained from the Point Judith Fishermen's Cooperative in Galilee, Rhode Island.

Studies on Freshness

For this, yellow flounder, whiting, scup and butterfish were used. They were obtained 5-6 hours after capture, taken to the laboratory as quickly as possible, covered with ice and placed in a walk-in cold room until needed. Tests were done on whole, dressed (gutted) and filleted (with skin on) fish. For each of these categories, twelve samples were used. Torrymeter readings

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were taken daily for the first eight days and at the eleventh and fifteenth day.

Sensory Evaluations

Whole fish were used here. Odor and appearance were evaluated by a panel of 4-6 persons, using an hedonic scale of 1-9. The condition of the skin, eyes and gills was evaluated using the criteria summarized in Table 9.

Microbiological Tests

Total plate counts and proteolytic counts were done on samples removed aseptically from each species. Analyses were done at 0, 3, 6, 12 and 18 days of storage on ice. The procedures outlined in the ICMSF Handbook (Thatcher and Clark, 1974) were used.

Chemical Tests

A few assays were done on mackerel and grayfish, mainly to check methodology and reagents prior to recommending them to the research associate in Central America. This exercise constituted a portion of the responsibility of the research assistant in Rhode Island. General and routine chemical methods were used to assess protein, ash, moisture and lipids. A very useful recent compilation of methods used for assessing fish quality has been prepared by Jhaveri et al. (1979).

Results and Discussion

Table 1 shows the composition of mackerel and grayfish. Histamine, TBA, hypoxanthine and other values are shown also. Since these experiments were designed merely to gain experience in the methodology, no decisions concerning quality, as reflected by the values obtained, will be attempted.

Table 2 shows Torrymeter readings taken on fish aboard the boat at about 10 minutes after capture. These readings do indicate that:

1) Torrymeter readings taken on fish right after capture tend to be high;
2) there is a great difference in the Torrymeter reading between species of fish. No two species of fish can be compared as to freshness on the basis of the Torrymeter reading.

This inter-species variation is a very serious consideration and, perhaps, a drawback in the use of the Torrymeter to assess the freshness of fish.

The Torrymeter and its operation are described in the booklet on "Fish Freshness."

Tables 3-6 and Figures 1-4 show the Torrymeter readings for whole, gutted fish and fillet stored under ice for varying periods, up to 15 days.

The Torrymeter readings of flounder, whiting, scup and butterfish (whole, dressed and skin-on fillets) decreased with time. Of all the four species, flounder started with the highest reading on 0 day and kept well for about 7-8 days. However, the 15 day reading did not go much below 10 on the Torrymeter scale (Table 3, Fig. 1).

The readings for whiting dropped very rapidly and after 15 days of ice storage the whole and the dressed samples gave very low readings on the Torrymeter scale (Table 4, Fig. 2). The skin-on fillets were found to be more stable than either the whole or the dressed samples.

Scup gave slightly lower initial readings than whiting. However, the readings tended to remain somewhat higher as the storage period increased (Table 5, Fig. 3).

Butterfish displayed trends similar to whiting but the filleted samples gave lower readings in the later storage stages (Table 6, Fig. 4).

Total aerobic plate counts and aerobic proteolytic counts of all four

TABLE 1. Proximate Analyses and Other Indices of Mackerel and Grayfish

Sample	Protein	NPN	Lipid	Moisture	Ash	TMA[a]	Hypoxanthine	Histamine	TBA[b]	REP[c]	Urea
	%					mg %			mg/Kg	%	
Mackerel Mean $\bar{x}$	17.16	—	5.1	76.7	1.11	3.6	25.8	2.05	4.5	30.39	—
S.D.	±0.43	—	±0.03	±0.18	±0.016	±0.07	±0.51	±0.13	+0.1	+1.4	—
Grayfish Mean $\bar{x}$	—	0.78	16.45	69.5	0.71	—	—	—	1.85	—	1.51
S.D.	—	±0.2	±0.32	±0.28	±0.01	—	—	—	+0.05	—	+0.04

[a]Trimethylamine

[b]Thiobarbituric acid

[c]Readily extractable protein

TABLE 2. Torrymeter Readings Taken on the Boat
(10 min after catch)

Torrymeter Readings*	Flounder	Whiting	Hake	Mackerel	Butterfish	Monkfish
Mean $\bar{x}$	15.75	14	15.9	13.3	14.58	9.83
Standard Deviations	0.66	0	0.3	0.64	0.49	0.37

*Torrymeter readings of 15 fish per species.

species are shown in Table 7 and in Figures 5 and 6. At the beginning of the study, flounder had the lowest counts, followed by scup.

Results of the sensory evaluations are shown in Figures, 7, 8, 9 and 10 and Table 8. Flounder and scup showed better general appearance and odor than whiting and butterfish, whose acceptability dropped rapidly over a period of time. Generally, a steady decrease in the sensory readings was observed. Flounder and scup showed better sensory evaluation (skin, eyes, gills and body smell) than whiting and butterfish. Even though the grading was done on a different scale (A,B,C,D), this sensory scheme gave a good comparative tool in assessing fish freshness.

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Jhaveri, S.; Montecalvo, J. Jr.; Karakoltsides, P.; and Howe, J. "Abstracts of Methods Used to Assess Fish Quality." University of Rhode Island Marine Technical Report 69, 1979.

Thatcher, F.S., and Clark, D.S. Microorganisms in Foods, 1. Their Significance and Methods of Enumeration. Toronto: University of Toronto Press, 1974.

TABLE 3. Torrymeter Readings of Whole, Gutted and Skin-on Fillets of Flounder During Ice Storage

Torrymeter readings:		# Days in Ice										
Sample		0	1	2	3	4	5	6	7	8	11	15
Whole:	mean *	15.34	15.00	15.33	14.00	13.00	12.08	12.16	11.66	10.9	10.58	10.91
	s.d. ±	.47	.41	.62	.71	.71	1.26	0.55	0.84	1.08	0.95	0.86
Gutted:	mean	15.83	15.00	14.83	14.25	13.00	12.81	12.16	11.16	11.36	11.08	11.36
	s.d. ±	.37	.58	.55	.59	.58	1.07	0.68	0.89	1.06	0.75	0.48
Fillet:	mean	15.75	15.33	14.67	13.34	12.97	12.50	12.66	12.00	12.41	10.91	9.19
	s.d. ±	.43	.62	.85	.60	.99	0.76	0.84	.70	.49	.49	.75

* n = 12 fish per group

s.d. = standard deviations

TABLE 4. Torrymeter Readings of Whole, Gutted and Skin-on Fillets of Whiting During Ice Storage

Torrymeter readings: Sample		# Days in Ice 0	1	2	3	4	5	6	7	8	11	15
Whole:	mean *	14.75	13.45	11.27	10.27	8.62	6.36	4.9	4.36	3.72	2.5	1.36
	s.d. ±	0.89	0.50	1.28	2.49	3.48	2.99	2.64	2.70	2.52	1.32	0.64
Gutted:	mean	15.25	13.00	11.33	10.08	6.5	5.00	5.33	4.33	2.25	2.25	0.9
	s.d. ±	1.64	1.68	1.65	1.50	1.66	1.35	2.01	1.10	1.01	0.59	0.66
Fillets:	mean	13.75	13.83	12.0	11.08	10.25	9.41	9.25	9.66	9.0	7.16	6.58
	s.d. ±	0.72	0.90	0.82	1.11	1.53	0.95	1.47	1.02	1.58	2.16	2.01

* n = 12 fish per group

s.d. = standard deviations

TABLE 5. Torrymeter Readings of Whole, Gutted and Skin-on Fillets of Scup During Ice Storage

Torrymeter readings:		# Days in Ice										
Sample		0	1	2	3	4	5	6	7	8	11	15
Whole:	mean *	12.83	12.27	11.41	11.5	10.75	9.00	10.66	9.41	10.00	8.75	6.66
	s.d. ±	0.55	0.86	0.86	1.12	1.01	0.82	1.49	0.49	0.91	0.92	0.62
Gutted:	mean	12.50	11.42	11.08	10.83	10.33	8.76	9.16	8.66	9.16	8.75	7.25
	s.d. ±	0.96	1.32	1.04	0.90	1.10	0.69	0.89	0.74	0.89	1.42	0.59
Fillets:	mean	12.17	11.45	9.92	9.24	9.25	8.25	8.25	8.07	9.0	—	—
	s.d. ±	1.14	0.66	0.86	0.70	0.60	0.43	1.08	0.61	0.7	—	—

* n = 12 fish per group

s.d. = standard deviations

TABLE 6. Torrymeter Readings of Whole, Gutted and Skin-on Fillets of Butterfish During Ice Storage

Torrymeter readings: Sample		# Days in Ice 0	1	2	3	4	5	6	7	8	11	15
Whole:	mean *	14.42	12.00	10.25	8.58	6.00	4.92	4.66	4.00	3.83	4.41	3.5
	s.d. ±	.95	1.41	1.74	1.11	1.47	1.75	2.03	1.29	1.77	1.32	1.65
Gutted:	mean	13.58	11.00	8.75	7.25	5.33	4.67	4.5	3.75	3.91	3.58	3.33
	s.d. ±	1.25	1.73	1.88	1.01	1.24	1.59	0.86	1.73	1.55	1.38	1.37
Fillet:	mean	12.30	11.36	9.27	8.27	6.65	4.18	3.81	3.00	2.81	2.0	0.58
	s.d. ±	1.19	.64	1.35	1.42	1.15	1.19	1.19	1.28	1.40	1.04	0.43

* n = 12 fish per group

s.d. = standard deviations

FIGURE 1

Torrymeter Readings of whole (●), Gutted (■) and Skin-on fillets (▲) of Flounder during ice storage.

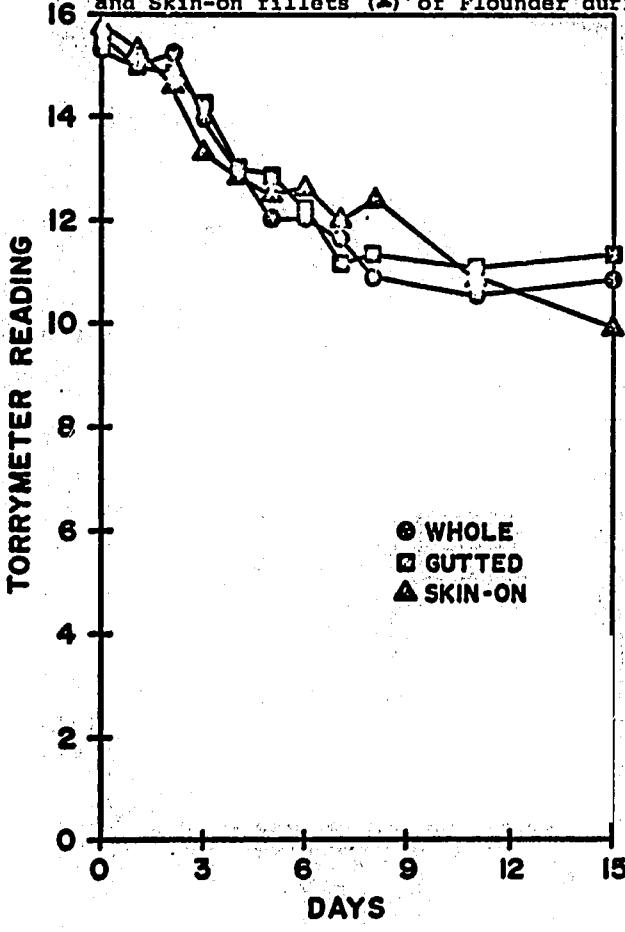


FIGURE 2

Torrymeter readings of whole (●), gutted (■) and skin-on fillets (▲) of Whiting during ice storage.

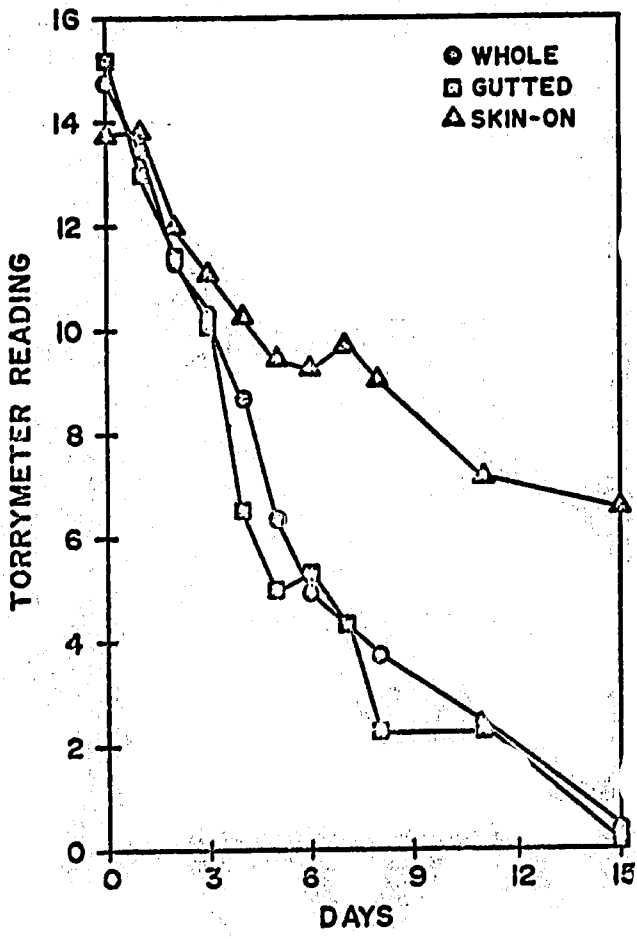
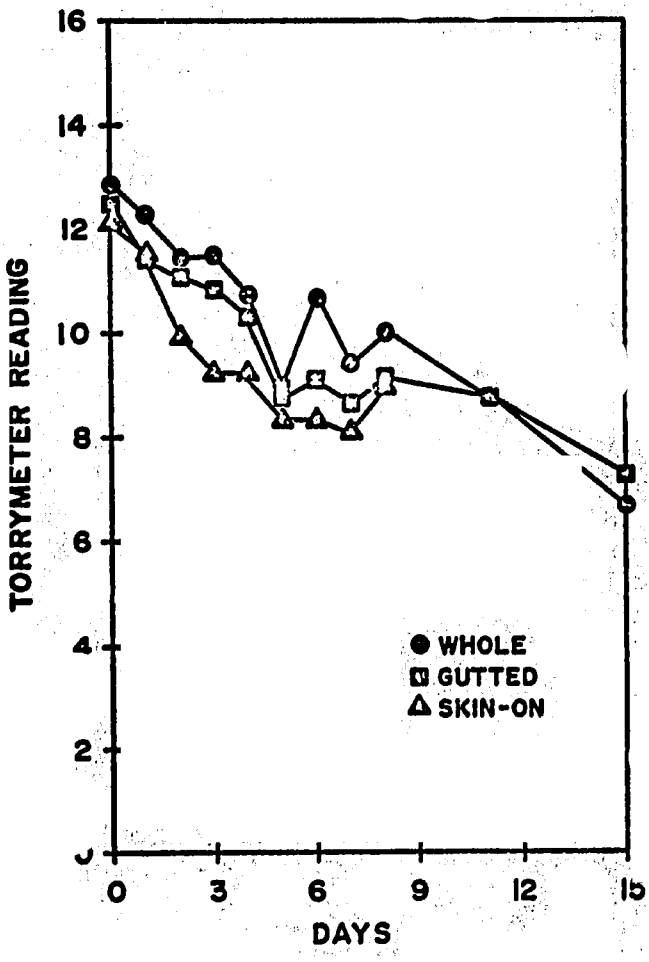


FIGURE 3

Torrymeter readings of Whole (●), Gutted (■) and Skin-on Fillets (▲) of Scup during ice storage.



FIGURL 4

Torrymeter readings of Whole (●), Gutted (■) and skin-on fillets (▲) of Butterfish during ice storage

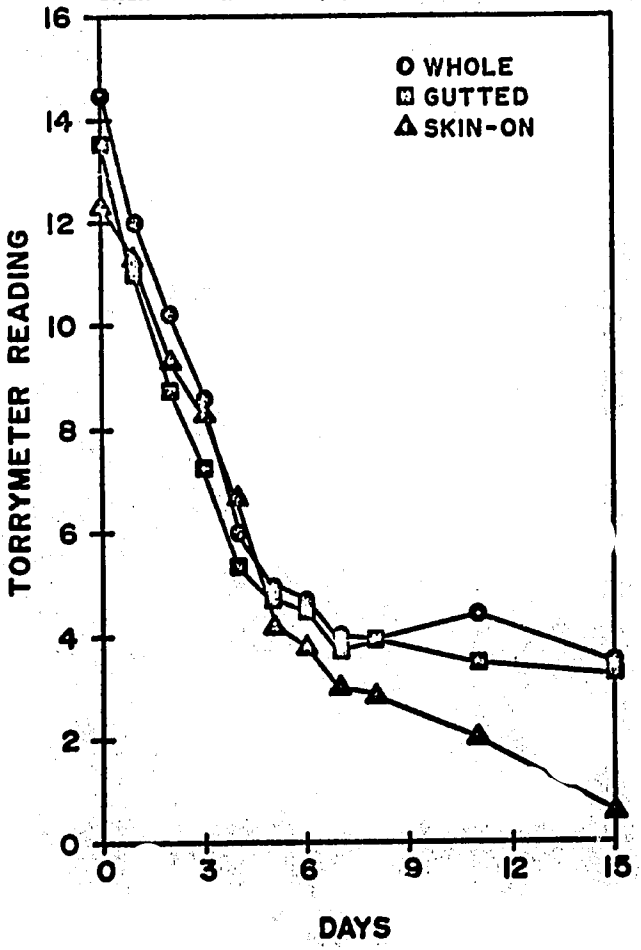


TABLE 7. Total Plate Counts and Proteolytic Counts of Flounder, Whiting, Scup and Butterfish, During Ice Storage

Species	# Days in Ice									
	0		3		6		12		18	
	TPC[a]	PC[b]	TPC	PC	TPC	PC	TPC	PC	TPC	PC
Flounder	1.02×10^2	<10	1.9×10^2	0.5×10^2	1.45×10^3	1.3×10^2	1.75×10^4	3.5×10^3	5.3×10^6	2.6×10^6
Whiting	1.65×10^2	<15	1.8×10^3	2×10^2	1×10^4	1.5×10^3	1.24×10^5	1.02×10^5	4.9×10^6	3.2×10^6
Scup	7×10^2	<25	1×10^3	1×10^2	3.1×10^4	2.3×10^3	8.65×10^5	6.3×10^4	6.7×10^6	3.3×10^6
Butterfish	9.6×10^2	<50	2.3×10^3	2×10^2	5.5×10^3	1.10^3	1.8×10^5	6.5×10^4	6.5×10^6	3.8×10^6

[a]Total Plate Counts

[b]Proteolytic Counts

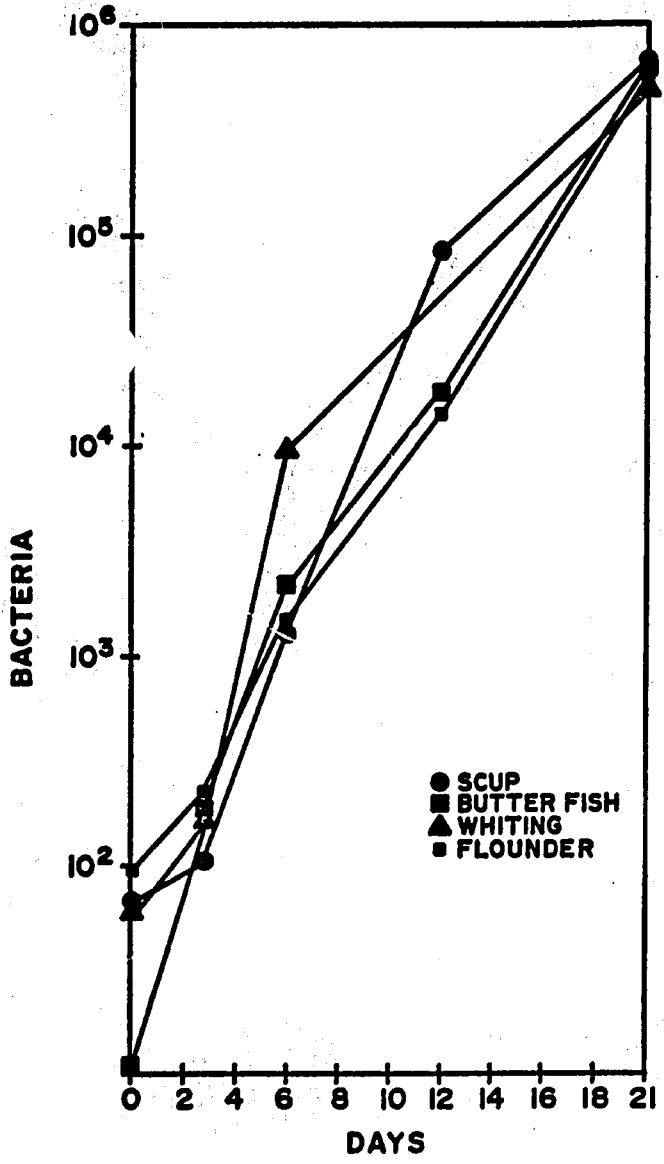


FIGURE 5

Total Aerobic Plate counts of Flounder (■) Whiting (▲), Scup (●) and Butterfish (▩) during ice storage.

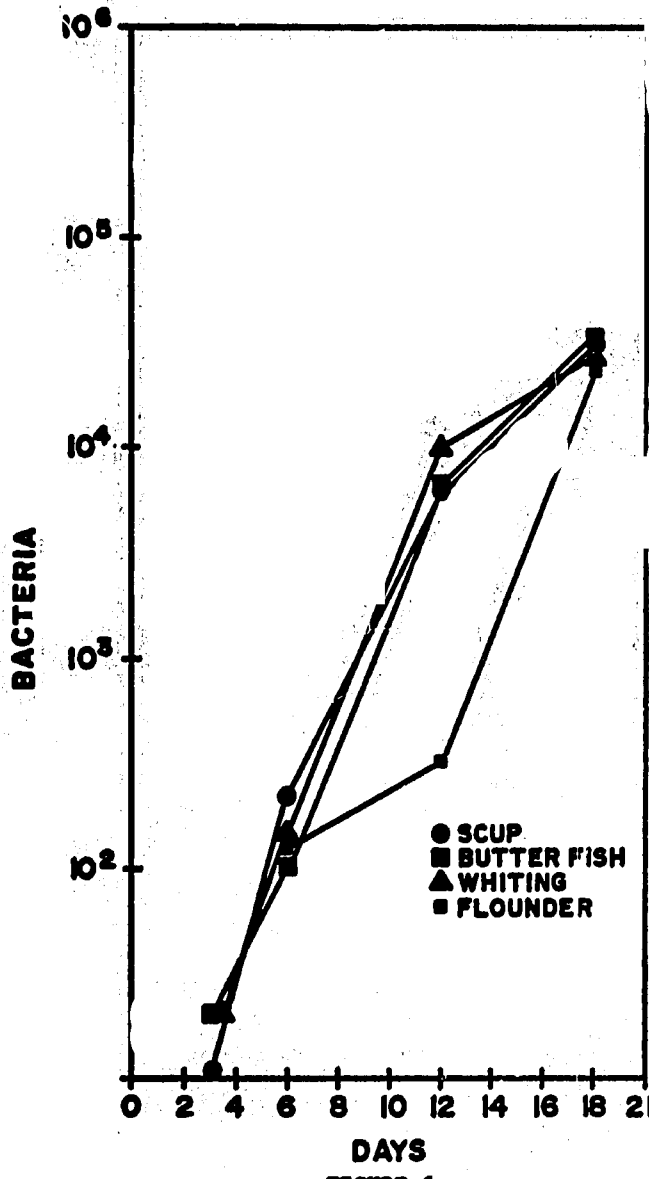


FIGURE 6

Total Aerobic Proteolytic Counts of Flounder (■), Whiting (▲), Scup (●) and Butterfish (■) during ice storage

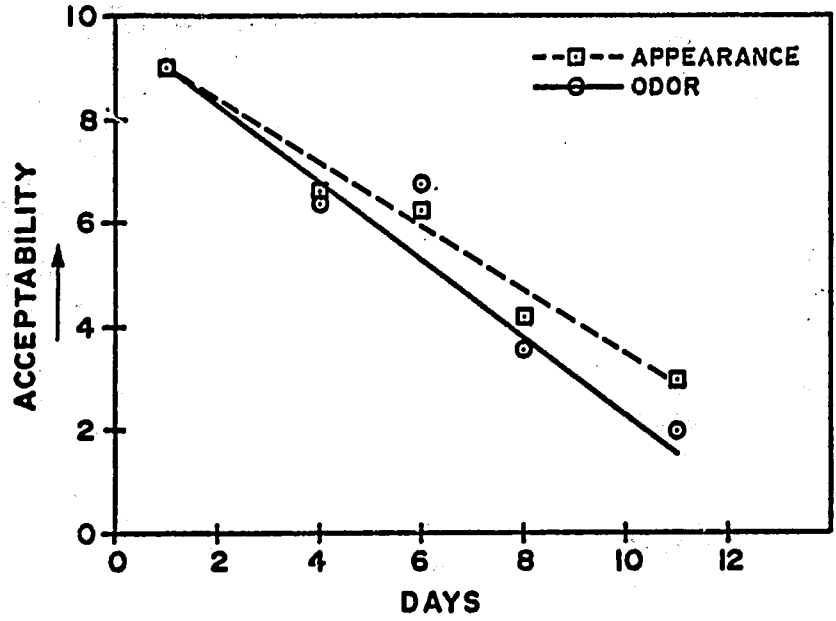


FIGURE 7

General Appearance and Raw Odor Scores for Flounder during ice storage

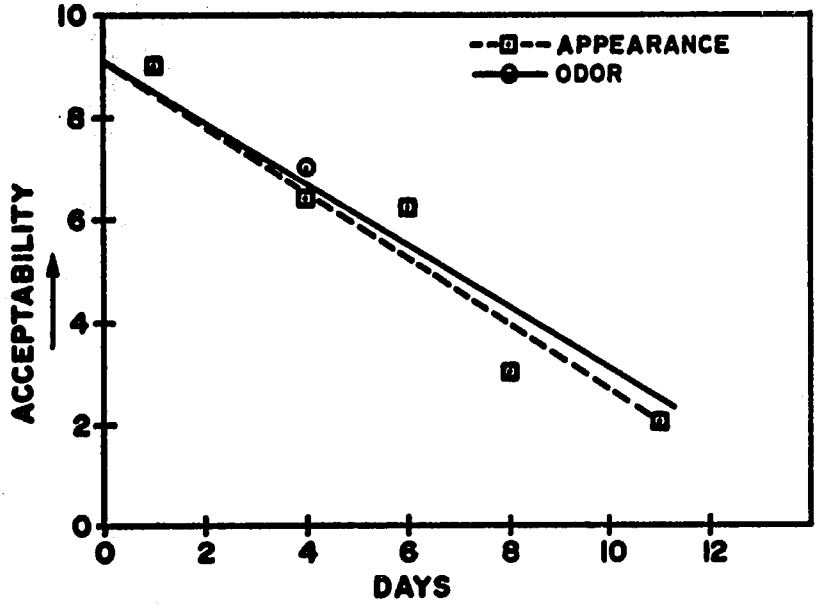


FIGURE 8

General Appearance and Raw Odor Scores for Whiting during ice storage

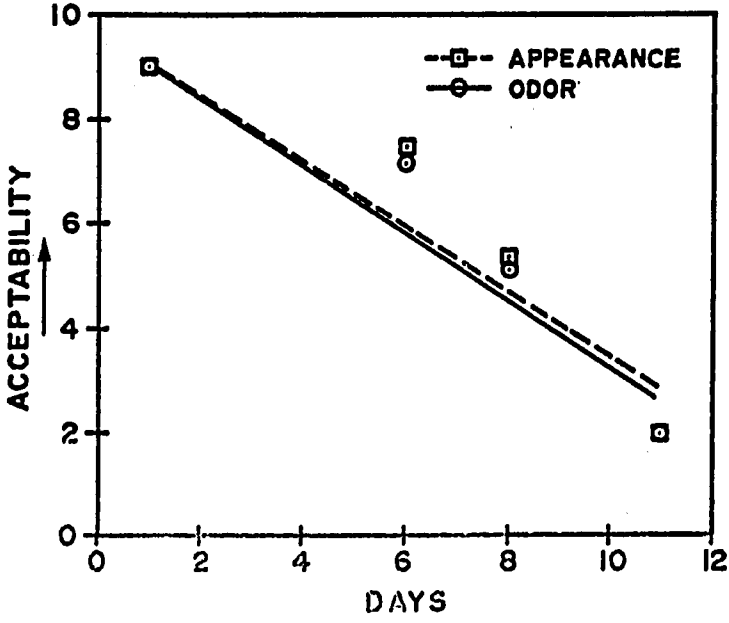


FIGURE 9

General Appearance and Raw Odor Scores for Scup during ice storage

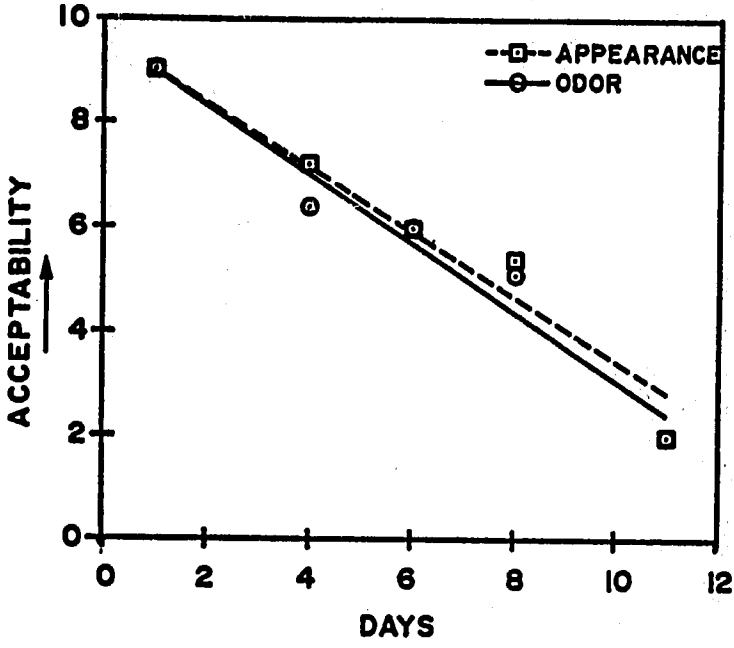


FIGURE 10

General Appearance and Raw Odor Scores for Butterfish during ice storage

TABLE 8. Sensory Evaluation of Flounder, Whiting, Scup and Butterfish During Ice Storage

Days	Skin[a] $\bar{x}$	Eyes[a] $\bar{x}$	Gills[a] $\bar{x}$	Odor of[a] Gills $\bar{x}$	General[b] Appearance $\bar{x}$	General[b] Odor $\bar{x}$
			Flounder			
1	A	A	A	A	9	9
4	A-B	B	A-B	B	6.6	6.4
6	B	C	B-C	B	6.15	6.75
8	B	C	B-C	B-C	4.2	3.6
11	C	D	D	D	3	2
			Whiting			
1	A	A	A	A	9	9
4	A-B	B	B	B	6.4	7
6	B	C	B-C	B-C	6.25	6.24
8	B-C	C	C	B-C	3	3
11	C	D	D	D	2	2
			Scup			
1	A	A	A	A	9	9
4	A	A-B	A-B	B	7	6
6	B	B-C	B-C	B-C	7.5	7.25
8	B-C	C	C	B-C	5.4	5.2
11	C	D	D	D	2	2
			Butterfish			
1	A	A	A	A	9	9
4	A	B	B	B	7.2	6.4
6	B	B-C	B	B	6	6
8	C	C	C	C	5.4	5.2
11	C	[illegible]	D	D	3	3

[a]See Appendix IV for the sensory criteria chart.

[b]Hedonic scale: 1-extremely unacceptable; 9-extremely acceptable.

TABLE 9. Sensory Criteria

	Grades			
	A	B	C	D (unfit)
A. SIGHT:				
1. Skin	bright, shining no bleaching	waxy, slight loss of bloom	dull some bleaching	dull, marked bleaching and shrinkage
2. Eyes	clear, dark appearance, convex shape	plane, slightly opaque pupil, slightly opalescent cornea	slightly concave gray pupil, opaque cornea	completely sunken, gray pupil, opaque discolored cornea
3. Gills	bright red, mucus, translucent (herring and mackerel brown)	pink, mucus, slightly opaque	gray, bleached, mucus opaque and thick	brown, bleached, mucus yellowish gray and dotted
B. SMELL:				
Gill and Body Odors	fresh, strong, seaweedy, shellfishy	no odor, neutral odor, trace of musty, mousy, etc.	definitely musty mousy, etc. bready, melty, etc.	acetic, fruity amines, sulfide, faecal
C. TOUCH:	fish flesh elastic scales stiff			

CHAPTER 24 GUATEMALA--AN INVESTIGATION INTO FISH QUALITY AT THE MARKETPLACE IN GUATEMALA CITY, GUATEMALA

BY L.F. Arias, G. Bonilla, C.O. Chichester, S.M. Constantinides, S. de Cabrera, R. de Leon, T-C. Lee, L.J. Nutley, and J.M. Ridelman

Fish is one of the foods of high nutritive value whose increased consumption would benefit the Guatemalan people. It is highly perishable unless methods such as drying, salting or freezing are used. Ice continues to be the principal means of preservation of fresh fish but even this is not used to full advantage in the markets of Guatemala. To clarify the nature of the problem, it was decided to study the sanitary conditions of fresh and processed fish at the retail level in Guatemala City. To this end, a contract was signed between the Central American Research Institute for Industry (ICAITI) in Guatemala City and the International Center for Marine Resource Development (ICMRD) at the University of Rhode Island.

Sanitary conditions were measured microbiologically and a visual assessment was made at the time of sampling. Bacterial counts were measured using the aerobic plate count (APC) at 25°C, the most probable number (MPN) of faecal coliforms and a Staphylococcus aureus count. These three parameters were studied in every sample, including fish, table and floor surfaces, ice water and fish drippings. Because coliforms and staphylococci are not part of the normal flora of raw seafood, their presence is taken to indicate contamination from human sources.

The work covered by the contract was done in two parts. The first part was a study of the conditions of retail sales of fresh fish at two public markets over a six-day period. The fish sampled remained at the place of sale under conditions normally found there. These sites generally lack modern equipment. Instead, working areas may contain a large wooden or cement table, another small table where fish are cleaned and cut, and generally a wooden chest lined with galvanized tin to keep fish with ice. If there is no such ice chest, cane baskets lined with plastic are usually used with "pacaya" leaves as insulation.

The second part of the study dealt with the microbiological conditions of fish that had received some type of processing such as freezing, filleting, drying and/or salting. Frozen fish is distributed by small fishing companies as whole or filleted fish. Dry fish is prepared at the artisan level and is found in Guatemala in large amounts only during Holy Week. In this part of the study, four supermarkets and one popular market were visited. To complement the laboratory data, several questions were asked at each market or supermarket about the source of fish, the means and conditions of transport and storage, the amounts of fish rejected and criteria, the use of ice, general sanitation practices and wholesale and retail prices.

I. Materials and Methods

Sampling procedures and analytical methods used were those recommended by the International Committee on Microbiological Specifications for Foods (Thatcher and Clark, 1968). During part one, the study of two municipal markets, the fish were purchased but remained at the place of sale for four days to be sampled under normal conditions. Each day a swab sample of the skin surface and of the body cavity were taken. This involved the use of a sterile metal square that circumscribes a 15 cm^2 area. The swab was moistened with a sterile peptone solution (0.1%), moved over the surface and replaced in its tube with 5 milliliters of peptone water. In the second part, samples of processed fish were purchased from four supermarkets and one municipal market and transported to the laboratory in the original packaging

(if any). Bacteria on freezer surfaces were sampled using the swab technique.

Aerobic plate count (APC):--The APC was carried out following the pour plate method of Thatcher and Clark (1968) with a lower incubation temperature of 25°C. Both psychrophiles and mesophiles were of interest. The three-day incubation period originally planned proved impossible in practice, since in that time spreaders and giant colonies developed. A 48-hour incubation period was used instead.

Faecal coliforms:--Determinations of the most probable number (MPN) of faecal coliforms were performed using the procedure of Thatcher and Clark (1968) with no further modifications. This count was seen as a measure of sanitation.

Staphylococcus aureus count:--The method of Thatcher and Clark (1968) was followed with no further modifications. This count was taken to demonstrate mishandling of the fish.

II. Results and Discussion

Brief descriptions of the markets follow. Graphs 1 and 2 show the temperatures and relative humidity at the markets when the samples were taken at 10:00 each morning. Responses to the questionnaire are presented in Appendices A and B.

Colon market:--This is a popular market located in one of the older quarters of the city. The large, high-ceilinged building is divided into two main sections, one where vegetables and staples are sold and the other housing tiny restaurants or "comedores" and butcher shops. Like other markets, the place is crowded with small stalls where selling takes place. There is no specific area where fish vendors are located. Of the three stands where fish are sold, two are located with the comedores and butcher stalls in the hallways and the other is located among the vegetable stands.

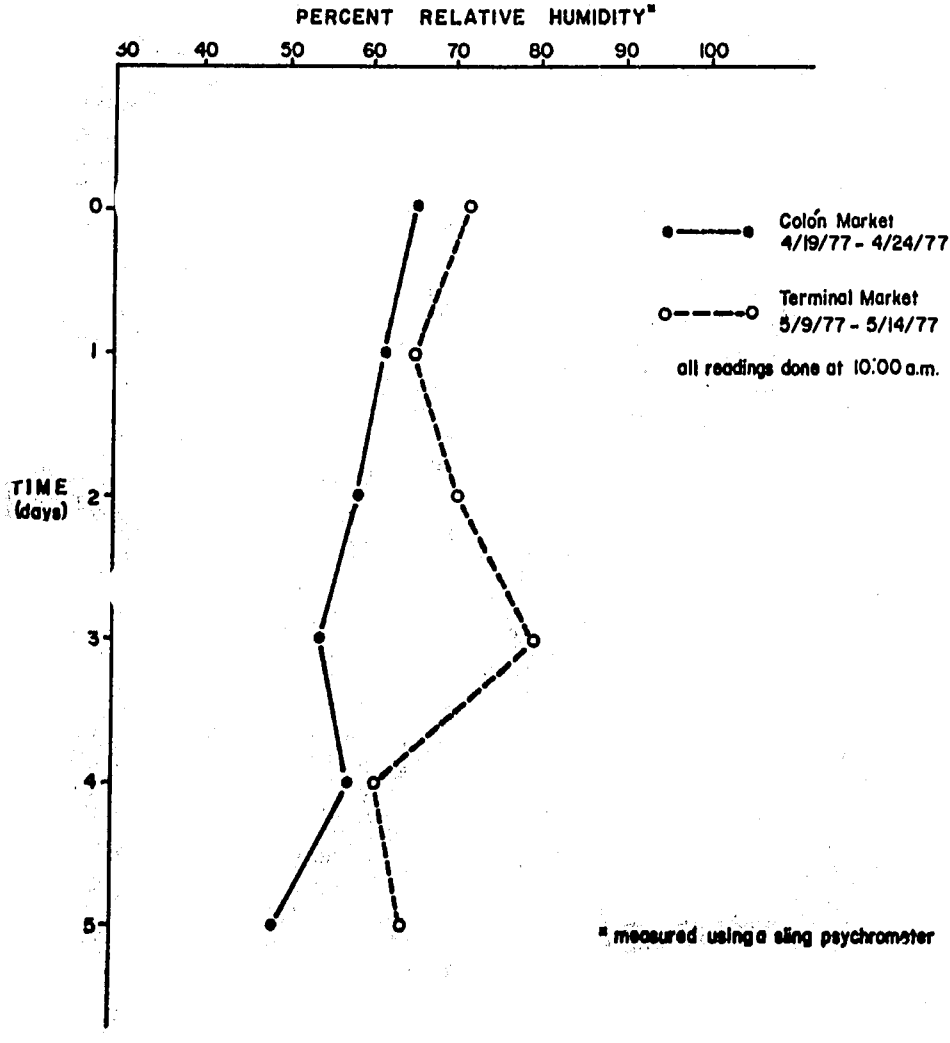
The fish stand selected for study is owned by a woman who cares for it with the help of her daughter. The place allows only a narrow passage way for shoppers and it is difficult to stay in front of the stand to purchase seafood. This made sample collection difficult. Although there are windows, natural light is scarce because of walls separating the stalls, and the smoke from the kitchens that has deposited soot on the walls and window panes over the years. No artificial light is available in the stand.

The area was infested with flies that continuously landed on the seafood, tables and scale. No control measures were taken to solve the problem. Since the stand does not occupy a stall, there is no water available. It has to be collected in cans from a central faucet. The people in charge use a large knife and a utensil made from wood and nails to scale and fillet the fish. Both items are rarely washed and never disinfected. The table is made of wood and the surface is full of cuts from the use of the knife. Ice is bought in big chunks and is broken by the people there. Because the pieces are still too large, there is poor distribution of ice around the fish. When the fish are stored overnight, they are put in a large wooden ice chest lined with galvanized metal and covered with leaves and plastic.

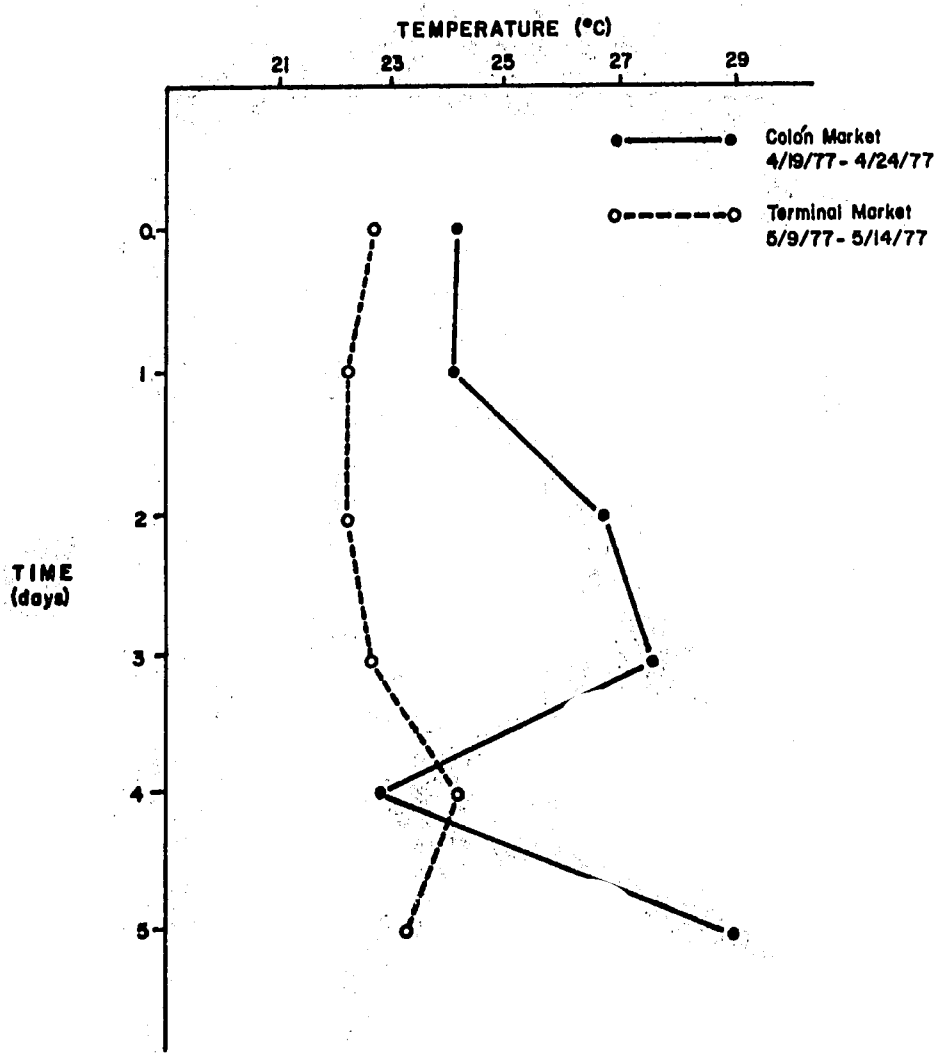
La Terminal market:--This market was designed to function as a wholesale distribution center, receiving products from the countryside and then distributing them to retail markets in different parts of the city. However, at present it also functions as the largest retail market in Guatemala.

There is a specific area for selling seafood and the stalls are built for that purpose. Each stand has cement benches covered with glazed tiles and a source of tap water. There is a great variety of seafood items on display, not only from Guatemala but also from El Salvador. Even though the installations are adequate, vendors do not use them correctly. In many cases, the benches are covered with plastic which prevents proper drainage. As in the Colon Market, flies are abundant and the problem of light is even more severe. The ceiling is low and the windows are covered with cardboard, since the panes

Graph 1. % of Relative Humidity at the Popular Markets During the Six Day Study Period



Graph 2. **Temperature at Markets**



are probably broken.

The fish stand chosen for study is owned and operated by a young couple. Even though there are tap water facilities, the vendors do not use this lavatory but instead wash items by dipping them in a hugh bowl. The water in the bowl was turbid. The seafood is prepared for sale on a wooden table; the table and filleting tools were not cleaned or disinfected during the time the samples were collected.

Ice is used in large chunks that are placed with the shellfish; no pieces of ice were observed with the other fish. The temperature of the fish was 9°C. The ice to be sold is prepared at the market entrance. Large rectangular pieces are cut into smaller pieces to be sold to the fish stands. The ice is prepared on a wooden platform outside the market on the street exposed to dust. At the stand, fish was stored overnight in cane baskets lined with plastic and pacaya leaves. It was the only time observed when fish were placed between layers of ice.

La Placita market:--This market is centrally located and was formerly much larger, part of it being destroyed by fire. It is in a tall building with a high ceiling with windows providing good illumination. Here it was possible to sample the dried-salted fish that is consumed in the days preceding and during Holy Week. The fish stand is located in an area where many different items are on sale in neighboring stands. The dried-salted fish were piled on wooden tables against a wooden counter, without any kind of packaging. There is no running water and occasional cleaning is carried out using a damp cloth.

The supermarkets:--The supermarkets sampled were located in different parts of the city. In general, they had similar sanitary conditions. They all had an open freezer where fish were placed for sale. The supermarkets are listed in Table 7 with a list of samples taken and the price per kilogram of fish species sampled.

At two supermarkets, Norte and La Torre, fish were not distributed in an orderly fashion in the freezer and some opened bags were found. In both these supermarkets no one could give us information on the fish for sale. In many cases, bags of whole fish carried no identifyign label and were of unknown species. Also there were some unpackaged fish for sale, mixed with the packaged fish. The same printed plastic bag was used for packing different kinds of fish fillets so the contents could not be identified as to species.

Results and Discussion

Parts one and two are discussed below. The results for each individual sample can be found in Table 1 through 8.

In phase one, two popular markets were studied for six days to obtain a picture of daily sanitary conditions so that the effects on the quality of fresh, chilled fish sold there would also be known. In each market, three of the most popular species of fish were chosen and sampled by swabbing the skin and body cavity surfaces. The fish remained in the market and were sampled daily for several days.

Results indicated that the Colon Market has tables, floors, and ice that are grossly contaminated. The liquid drippings from the piled fish are also heavily contaminated (Tables 1, 2 and 3). Ice and liquid drippings would seem to be the most important factors resulting in high counts since both are in contact with fish and can be a source of cross contamination. In spite of these conditions, at the end of three days, the APC of fish samples was $10^6/cm^2$ or less, even inside body cavities. (According to the American Public Health Association [APHA, 1976], figures higher than 10^6 per gram or cm^2 are considered indicative of incipient spoilage.) The general appearance of the fish was also good; no signs of spoilage were evident.

The location at the other market, La Terminal, was similar. The most heavily contaminated samples were ice and liquid drippings (Tables 4, 5. Fish sampled were in the market for four days and were spoiled at the end of the

trial. Because the exact day of their arrival at the market was unknown, they could have been in ice longer than assumed. One of the problems in markets is the tendency of people selling fish to cover tables and benches with plastic, allowing water to accumulate. In this market, the failure to allow for good drainage is unnecessary since vendors have a cement bench covered with glazed tiles with proper inclination and drainage facilities; yet the drain is covered with plastic.

During part two, the purpose of sampling the processed fish was to check the microbiological condition of the products and the markets. In frozen fish, all samples are sold in plastic bags so there is no real contact between the freezer walls and the fish. In only one place, Supermarket Paiz Mortufar, unpackaged frozen fish is displayed on ice, not for preservation but to keep the fish surface wet and shiny for ornamental reasons. Dried-salted fish is displayed without refrigeration or packaging of any kind. In Table 7, samples taken are listed with current prices of the fish.

The microbial loads of the products, as measured by the APC at 25°C are shown in Table 8. Most samples consisted of filleted and frozen fish. As can be seen in Table 8, samples from two supermarkets, Norte and La Torre, have products with APC results in order of 10^7 per gram.

In the case of La Placita where only dried-salted fish was sold, the situation is similar. Counts in excess of 10^6 per gram suggest improper handling conditions in processing and storage. If faecal coliforms are in excess of 10/g for frozen fish and 40/g for salted-dried fish, it is supposed that products have been subjected to mishandling (APHA, 1976). Staphylococcus aureus should not be in excess of 10^2/g; higher counts are also indicative of mishandling. As can be noted in Table 8, there are samples where both these indicators, faecal coliforms and S. aureus, are in excess of the limits.

The need for improved conditions in Guatemalan fish markets is evident from this study. Yet even with improved conditions, it is important that vendors become aware of the importance of their role in preserving fish quality. With increased interest and understanding of their role, facilities which are adequate will be used more effectively to supply fresh and processed fish to the people of Guatemala.

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PART 1 -- Fresh Fish

TABLE 1. Aerobic Plate Count at 25°C per cm^2 or per ml* -- Colon Market

Sample	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5
A Juilin skin surface	3.8×10^4	7.3×10^5	6.4×10^5	--	--	--
B Juilin cavity surface	1.6×10^4	1.0×10^6	1.9×10^6	--	--	--
C Palometa skin surface	4.5×10^5	2.6×10^6	1.0×10^6	--	--	--
D Palometa cavity surface	4.6×10^4	8.0×10^5	7.3×10^5	--	--	--
E Pepemechin skin surface	1.9×10^5	1.3×10^6	8.6×10^5	--	--	--
F Pepemechin cavity surface	8.6×10^4	8.0×10^5	1.8×10^6	--	--	--
G Floor surface	1.8×10^6	2.4×10^6	1.5×10^6	3.2×10^6	3.8×10^6	3.5×10^6
H Table surface	1.4×10^6	1.6×10^6	2.8×10^6	1.9×10^6	3.9×10^6	6.6×10^5
I Water *	$<10^3$	8.0×10^4	$<3.0 \times 10^1$	7.0×10^1	7.0×10^5	1.9×10^4
J Ice *	2.7×10^6	3.4×10^6	1.3×10^7	4.7×10^6	4.3×10^6	1.9×10^7
K Fish-ice drippings *	3.6×10^7	1.1×10^8	7.0×10^7	9.3×10^7	2.5×10^8	5.0×10^7

PART 1 -- Fresh Fish

TABLE 2. Faecal Coliforms Count as MPN per cm or per ml* -- Colon Market

Sample	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5
A Julin skin surface	3	15	0	--	--	--
B Julin cavity surface	10	160	60	--	--	--
C Palometa skin surface	1.5	30	0	--	--	--
D Palometa cavity surface	3	0	0	--	--	--
E Pepemechin skin surface	1	15	150	--	--	--
F Pepemechin cavity surface	.73	4.8	150	--	--	--
G Floor surface	73	310	60	60	2.4	24
H Table surface	31	73	0	24	6	0
I Water *	0	930	0	0	390	0
J Ice *	1100	150	360	0	430	730
K Fish-ice drippings *	>2400	2400	4300	9300	>2400	4300

PART 1 -- Fresh Fish

TABLE 3. Staphylococcus aureus Cell Count per cm^2 or per ml* -- Colon Market

Sample	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5
A Juilin skin surface	0	70	7	--	--	--
B Juilin cavity surface	0	0	0	--	--	--
C Palometa skin surface	0	0	0	--	--	--
D Palometa cavity surface	0	1	0	--	--	--
E Pepemechin skin surface	0	0	0	--	--	--
F Pepemechin cavity surface	0	1	0	--	--	--
G Floor surface	0	70	0	0	70	700
H Table surface	0	1	700	7	0	70
I Water *	0	0	0	0	0	0
J Ice *	0	10^3	10^2	10^2	0	10^2
K Fish-ice drippings *	0	0	0	10^3	10^4	10^3

PART 1 --Fresh Fish

TABLE 4. Faecal coliforms Count in MPN per cm^2 or per ml* -- La Terminal Market

Sample	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5
A Robalo skin surface	31	160	31	62	--	--
B Robalo cavity surface	31	31	6.2	15.3	--	--
C Mojarra skin surface	73	31	14	160	--	--
D Guapote skin surface	>160	>160	73	62	--	--
E Floor surface	>160	31	31	160	6	4.6
F Table surface	>160	8	>160	733	2.6	15.3
G Ice *	>2400	240	1100	930	230	2400
H Water *	0	0	0	0	0	0
I Fish-ice drippings *	>2400	2100	11000	1500	>24000	>24000

PART 1 — Fresh Fish

TABLE 5. Staphylococcus aureus Cell Count per cm^2 or per ml* — La Terminal Market

Sample	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5
A Roballo skin surface	0	0	0.6	0	—	—
B Roballo cavity surface	0	0	0	10^1	—	—
C Mojarra skin surface	0	0	0	0	—	—
D Guapote skin surface	—	0	6.6×10^1	0	—	—

E Floor surface	0	0	0	0	0	10^1
F Table surface	0	0	0.6	0	0	10^3
G Ice *	0	0	10^1	10^1	10^1	10^2
H Water *	0	0	0	0	0	0
I Fish-ice drippings *	0	0	10^2	10^4	0	10^2

PART 2 -- Processed Fish

TABLE 6. Samples Taken at Each Supermarket and Prices of Fish in U.S. Dollars per Kilogram

Place	Identification*	US $/Kilogram**
Paiz-Montufar Supermarket (PM)	Corvina fillets	3.19
	Robalio slices	3.30
	Dried robalio	2.84
	Whole corvina	1.54
	Ice	--
La Placita Market (LP)	Dried robalio	3.30
	Dried juilin	1.76
	Dried codfish	2.75
	Table surface	--
	Counter surface	--
Residential Supermarket (R)	Corvina fillets	3.30
	Whole salmonette	0.55
	Pristis perotetti	2.86
	Front wall of freezer	--
	Back wall of freezer	--
Norte Supermarket (N)	Whole salmonette	0.46
	Corvina fillets	3.52
	Pristis perotetti fillets	2.33
	Side wall of freezer	--
	Back wall of freezer	--
La Torre Supermarket (LT)	Pristis perotetti fillets	2.49
	Corvina fillets	2.42
	Corvina fillets	2.42
	Corvina fillets	2.42
	Unidentified fish fillets	1.36

*All samples frozen unless otherwise indicated.
**For comparison, the average price for fresh, whole Corvina agria and China in Costa Rica from May to June of 1977 was $2.05/kilo while the price for Corvina aguada fillets was $4.82/kilo.

PART 2 — Processed Fish

TABLE 7. Bacterial Counts of Supermarket Samples

	Samples	Sample Location	APC Colonies/gram	Fecal Coliforms MPN/gram	S. aureus Coagulase+/gram
Frozen fish	Corvina fillets	PM	9.3×10^5	23	0
	Corvina fillets	R	6.3×10^6	7.3	10^2
	Corvina fillets	N	3.4×10^5	7.3	10^2
	Corvina fillets	LT	1.4×10^7	150	10^2
	Corvina fillets	LT	1.4×10^7	150	0
	Corvina fillets	LT	6.6×10^5	23	10^2
	Unidentified fillets	LT	3.5×10^6	23	0
	Roballo slices	PM	2.7×10^5	23	0
	Pristis perotetti fillets	N	5.3×10^7	460	10^2
	Pristis perotetti fillets	LT	5.3×10^7	0	10^1
	Whole corvina	PM	3.7×10^6	7.3	10^3
	Whole salmonette	R	2.6×10^4	0	10^2
	Whole salmonette	N	1.3×10^7	0	0
	Pristis perotetti	R	6.9×10^6	460	10^3
Dried fish	Roballo	PM	1.5×10^4	0	0
	Roballo	LP	2.3×10^6	3.6	0
	Juilin	LP	2.4×10^6	0	0
	Cod	LP	1.2×10^7	0	10
Ice and surfaces	Ice	PM	1.6×10^5/ml	0/ml	10/ml
	Table surface	LP	5.0×10^4/cm^2	0/cm^2	6.6/cm^2
	Counter surface	LP	1.6×10^2/cm^2	0/cm^2	0/cm^2
	Front freezer wall	R	8.0×10^6/cm^2	0	0
	Back freezer wall	R	1.3×10^1 cm^2	0	0
	Side freezer wall	N	0	0	0
	Back freezer wall	N	0	0	0

PART 2 -- Processed Fish

TABLE 8. Bacterial Counts of Supermarket Samples

	Samples	Sample Location	APC Colonies/gram	Fecal Coliforms MPN/gram	*S. aureus* Coagulase+/gram
Frozen fish	Corvina fillets	PM	9.8×10^5	23	0
	Corvina fillets	R	6.3×10^6	7.3	10^2
	Corvina fillets	N	3.4×10^5	7.3	10^2
	Corvina fillets	LT	1.4×10^7	150	10^2
	Corvina fillets	LT	1.4×10^7	150	0
	Corvina fillets	LT	6.6×10^5	23	10^2
	Unidentified fillets	LT	3.5×10^6	23	0
	Robalio slices	PM	2.7×10^5	23	0
	Pristis perotetti fillets	N	5.3×10^7	460	10^2
	Pristis perotetti fillets	LT	5.3×10^7	0	10^1
	Whole corvina	PM	3.7×10^6	7.3	10^3
	Whole salmonette	R	2.6×10^4	0	10^2
	Whole salmonette	N	1.3×10^7	0	0
	Pristis perotetti	R	6.9×10^6	460	10^3
Dried fish	Robalio	PM	1.5×10^4	0	0
	Robalio	LP	2.3×10^6	3.6	0
	Juilin	LP	2.4×10^6	0	0
	Cod	LP	1.2×10^7	0	10
Ice and surfaces	Ice	PM	1.6×10^5/ml	0/ml	10/ml
	Table surface	LP	5.0×10^4/cm^2	0/cm^2	6.6/cm^2
	Counter surface	LP	1.6×10^2/cm^2	0/cm^2	0/cm^2
	Front freezer wall	R	8.0×10^6/cm^2	0	0
	Back freezer wall	R	1.3×10^1 cm^2	0	0
	Side freezer wall	N	0	0	0
	Back freezer wall	N	0	0	0

APPENDIX A

Questionnaire Results for Markets Selling Fresh Fish

Place surveyed	Colon	Terminal
How are the fish delivered to market?	Wooden boxes with ice and sawdust; fish are bought at Terminal market.	Wooden boxes with ice and cane baskets with ice.
How are the fish displayed?	On wood table with small amount of ice. The table is covered with plastic.	On a cement table covered with glazed tile with small amount of ice. Although the table has a drain, plastic is placed over it.
Washing of fish.	All fish are washed with ice-water (melted ice).	Only when ice is dirty.
Rejections.	Occasionally, on basis of texture, gill odor, cavity color.	Occasionally, on basis of texture, slime.
Ice for storage.	Yes.	Yes.
Relation: ice to fish.	They buy 75 pounds of ice per each 50 pounds of fish but it is not properly distributed with the fish.	About 1:1 by volume. Ice is properly placed in layers over and under fish.
Is the stor .ge chamber adequate in size?	Large enough for the amount stored.	--
How is the fish placed in the chamber?	Inside plastic bags and pacaya leaves for insulation.	Sandwiched between layers of ice.
Storage time.	Maximum two days.	Maximum three days.
Retail side conditions.	Wood bench plastic covered without drain. No tap water at the site. Water is brought in from a faucet in small cans. No place to wash hands, fish or instruments. A large knife and nail brush to scale fish but seldom washed or disinfected. The place is dark with not enough room. Table for cutting and scaling fish is not clean and is made of wood. Weighing scale is also not clean. Flies are abundant.	They have running water (chlorinated) but use a large tub where they wash instruments, knife and nail brush. Table where seafood is cut and scaled is not clean and is made of wood. Flies are abundant.

Appendix A, Questionnaire Results for Markets Selling Fresh Fish, continued

Place surveyed	Colon	Terminal
Observations.	People in charge have years of experience and differentiate among different kinds of fish. Almost all merchandise is fresh fish.	Sale of various kinds of seafood besides fresh fish, turtle eggs, seawater and freshwater, shrimp, crabs and molluscs. Prices during the week of survey were fluctuating because of a nationwide strike by meat producers and distributors.

APPENDIX B

Questionnaire Results for Processed Fish Samples

Place surveyed	Paiz-Mintufar Supermarket	Residential Supermarket	Norte Supermarket	La Torre Supermarket	La Placita Market
Products sold	Frozen fish	Frozen fish	Frozen fish	Frozen fish	Solid, dried fish
How are the fish delivered to the store?	Wooden boxes with ice in insulated truck	Plastic bags in refrigerated truck	Plastic bags in small vans	Personnel questioned were not sure	Dried fish in nets in ordinary trucks
How are the fish displayed?	Open freezer Whole, eviscerated fish, fillets in plastic bags	Open freezer	Open freezer	Open freezer	On a wooden table rough surface, uncovered
Are fish washed?	No	No	No	No	No
Rejection criteria	i. Firmness ii. Color iii. Odor	Odor, gill color	Gill color	Personnel questioned were not sure	Rejection uncommon
Storage	Frozen fish is kept overnight in closed freezer	In the same freezer	In the same freezer	In the same freezer	Covered burlap bag and tied with rope
Ice	Used to wet surface, preservation relies on freezer	Not used	Not used	Not used	Not used (dried fish)
Relation Ice:Fish	Not important	Not applicable	Not applicable	Not applicable	Not applicable
Relation Fish volume:	They used closed cabinets and one room with regrigerator equipment	Half full	More than half full	Half full	Not applicable

Appendix B, Questionnaire Results for Processed Fish Samples, continued

Place surveyed	Paiz-Mintufar Supermarket	Residential Supermarket	Norte Supermarket	La Torre Supermarket	La Placita Market
How are fish arranged in the storage box?	Piled according to kinds	Piled according to kinds	Piled according to kinds	Piled at random	Piled at random
Maximum storage time before selling	Four days	One week	One week	One week	Five days
Description of retail site	Freezing and chilling facilities. Place seems adequate with sufficient light. No disinfection is applied, only cleaning with detergents	All fish are inside the display freezer, which seems to be clean but not disinfected. Light is adequate	---	---	The place has no metal tables, only wood. There are no refrigeration facilities. Light which comes from windows seems adequate. No disinfection. Cleaning is done rarely and poorly
Other observations	Personnel in charge have experience in handling fish and differentiate between genera (kinds). Fish sold is mainly filleted by commercial companies or at the supermarket. Whole fish is sold frozen.	Almost all fish is processed by commercial fish companies. Once in a while frozen fish is filleted at the supermarket.	Almost all fish is processed by commercial fish companies. Once in a while frozen fish is filleted at the supermarket.	Filleted by commercial fish companies and some at the supermarket. Several bags of fish were identified and contents were of unknown species.	People in charge do not know how to differentiate between genera. In the season when the survey was done, only dry fish was on sale.

CHAPTER 25 COSTA RICA--AN INVESTIGATION INTO FISH QUALITY OF THE ARTISAN CATCH OF COSTA RICA FROM CAPTURE TO POINT OF SALE

BY L.F. Arias, G. Bonilla, C.O. Chichester, S.M. Constantinides, S. de Cabrera, R. de Leon, T-C Lee, L.J. Nutley, and J.M. Ridelman.

Artisan fisheries contribute to the economy and nutritional well-being of Costa Rica. Therefore, losses of fish in this sector through mishandling and spoilage have far-reaching consequences. Before these losses can be reduced, some idea of their extent and underlying causes are needed. It is hoped that this study of the small-scale fishery will help provide some of this information.

Deterioration of fish is caused by autolytic processes, oxidation and microbial activity, with the latter being the most important (Shewan, 1976). In order to obtain information on the extent of bacterial spoilage of fish in Costa Rica, microbiological studies were conducted on three fish species. Samples of fish were taken (1) at capture, (2) when placed in ice at the receiving station, and (3) when displayed for sale. See Figure 1 for the position of these sampling points in the entire distribution process. Three of the predominant fish species caught by the artisan fishermen in the Gulf of Nicoya were selected for this study:

Corvina Aguada (Cynoscion spp.);
Corvina Agria (Micropagon spp.); and
China (Stellifer spp.).

Fishing in Costa Rica is still carried out largely using traditional methods and gear. Fishermen live near each other on the islands in the Gulf of Nicoya and in the coastal city of Puntarenas, close to the fishing grounds. Fishing areas are shown in Figure 2. The capture methods used in the artisanal fishery of the Gulf of Nicoya are:

a) Longlines or handlines, primarily used by the inhabitants of the islands fishing from small boats. The fishing grounds are close to the coast where the water is known to be contaminated.

b) Gill nets, used by the fishermen of Puntarenas fishing from larger boats. These nets are used to catch bottom fish primarily, though some nets float near the surface. This fishing is done further out in waters presumably less polluted.

Fishing takes place in the early hours of the morning or the late hours of the evening depending on the methods used. The catch is stored on the deck during the fishing period. Once fishing stops, the fish is eviscerated and the abdominal cavity is cleaned with a brush and washed in seawater. The fish may then be stored on ice in a box constructed on deck for that purpose. The fishermen, upon returning to land, transfers the fish to another ice box or "nevera" and resumes his activity. The temperature of the neveras was found to vary from 1°C to 19°C. The fish remain in the nevera until it is full, about two days, whereupon the fisherman takes the load of fish to Puntarenas where it is sold to wholesalers. The fish are transferred in plastic containers to the place of sale where they are emptied onto the wooden floor. Here, they are cleaned, classified according to odor by the buyer and weighed. The fish remain in ice for up to two days more, the temperature varying between 1°C and 19°C. They are then transported by truck to cities in the center of the country.

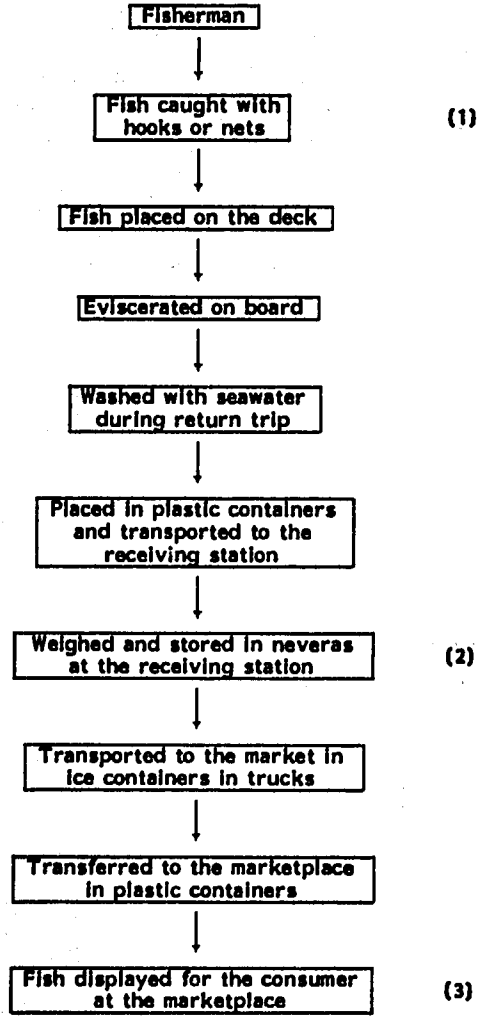

Figure 1.--Flow diagram of the fish from landing to the point of sale. The numbers in parentheses show where samples were taken.

In addition to the initial load on the fish from the water in which it was caught, other sources of bacterial contamination include:

1) the water used to wash the fish;
2) ice which comes in contact with the fish over a long period of time;
3) table or boards used in the preparation of fillets in the fish market; and
4) Liquid and drippings in the boats and in the neveras.

The results of this study indicate that the fish is highly contaminated by the time it is sold. Fish sold in the fish market of Valle Central do not appear to merit the term "fresh" used in its sale. It exhibits spoilage characteristics including caved-in eyes, opaque corneas, soft flesh, sour odor, easily-removed scales. Recently captured, truly fresh fish has no odor, little mucous, firm flesh and intact scales. In general, handling procedures for fish could be improved in all areas from the time of capture until the fish are sold.

I. Materials and Methods

Sampling procedure:--Fish samples were collected initially at the point of capture, next at an intermediate collecting point, and finally following arrival at the fish market. The time between sampling and culturing was reduced to the minimum to avoid significant changes in the bacterial populations which would have made results meaningless. Noting the location of capture (see Figure 2), approximately 12 trips were made in small fishing boats in the Gulf of Nicoya. During three of these trips, samples were taken with one trip per species. The captured fish of the desired species were tagged but treated normally until they reached the marketplace. Samples were taken aseptically from different areas of the skin and body cavity using the swab method. A sterilized aluminum template (80 x 70 x 3 mm) was pressed against the surface of the skin and microorganisms taken up with the swab from this area (Yokoya and Zulzke, 1975). The swabs were inserted in screw-capped plastic tubes containing 0.1% peptone solution (Thatcher and Clark, 1968). Samples of wash water and ice were collected in sterile containers. All samples were placed on ice in insulated boxes and carried to the laboratory in the shortest time possible. Microbiological culturing was performed on the same day as sampling.

Bacteriological examinations:--Total aerobic counts were determined using serial dilutions of the sample in tryptone-glucose agar (Difco). The plates were incubated at 27°C ± 1°C for 48 hours (I.C.M.S.F., 1974).

Coliform counts were made by plating serial dilutions of the same sample in Violet Red Bile Agar (Difco). Incubation was at 35°C ± 1°C for 24 hours. In order to confirm the presence of faecal coliforms, typical colonies were inoculated in fermentation tubes of Lauryl tryptose (Difco). The incubation was at 35°C ± 1°C for 24 hours (Sharf, 1972).

Staphylococcus aureus counts were made using plates previously prepared with Baird-Parker agar (Difco), distribution 0.1 ml of the appropriate serial dilution over the agar surface with a bent glass rod until absorbed. The plates were incubated at 35°C ± 1°C for 48 hours. Selected colonies were then incubated in Brain Heart Infusion Agar (Difco) for 24 hours at 35°C ± 1°C and tested for coagulase activity (USDA, 1974).

II. Results and Discussion

Table 1 shows the variation in the microflora in contact with the fish at the different locations of sampling. A high bacterial count was found in containers, ice and table surface at the fish market. The highest count was found on the tables and boards used to prepare the fillets. The high

Location	Description
1	Departure from the harbor, the boats go near the beach.
2	Arrival at the fishing area, Bejuco Island.
3	Arrival at the fishing area, Caballo Island.
4	Capture near Naranjo beach.
5	Arrival at the fishing area, Negritos Island.
6	Arrival at the fishing area.
1	Return to the point of departure and to the point of sale.

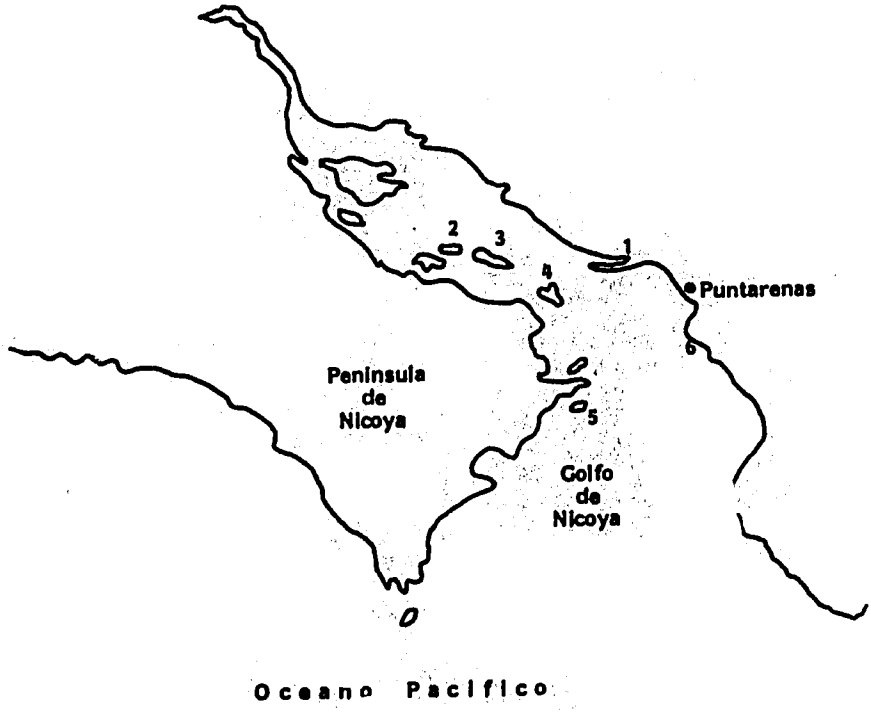

Figure 2.--Map indicating different sites of capture in the Gulf.

bacterial count found in the ice is not surprising since the same ice is reused until it melts. Coagulase-positive staphylococci were found in the residual liquid of the boat and in the drip at the fish market. Such unsanitary conditions must affect the bacterial numbers on the fish when purchased by the consumer.

In Table 2, bacterial counts on three fish species at the three sampling points are presented. Samples of corvina aguada and china present an initial bacterial load which is higher than the samples of corvina agria. The first two species were captured near the islands of Bejuco and Caballo which are in the more contaminated waters of the Gulf. Corvina agria was captured outside the Gulf of Nicoya. The fish were left for an hour or more until the total catch was collected. After being put on ice, the temperature of these fish was found to vary between 1°C and 19°C. This would facilitate bacterial deterioration. Coliform counts varied little between 10^3 and 10^5 except for the corvina agria which showed no coliform contamination initially. The samples of corvina agria showed signs of contamination by coliforms after storage in the ice containers at Puntarenas, possible because at that point all the species are mixed together. Coagulase positive staphylococcus were found in some of the samples stored at the fish markets.

This study, while exploratory in nature, does demonstrate a lack of adequate sanitary practices in the artisan fishery of Costa Rica. It is of special interest now because Costa Rica is setting up its first "National Fisheries Plan" in an effort to increase the quantity and quality of food from marine sources. It is felt that more thorough studies should be conducted along these lines. These would cover larger areas and more species so that proper recommendations for handling and processing might be made. Thus, fish from the Costa Rican coast would be used more efficiently to feed the Costa Rican people and strengthen the economy.

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TABLE 1. Total Bacteria Count in Samples Taken at the Different Stages of Handling

Sample	Total count of aerobic bacteria N°/ml	Coliform count N°/ml	Staphylococcus count N°/ml
Water used for washing fish before they reached selling area.[a]	129×10^4	10×10^2	---
Liquid from the ice container at the selling area.	62×10^6	90×10^2	---
Water used for washing at the receiving area.	29×10^3	39×10^2	---
Residual liquid in the boat.	150×10^6	76×10^3	129×10^1 [c]
Ice in the container (Punarenas).	80×10^5	32×10^1	160×10^1
Ice in the fish market (San Jose).	200×10^{10}	141×10^3	100×10^2
Table at the fish market.[b]	$118 \times 10^{11}/cm^2$	$86 \times 10^3/cm^2$	$59 \times 10^6/cm^2$
Residual liquid at the fish market.[b]	300×10^{12}	46×10^4	80×10^2 [c]

[a]Sometimes water from the river was used for washing.

[b]Central market.

[c]Coagulase positive.

TABLE 2. Bacterial Count Expressed in N^{o}/cm^{2} of the Different Species Studied

Species	Bacteria		Days of Sampling (taken at 3 sampling points) 0	1	2	3	4
Corvina agria (Micripago spp.)	Total count	a.	4.5×10^{2}*	1.3×10^{6}	1.3×10^{10}	3.5×10^{12}	3.0×10^{9}
		b.	9.3×10^{3}	2.5×10^{4}	2.1×10^{10}	2.0×10^{12}	3.2×10^{14}
	Coliforms	a.	--	3.9×10^{3}	2.8×10^{4}	4.9×10^{4}	8.7×10^{4}
		b.	--	--	3.5×10^{3}	3.7×10^{3}	6.0×10^{4}
	Staphylococcus	a.	--	8.3×10^{2}	9.3×10^{2}	4.9×10^{3}	6.9×10^{3}*
		b.	--	3.2×10^{2}	3.3×10^{2}	3.6×10^{3}	1.1×10^{3}*
Corvina aguada (Cynoscion spp.)	Total count	a.	1.9×10^{7}	2.8×10^{8}	2.7×10^{10}	3.2×10^{12}	3.1×10^{14}
		b.	1.1×10^{4}	2.7×10^{6}	1.1×10^{7}	2.5×10^{1}	1.6×10^{14}
	Coliforms	a.	1.1×10^{3}	1.4×10^{4}	7.0×10^{4}	3.2×10^{4}	3.6×10^{4}
		b.	5.5×10^{2}	1.2×10^{3}	6.2×10^{3}	1.2×10^{5}	4.0×10^{3}
	Staphylococcus	a.	3.0×10^{2}	7.1×10^{3}	1.7×10^{5}	7.3×10^{5}	5.5×10^{4}
		b.	3.1×10^{2}	3.0×10^{3}	2.0×10^{4}	1.3×10^{5}	9.0×10^{2}*
China (Stellifer spp.)	Total count	a.	1.1×10^{6}	2.1×10^{7}	3.4×10^{10}	1.4×10^{12}	1.7×10^{14}
		b.	1.9×10^{5}	8.3×10^{5}	3.2×10^{10}	3.0×10^{14}	3.1×10^{14}
	Coliforms	a.	4.1×10^{3}	4.9×10^{3}	4.9×10^{4}	4.6×10^{4}	3.3×10^{4}
		b.	4.8×10^{2}	3.0×10^{3}	6.1×10^{4}	3.2×10^{4}	3.6×10^{4}
	Staphylococcus	a.	--	1.2×10^{4}	4.9×10^{4}	8.0×10^{3}*	1.2×10^{4}*
		b.	--	4.0×10^{2}	1.6×10^{4}	4.3×10^{4}	9.4×10^{4}

a: Sample from skin.
b: Sample from body cavity.
0: Samples of fish as caught.
1,2: Days held in the ice container at the receiving station.
3,4: Days held in the fish market.
* Average of three determinations.

CHAPTER 26 CHARACTERISTICS OF DEMAND FOR FRESH FISH IN GUATEMALA CITY

BY R.Y. Coslit, H.C. Lampe and J.G. Sutinen

This chapter presents the results of a study of consumer attitudes and consumption habits regarding fish in Guatemala City. In the last few years the government of Guatemala has embarked on a program to increase domestic production of fish for local consumption. The hope is that the increased supply of fish will lead to a lower retail price, thus making fish available to a greater number of Guatemalan consumers.

However, it is by no means clear that the program to increase fish production will lead to expanded consumption at lower prices. This goal can be attained only if production and marketing efficiency is improved, and if potential demand is sufficient to support the planned increase in production. The shape of the present demand curve for fish will determine the effect of increased supply on prices and consumption. Therefore, the first objective of this study is to analyze the present demand for fish. The analysis should reveal which variables are significantly related to consumption as well as provide a greater understanding of the fish consumption habits of the residents of Guatemala City. With this information one should be in a better position to predict the effects of increased fish supplies.

As is true of many developing areas, little is known about the demand for fish in Guatemala. It is not known to what extent the quantity demanded will change in response to a given decrease in price. And demand may be responsive to other factors (e.g., quality) that we can regard as barriers to increased consumption. If so, it may be possible to devise measures to eliminate or reduce such barriers and thereby increase the welfare of fishermen and consumers of fish in the country. Therefore, the second objective of this study is to identify and analyze possible barriers to increased fish consumption in Guatemala City.

Finally, we apply novel methods for analyzing demand for fish in developing countries. These methods are tested here for their effectiveness in providing information useful for planning fisheries development programs.

1. The Relation of Demand Theory to the Present Study

An individual's demand for goods and services results from his maximization of utility. The theory of consumer behavior is formulated as a choice problem. An individual consumer with given income, prices, and tastes and preferences is confronted with a set of goods and chooses among the alternatives available to him in such a manner that the satisfaction derived from consumption is as large as possible. Therefore, the consumer attempts to allocate his limited money income among available goods and services so as to maximize his satisfaction. The price of a good, money income and prices of related commodities affect the quantity demanded.

The law of demand predicts that quantity demanded will vary inversely with price.[1] The price elasticity of demand, or responsiveness of quantity demanded to changes in commodity price, has been widely studied particularly because of its implications for government policy. The goals of the Guatemalan Fisheries Department include increased income to fishermen and reduced prices of fresh fish to the consumer. Figure 1 (Appendix I) illustrates the effects of a change in supply with unchanged demand such as that proposed by the government. The retail supply schedule will shift to the right and retail price will fall from Pr to Pr'. Q sold will increase from Q to Q' and both ex-vessel and retail markets will clear. A measure of the price elasticity of demand will indicate the amount by which the retail price will fall.

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There have been no studies to date that estimate price elasticity for fish in Guatemala. However, studies conducted in the U.S. find certain species of fresh fish to be generally price elastic (Nash, 1967; Bockstael, 1977). If the demand for fish in Guatemala is also price elastic, the government's proposed increase in the supply of fish and the resulting decline in price would stimulate a proportionately greater quantity demanded. Total earnings of the producing sector would increase as a result.

A second determinant of demand recognized by traditional economic theory is prices of related goods. The cross price elasticity measures the relative responsiveness of quantity demanded of a good to changes in the price of a related good. Fish is generally thought to be a substitute for other protein sources such as pork, chicken, and beef (i.e., if the price of beef, chicken or pork increases, the quantity demanded of "fish" would be expected to increase). Information provided in the present study, as well as casual observation, supports this relationship in Guatemala.[2]

In his study of the demand for fishery products in New England, Nash estimated the cross price elasticity of all fish products to meat to be in the range of .35 to .60. For fresh and frozen fish and shellfish to meat he estimated a cross price elasticity of .55 to 1.4. Bockstael found a cross price elastiticy in the U.S. between fresh fish and beef to be 3.16, and between fish and poultry 1.14. An often mentioned problem in determining cross price elasticity relations is that the results depend on the agreement among households as to the substitutability, complementarity, or neutrality existing between pairs of commodities. In Guatemala this problem is exacerbated because "fresh fish" is not homogeneous (i.e., fresh fish prices range from U.S.$.20 to 1.20 per pound and are related to desirabilty). Thus, some species may be substitutes for meat while others are not.

With the decrease in the price of fresh fish that can be expected from the Government's plan to increase the efficiency of fishermen and thus shift the supply function to the right, fish consumption is hypothesized to increase in part at the expense of meat.

A third determinant of demand addressed by economic theory is income. In the case of a normal good, quantity demanded varies with real income. As an individual's real income increases, he purchases more of the good in question. The opposite is true of an inferior good for which consumption decreases with an increase in income as other goods are substituted for it. Income elasticity is the measure of the relative responsiveness of quantity demanded to changes in income.

Various studies of consumption of fish in the U.S. have indicated that fish[3] is a normal good. Nash found most fishery products to be income elastic. He estimated the elasticity of fresh and frozen fish and shellfish to be .65 to 1.00, and the elasticity of groundfish to be 2.50 to 5.90. Bocktael estimated the income elasticity for fresh groundfish at 2.26. According to M.A. Robinson (1973), the effect of changes in income on the demand for fish varies according to tastes, and the level of consumption already enjoyed. He estimates an income elasticity for all fish of 1.0 for Indonesia, but only .28 for the U.S. It is expected that a smaller proportion of any income increase in the U.S. will be used to purchase food as opposed to a developing country.

Because the present study is based on cross-section data related to the consumption behavior of a given sample of the population at a point in time, it was not possible to derive quantitative measures such as price elasticities or cross price elasticities. Demand has most often been studied through the analysis of time series price and market information. Although this methodology is particularly suitable for estimating demand functions and will result in a measure of price elasticity, this method is not useful in analyzing the effect of socio-economic characteristics and other qualitative information. Because so little is known about the determinants of demand for fish in Guatemala, the qualitative descriptive information such as that

pertaining to socio-economic characteristics, present consumption habits, and attitudes that may act as barriers to consumption, are of great value as fundamental background to the study of present demand.

In addition to price, income, and prices of other goods, there is reason to believe there are other factors that influence demand. Examination of the literature and a knowledge of fish marketing in Guatemala have led to the inclusion of family size, education, availability, quality, and tastes in the demand equation. Various authors have included education as a variable in the study of demand (Purcell and Raunikar, 1965; Nash, 1967). Holding other things constant, consumption of fish in Guatemala might be expected to increase with education due to 1) a greater awareness of the high nutritional value of fish, 2) less reliance on misconceptions of fish (i.e., that fish is dangerous, causes allergic reactions, etc.), and 3) a greater desire on the part of an educated person for variety.

Family size is another socio-economic characteristic included in demand research because consumption is often found to vary with family size (Purcell and Raunikar, 1965; Goldman and Ranada, 1976; Nash, 1967). It is hypothesized that the absolute quantity of fish consumed by a family will increase as family size increases, but that per capita consumption may decrease with an increased number of family members. The number of family members as well as the age composition of the family is hypothesized to affect consumption and, therefore, changes in the composition of the population will affect buying patterns.

According to Robinson (1973), "Deficiencies in the distributive sector are probably the major constraint to greater fish consumption in many parts of the world (particularly in the less developed countries) not only because of their effect on price, but also simply because they prevent the wider and more regular availability of fish and fishery products...." E.J. Griffiths (1977), in his study of demand for fish in Australia, points to the 1) inconvenience of supply outlets, and 2) lack of regularity of supply as the most important deterrents to increased consumption. Because fish is sporadically available in the markets and not available in many areas of Guatemala City, scarcity of fish is hypothesized to be a deterrent to consumption. To help alleviate the problem of quality of fish as well as availability, the Fisheries Department plans to build a central fish market. A network of ferias libres, or door-to-door fish vendors, has been proposed to cover areas of the city not served by the public markets.[4] A knowledge of the relation of availability to consumption will guide the Fisheries Department in setting policy priorities.

The lengthy processing and transport of fish from the Pacific ports to Guatemala City and inadequate overnight storage facilities in the markets mean that the fish sold in the Guatemalan markets is not of consistent quality. Thus, it is hypothesized that quality is a deterrent to increased consumption. The Fisheries Department is planning to constuct a central market exemplifying the sanitary handling of fish. Ferias libres have been discussed as substitues to the traditional street vendors because the fish could be transported door-to-door in refrigerated carts, rather than in unprotected aluminum pans. If quality is found to be a deterrent to consumption, the Fisheries Department would place greater emphasis on improving quality through improved marketing and transport.

Economists have had little to say about the effects of taste on consumption, because tastes are difficult to measure. In Guatemala, fish consumption is estimated at only 1.7 percent of total animal protein supplied (FAO, 1971); and since availability of fish in th market also is sporadic it is hypothesized that consumers do not regularly come in contact with fish, and therefore may not have developed a taste for fish.

II. The Models

The demand for fish is hypothesized to be a function of many variables. Based on the knowledge at hand, we propose to estimate the following model:

$$C = f(I,F,T,A,E,Q,P) \quad (1)$$

where C = consumption
I = income
F = family size
T = tastes
A = availability
E = education
Q = quality
P = price.

A model represents a simplification of reality and many variables are necessary omitted. Lack of previous research work on the demand for fish in Guatemala contributes to the difficulty in specifying variables for inclusion in the analysis.

Although economic theory has much to say about the impact of certain variables on demand, theory does not indicate how these variables should be measured, For example, the measurement of "taste" for fish is particularly arbitrary because there is no literature on its measurement and because of the subjective nature of the term itself. The questionnaire elicited much information concerning both quality and availability; however, combining and translating subjective information into an appropriate numeric value is necessarily judgmental.

A measure of family size (F) was derived from question three in the questionnaire, the number of household members by age group. Because demand was thought to be influenced by age composition of the family, as well as family size, a weighted family size index was derived (Wold and Jureen, 1953). That is, the number of family members in each age group was multiplied by the percent of adult consumption hypothesized for that group. Ages 0-10 were theorized to eat 50 percent of adult consumption, ages 11-18, 90 percent. Above age 19, an adult consumption pattern is assumed. An example follows:

Age	Number		Index		
0-10	2	x	.5	=	1.00
11-18	1	x	.9	=	.90
19+	2	x	1.0	=	2.00
					3.00

The weighted factors used are based on those of Wold and Jureen (1953); however, the age group specifications in the present study are different and needed adaptation. While there is some question as to the appropriateness and arbitrariness of adapting an American family size scale to Guatemalan data, it was necessary to reflect likely variations in demand as a result of family age composition.

Total family income was calculated from income information on the head of the household as well as income earned by other family members. For those respondents reluctant to answer the income questions, or those who did not know the household income, the interviewers estimated household income. There are a variety of theories to "define" total household income. Goldman and Ranade (1976) considered income to include current savings, in addition to total expenditures on all commodities. Although some precision may have been lost in the present study by including only current earnings as a measure of household income (income would be understated in the case of retired or

unemployed persons), information regarding savings was not readily available, nor was it information a respondent would likely divulge in an unannounced door-to-door interview.

Family size and age of family members were thought to enter into the relationship of income and consumption. That is, the relation of per capita income (I) to per capita consumption (C) is hypothesized to depend on the number of family members and the age of the family members. Thus, total family income was divided by a "weighted" family size, weighted by the percent of total income hypothesized to be spent by each age group. Ages 0-10 were assumed to require expenditures at 30 percent of adult expenditure requirements, ages 11-18 80 percent, and above age 19, 100 percent. An example follows:

Age Group	Number of Members		Index		
0-10	2	x	.3	=	.6
11-18	1	x	.8	=	.8
19+	2	x	1.0	=	2.0
					3.4

The number of family members in each age group was multiplied by an index for that age group and then summed. While the selected weights are arbitrary, we again felt some attempt should be made to reflect the direction in which family age composition affects spending and consumption decisions.

The education variable (E) was measured by the number of years of education of the head of the household. The number of years given was used directly in the analysis. Although the educational level of the wife also was obtained, the attitudes of the household, or head of the house, were felt to be more closely related to the consumption of fish.

Tastes and preferencea (T) for fish were represented by an index concerning 1) the degree to which a respondent liked fish and 2) a respondent's preference for fish in relation to other meats (i.e., beef, pork, chicken, or any other). An index from 2 to 10, least to most favorable, was derived from answers to the above questions (method presented in Appendix 1). These index figures were included in the regression analysis. Due to the difficulties encountered in combining answers to the above questions into index form, this index is rather arbitrary. It is not known if the transition from the ordinal ranking given by the respondent to a cardinal scale will accurately reflect variations in tastes.

Availability, quality and a concern with price were derived from the questions "What is your biggest problem buying fish?" and "Why don't you eat more fish?". Dummy variables differentiated those who mentioned quality, availability and a concern with price from those who did not. Although respondents mentioned these variables in response to a number of questions, the above questions appeared to elicit the least ambiguous answers. However, it is not certain that responses to these open-ended questions are suitable as a measure of concern with these variables. Availability was alternatively measured by the zone in which the respondent lived; each zone was assigned a value of 0 or 1 through knowledge of the accessibility of fish. This is represented by the distance variable.

One way of measuring "availabilty" might be the additional expense, in terms of time and transportation, necessary to purchase fish. Viewed in this way, the costs of reaching fish markets should be added to the market price of fish to determine the relation between consumption and price. Future studies might benefit from this approach if transportation costs could be collected.

Many questionnaires were eliminated from analysis because there was no numeric answer suitable for regression. For those who do not purchase fish, there would be no answer to "quantity last purchased," and that questionnaire would be deleted from this analysis. The consumption variable should

therefore be interpreted as per capita yearly consumption for those who consume.

A second model was estimated with expenditure on fish as the dependent variable. Because of the heterogeneity of fish in Guatemala, it is possible that with an increase in income the quality of fish purchased, rather than the quantity of fish purchased, will increase. If this is true, expenditures on fish should increase with increasing incomes because more expensive species are consumed even if the quantity of fish consumed does not rise. We assume expenditures is a function of the following form:

$$Ex = f(I,F,T,P) \qquad (2)$$

where Ex = expenditure
I = income
F = family size
T = tastes
P = dummy variable representing a concern with the price of fish.

The expenditure variable was developed by multiplying yearly household consumption by a price index derived from quantity and species last purchased. The resulting expenditure variable represents yearly household expenditure. Although this variable was the best approximation to expenditures, the expenditure variable is somewhat arbitrary and suffers from the shortcomings of its components:

1) the assumption that last purchase information is indicative of general buying habits; and

2) many questionnaires were eliminated because the respondents could not specify which species of fish they had purchased.

Although there were 1,419 respondents to the questionnaire, the sample size reported in various analyses was substantially smaller due to incomplete answers that caused a questionnaire to be deleted from a particular analysis. Thus, sample size is dependent on the number of variables incorporated into each analysis. It is not known in what direction the results are biased due in incomplete questionnaires.

III. Results of Estimating the Models

Present Demand with Regard to Consumption. The initial analysis is based on a log-linear version of model (1):

$$\text{Log } C = b_0 + b_1 \log I + b_2 \log F + b_3 \log T + b_4 A + b_5 \log E + b_6 P + b_7 Q \qquad (1)$$

where C = per capita consumption
I = per capita income
F = "adjusted" family size
T = index of tastes and preferences
A = index of availability of fish
E = educational level
P = dummy variable representing a concern with the price of fish
Q = index of quality of fish.

The results are given by Equation (1) in Table 1. The estimated relationship between tastes and preferences, family size, a concern with the price of fish, and per capita income on the one hand and consumption on the other are significant. The degree to which a person likes fish is positively related to

consumption as expected.

The dummy variable representing a concern with price did prove significant at the 5 percent level. Also as expected, per capita consumption was found to be negatively related to a concern with price, indicating that those respondents who answered that the price of fish was a problem did consume less on a per capita basis.

Due to the nature of cross-section information taken from one point in time, these results yield little predictive information. However, the results suggest that respondents answers to open-ended questions are highly correlated to their behavior. Because there were no previous studies to suggest appropriate methods for studying demand, this information is particularly important.

The quality, availability, and education varisbles did not prove significantly related to consumption. In light of the marketing of fish in Guatemala as well as other findings in the present study, this result is highly suspect and is perhaps due to variable construction. The variables quality and availability were constructed from answers to open-ended questions. Two possible problems come to mind:

1) The rate of response to these open-ended questions was not high; thus there is the possibility of bias.

2) In the interpretation and coding of the raw data, some exactness may have been lost.

An alternative measure of availability, distance of the household from the market, was substituted in the model. The results indicated no relation between this measure and consumption. The problem with this may lie on the diversity of each zone with regard to the accessibility of fish. Some areas of a zone may be close to a market while others are distant. Assignment of an availability index by actual address would be extremely time consuming and would require great familiarity with each area of Guatemala City.

Family size was found to be negatively related to per capita consumption (i.e., as family size increased, per capita consumption decreased). This result is not surprising and indicates that as family size increases, each family member eats less fish. Perhaps fish is prepared in alternative ways to make it stretch further for a large family. Although education data were obtained from the question "How many years of school did the head of the household attend?", the results obtained do not appear to be reliable. Results of other analyses using this education information also lead to the belief that the data may be inaccurate. A number of explanations may be suggested for this:

1) The respondent did not know how many years of school the head of the house had attended.

2) An exaggeration on the part of the respondent (usually the wife) regarding her spouse's education level.

3) The possibility that our sample was biased toward those with higher educational levels by virtue of respondent accessibility.

Per capita income for the full sample is found to be positively related to per capita consumption, inducating that as income increases consumption of fish does also. Thus, fish as a whole is a normal good with an income elasticity of .29.

Although income is hypothesized to be a significant fator in the determination of demand, it is not clear whether there is a constant income elasticity over all income levels, or a change within subgroups. Much has been

TABLE 1. Regression Results with Consumption as the Dependent Variable

(1) $\text{Log } C = -1.6 + .29 \text{ Log } I - .22 \text{ Log } F + .43 \text{ Log } T - .09A - .05$
$(-4.57)^*(4.7)^* \quad (-2.17)^* \quad (13.96)^* \quad (.97) \quad (-.65)$

$\text{Log } E - .20P - .002Q$
$(-2.4)^* \quad (-.02)$

$R^2 = .2714$ $\quad F = 42.34$ $\quad$ Sample size = 778

(2) $\text{Log } C = -1.2 + .30 \text{ Log } I - .20 \text{ Log } F + .36 \text{ Log } T - .15 \text{ Log } P$
$(-3.32)^*(5.82)^* \quad (-1.94) \quad (11.22)^* \quad (-1.40)$

$R^2 = .2403$ $\quad F = 45.10$ $\quad$ Sample size = 889

(3) A. Low Income

$\text{Log } C = -2.65 + .47 \text{ Log } I + .08 \text{ Log } F + .42 \text{ Log } T - .02A$
$(-3.44)^* \quad (3.22)^* \quad (.44) \quad (8.6)^* \quad (-.15)$

$-.23P + .09Q$
$(-1.98)^*(.53)$

$R^2 = .2202$ $\quad F = 15.98$ $\quad$ Sample size = 360

B. Middle Income

$\text{Log } C = 1.93 - .27 \text{ Log } I - .88 \text{ Log } F + .41 \text{ Log } T - .19A$
$(1.52) \quad (-1.33) \quad (-3.51)^* \quad (9.53)^* \quad (-1.41)$

$-.14P - .11Q$
$(-1.13) \quad (-.75)$

$R^2 = .2317$ $\quad F = 19.55$ $\quad$ Sample size = 370

C. High Income

$\text{Log } C = -3.4 + .47 \text{ Log } I + .01 \text{ Log } F + .46 \text{ Log } T - .09A$
$(-2.78)^* \quad (2.90)^* \quad (.04) \quad (6.90) \quad (-.41)$

$-23.P + .12Q$
$(-.97) \quad (.58)$

$R^2 = .3020$ $\quad F = 12.39$ $\quad$ Sample size = 159

*Significant at 5% level.

t-values are in parentheses.

written on the differences in income elasticities by income level. Goldman and Ranade (1976) hypothesize that income elasticity decreases as income increases because the marginal propensity to consume is less for higher income groups. Thus, regression analysis was performed on the low, middle, and high income groups to determine if the elasticity of demand for fish varies by income group. The results (see equations (3A-C), Table 1) indicate that income elasticities are equivalent for the low and high income groups. Within the middle income group, income level does not appear to be significantly related to consumption. The results were not those anticipated and do not support the hypothesis that income elasticity will decrease as income increases. A few explanations may be given to justify the results. There are many species of fish in Guatemala. The per pound price of fish ranges from approximately $.20 to $1.30; the first class, and most desired fish, being the higher priced varieties. Because "fish" is not a homogeneous commodity, the interpretation of the income elasticity calculated at each income level may be confused by the heterogeneity of the species bought by the respondents in each group.

The income elasticity of .47 for both the low income and high income groups indicates that fish is considered a normal good. With the middle income group, the coefficient on income is not significantly different from zero. Although this was not the expected result, it may indicate that for this middle income group the lower priced fish is inferior, but that these respondents do not have the means to buy the more expensive varieties. It may indicate a mixing of qualities. Perhaps individuals in this group are in a transition from consuming a larger quantity of low cost fish to a smaller quantity of high cost fish.

The family size variable is only significant for the middle income group, suggesting that family size is an important determinant of consumption at this income level.

The continuous variable representing price was incorporated into the specification of model (1') as follows:

$$\text{Log } C = B_0 + B_1 \text{ Log } I + B_2 \text{ Log } F + B_2 \text{ Log } T + B_3 \text{ Log } P \qquad (1")$$

where C = per capita consumption

I = per capita income

F = adjusted family size

T = tastes

P = continuous price variable.

The continuous price variable used in this analysis did not prove to be significant (see equation (2), Table 1). This seems surprising, but is most likely due to the construction of the variable from last purchase quantity and species information. The results point to the possible inaccuracy of information provided by respondents who perhaps did not remember the number of pounds they last bought or what species was bought. Many questionnaires were eliminated from this analysis because the respondents did not know the species they last purchased.6

Present Demand with Regard to Expenditure. Model (2) was estimated in logarithmic form as follows:

$$\text{Log } Ex = B_0 + B_1 \text{ Log } I + B_2 \text{ Log } F + B_3 \text{ Log } T + B_4 P \qquad (2')$$

where Ex = expenditure

I = per capita income

F = "adjusted" family size

T = index of tastes and preferences

P = dummy variable representing a concern with price.

The results, present in Table 2, indicate that all variables, with the exception of family size, are significantly related to expenditure. The index of tastes and preferences is positively related. The large value of the t-statistic indicates a positive relation between the index of tastes and preferences and expenditure on fish.

Although previous analysis indicated family size was related to consumption, family size is not related to household expenditure on fish. This implies that larger families may consume lower quality of fish. Our data indicate a decrease in total family income associated with increasing family size. Perhaps as family size increases, alternative uses of fish are found to feed a larger group (fish soup is widely prepared).

The "dummy" variable representing a concern with price was used in this analysis. This price dummy apeared to be negatively related to expenditure, indicating that for those who mentioned a concern over price, expenditure on fish was less.

Finally, per capita income appears to be positively related to expenditure. The results indicate that fish as a whole is a normal good with an expenditure elasticity of .42. The sample was divided into three income groups to determine if there was a difference in expenditure elasticities as had been hypothesized. Results can be found in equations (2A-C), Table 2. A comparison of low and high per capita incomes indicates that the expenditure elasticity is lower for the high income group, as the hypothesis suggested. In other words, within the lower income group, an increase in income would be accompanied by greater incremental spending on fish than is so for the high income group. However, per capita income in the middle income group may be used here to explain the relation of income and expenditure in the middle income group. For this group, the lower priced fish would most likely be thought of as an inferior good, while the high priced fish may be considered a normal good, but beyond the means of this group. Alternatively, some families may buy a larger quantity of lower priced fish, others may buy a smaller quantity of higher priced species. For this middle income group, family size becomes important, but it is not for both the low and high income groups. As family size increases, household expenditure on fish decreases. This result is contrary to what was expected. However, when taken with consumption results, this possibly indicates that some middle class consumes can afford high quality fish, but as family size increases, they will shift to the lower priced species.

It was important to look at quality, availability and a concern with price as possible determinants of demand. However, only the price dummy was determined to be related to consumption, possibly because of the construction of the variables, or because one of the stronger variables was picking up the variation. Although regression analysis is a useful tool to estimate the relation between continuous dependent variables, such as consumption or expenditure and continuous independent variables, it is not particularly suited to the analysis of discrete variables such as the measures of quality, availability, or a concern with price. Experience in Guatemala indicates that these variables are possible barriers to increased consumption. Thus, alternative methods of analysis are offered.

TABLE 2. Regression Results with Expenditure as the Dependent Variable

(1) $\text{Log Ex} = -1.87 + .42 \text{ Log I} - .15 \text{ Log F} + .34 \text{ Log T} - .19P$
$(-5.07)^* \quad (8.12)^* \quad (-1.42) \quad (10.21)^* \quad (-2.17)^*$

$R^2 = .2548$ $\quad F = 60.59$ $\quad$ Sample size = 698

(2) A. Low Income

$\text{Log Ex} = -3.2 + .64 \text{ Log I} + .13 \text{ Log F} + .35 \text{ Log T} - .13P$
$(-3.45)^* \quad (3.70)^* \quad (.59) \quad (6.39)^* \quad (-.95)$

$R^2 = .1772$ $\quad F = 16.03$ $\quad$ Sample size = 280

B. Middle Income

$\text{Log Ex} = 1.09 - .03 \text{ Log I} - .74 \text{ Log F} + .33 \text{ Log T} - .18P$
$(.74) \quad (-.12) \quad (-2.56)^* \quad (6.34)^* \quad (-1.29)$

$R^2 = .1779$ $\quad F = 16.46$ $\quad$ Sample size = 28[illegible]

C. High Income

$\text{Log Ex} = -2.71 + .48 \text{ Log I} + .13 \text{ Log F} + .34 \text{ Log T} - .52P$
$(-2.04)^* \quad (2.77)^* \quad (.41) \quad (4.84)^* \quad (-2.22)$

$R^2 = .214$ $\quad F = 10.1195$ $\quad$ Sample size = 135

* Indicates significance at 5% level.

IV. Analysis of Possible Barriers to Increased Consumption

If concern with price, availability and quality considerations are barriers to consumption, it is important to analyze the characteristics of those who were concerned with these variables. Thus, each variable will be analyzed by income and educational level. In addition, an attempt will be made to obtain a profile of a person who likes or does not like fish based on educational level, income, and family size.

Availability Analysis. When the sample as a whole was asked, "What is your biggest problem buying fish?", and "Why don't you eat more fish?", 15 and 7 percent, respectively, answered that fish was hard to obtain. Coupled with the information that fish is not available at all times and in all markets, availability is a problem that can be given priority by the Fisheries Department. Fifty-three percent of the sample did not own a car. Thus, accessibility becomes more important.

However, as can be seen in Table 3, equation (1), income group does not appear to be related to the mention of availability; the F value resulting from this analysis is not significant at the 5 percent level. Due to the fact that low-income respondents must rely on public transportation as compared to higher income families with autos,[7] it was felt that an analysis of availability problems by income group might yield significant results. However, the conclusion to be drawn is either that income group plays no part in availability, or an open-ended measure of availability is not adequate.

Again, availability does not appear to be related to the educational level of the wife[8] due to the low value of the F statistic. It was felt that with increased education, the housewife might find fish more acceptable, particularly for its nutritional qualities. She also might have greater familiarity with fish, and thus exhibit greater concern with availability. However, educational level does not appear to predispose a housewife to be more concerned about availability of fish.

Quality Analysis. When consumers were asked, "Why don't you eat more fish?", only 2.7 percent answered that the fish was not fresh. To the question, "What is your biggest problem buying fish?", 12.8 percent answered that finding fresh fish was a problem. When consumers were asked, "Are the conditions satisfactory where you buy fish?", the great majority said yes. Of the 10 percent that answered "No," only 1 percent felt that the quality of fish was bad. It is difficult to know which answers most accurately represent the intensity of consumer attitudes toward quality. However, quality does not consistently appear as a concern.

It was hypothesized that those respondents in the higher income groups would be more likely to view the quality of fish as a problem. Presumably, at a high income level the quality of an item more than its price would be a barrier to consumption. As expected, there is a significant difference in income between those who answered that quality was a problem and those who did not. Additionally, those respondents who worry about quality have significantly higher incomes.

It was hypothesized that the educational level of the wife might serve to distinguish those who felt quality was a problem from those who did not. With more education, a housewife may be more discriminating in her purchases, therefore finding fault with the present marketing of fish.

Eight hundred and twenty-seven observations were used in the analysis. The results are presented in Table 4. The results do not support the hypothesis. In other words, those who answered that quality was a problem could not be distinguished on the basis of educational level.

Price Analysis. Because of the importance of the price variable, and the fact that the continuous price variable in the regression analysis was not significant, a tabular description of consumers' attitudes toward price was regarded as a alternative method of analysis. All respondents were asked, "Is the price of fish high or low?". The responses are as follows:

TABLE 3. Analysis of Variance by Availability

(1) Availability by income

Source of Variance	Sum of Squares	DF	Mean Sq.	F
Explained	29091.7	1	29092.7	2.21
Residual	12915117.6	981	13165.26	
Total	12944209.3	982		

(2) Availability by years of education of the wife

Source of Variance	Sum of Squares	DF	Mean Sq.	F
Explained	27.8	1	27.8	2.12
Residual	10847.1	825	13.1	
Total	10874.9	826		

	Frequency	Percent
No response	189	13.338
High	810	57.163
Low	156	11.009
Regular	194	13.691
Depends on the type of fish	16	1.129
Didn't know	52	3.670
Total	1417	100.000

The results indicate that the price of fish is considered high by a great number of responents. Other questions, "Why don't you eat more fish?", and "What is your biggest problem buying fish?", yielded a considerable number of answers, such as "too high a price": 21 and 9.7 percent, respectively.

However when respondents were asked to rank the price of fish in relation to other meats, the results indicate that consumers in general feel that beef and pork are priced higher than fish. The results are as follows:

"Generally, which is more expensive?"

Fish or Beef:	Frequency	Percent
No response	161	11.362
Fish	369	26.041
Beef	672	47.424
Equal	199	14.044
Didn't know	16	1.129
	1417	100.000

Fish or Chicken:		
No response	158	11.150
Fish	783	51.729
Chicken	376	26.535
Equal	133	9.386
Didn't know	17	1.200
	1417	100.000

Fish or Pork:		
No response	163	11.503
Fish	282	19.901
Pork	803	56.669
Equal	117	8.257
Didn't know	52	3.670
	1417	100.000

For the Fisheries Department to analyze its goal of substantially increasing the supply of fish at the Guatemalan market, it is important to know what type of individual answered that price was a problem. Clearly, form market observation the price of fish is high relative to an average wage earner's salary, and is suggested to be a barrier to increased consumption. It was therefore hypothesized that those who expressed concern with price could be distinguished by income group; i.e., the lower income group would be more likely to answer that price was a problem. In this analysis, 983 observations were used. The results, shown in Table 5, equation (1), support the hypothesis. This result points out that a concern with price is possibly a barrier to expanded consumption by the lower income groups. Lowering

TABLE 4. Analysis of Variance by Quality

(1) Income by quality

Source of Variance	Sum of Squares	DF	Mean Sq.	F
Explained	58794.	1	58704.	4.46
Residual	12884902.	981	13134.5	
Total	12943696.	982	13181.0	

(2) Years of education of the wife by quality

Source of Variance	Sum of Squares	DF	Mean Sq.	F
Explained	22.1	1	22.1	1.68
Residual	10852.8	825	13.2	
Total	10874.9	826		

prices, then, may substantially increase consumption by this group.

Although it was not clear whether those wives with greater education would be more price conscious, or alternatively that they would be more concerned with quality and nutritional value, it was argued that educational level might distinguish those who answered price as a problem.

In this analysis, 827 observations were used. Again, many observations were eliminated because they lacked education answers. The results shown in Table 5, equation (2), indicate that price considerations are related to the educational level of the wife. Those with lower educational levels were more likely to answer that price was a problem. Perhaps for the wife with a low level of education, price is the most important consideration. However, it is more likely that the education variable is picking up the effect of income.

If the Fisheries Department could obtain a profile of the person who likes fish or consumes fish, it would be better able to predict the results of its policies. Discriminant analysis was used here to classify, if possible, a consumer from a non-consumer and one who likes fish from one who dies not on the basis of income, education and family size.

In this analysis, 1006 observations were used. However the analysis could not distinguish between consumers and non-consumers or those who like fish from those who do not on the basis of the information given, indicating that there is little measurable difference between these groups, at least with regard to these three socio-economic variables. The results of these analyses are presented in Table 6.

V. Sumary and Conclusions

The objectives of this study were to determine the variables that are significantly related to fish consumption, and to identify and analyze barriers to increased fish consumption in Guatemala City. The results indicate that income is positively related to fish consumption and expenditures. Fresh fish is a normal good with an income elasticity of .29 and an income elasticity of expenditure of .42.

Availability did not prove to be a significant barrier to the increased consumption of fish. This result may be due to variable construction or simply indicate that availability is of no great concern to Guatemalans who consume little fish.

A large number of respondents did not know the names of fish species nor the market prices of fish. That is, there is a considerable lack of information in the market for fish and consumer education programs may be necessary before increased availability and lower prices can induce increased consumption of fish.

The quality of fish did not prove to be significantly related to consumption and expenditure either. While this may have resulted from imperfect variable construction, it may be true that consumers are not concerned about fish quality. Therefore, more hygenic marketing conditions may have little or no impact on fish consumption without additional consumer education.

A major shortcoming of this study is the lack of measures of demand elasticity. Time series data on prices and quantities will have to be collected before such measures can be obtained.

TABLE 5. Analysis of Variance by Price

(1) Per capita income by a concern with price

Source of Variance	Sum of Squares	DF	Mean Sq.	F
Explained	339409.1	1	339409.1	26.42
Residual	12604800.2	981	12848.9	
Total	12944209.4	982		

(2) Years of education of the wife by a concern with price

Source of Variance	Sum of Squares	DF	Mean Sq.	F
Explained	162.0	1	162.0	12.47
Residual	10712.9	825	13.0	
Total				

TABLE 6. Discriminant Analysis--Consumers vs. Non-Consumers, Those Who Like Fish vs. Those Who Do Not

(1) Those who consume vs. non-consumers

Discriminant Function Coefficients

Education	-.75665
Family size	-.50293
Income	-.31210

Wilkes-Lambda .9902 Chi-Square 9.922 Significance .019

Sample Size = 1006

(2) Those who like fish vs. those who do not

Discriminant Function Coefficients

Education	-.68895
Family size	-.57015
Income	-.36414

Wilkes-Lambda .9845 Chi-Square 15.664 Significance .001

Sample Size = 1006

FOOTNOTES

[1]The only exception to this "law" is the Giffin good, which is characterized by a large negative income effect which exceeds, in absolute value, the positive substitution effect.

[2]Fish is generally eaten as a "main dish" or primary protein source for a meal, as is beef, chicken and pork.

[3]The definition of "fish" refers either to all fresh fish and shellfish, all fresh groundfish, or all fish products. This difference in definition accounts for the widely divergent income elasticities. It is also true that the definition of "income" varies by study.

[4]Over 50 percent of our sample did not own cars; therefore, accessibility to a market by bus is important.

[5]Because the education variable did not prove significant, it was eliminated from analysis. Thus, sample size increases from 778 to 889 in subsequent analyses.

[6]"Unfamiliarity" with the marketing of fish, possibly due to the general unavailability of fish, is reflected in answers to the questions "What is the price of [species] in the market?" and "What species did you last buy?".

[7]Fifty-three percent of our sample did not own a car.

[8]In his analysis, educational level of the wife was used rather than that of the husband because it was felt she would have more knowledge of the price, availability, and quality of fish.

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APPENDIX I

Tastes and Preferences Index

Question 14. Do you like Fish?		points given to each response
possible responses	yes, a lot	4
	regular	3
	little	2
	no	1

Question 36. How much do you like fish in relation to beef, chicken, pork and other?

possible responses	points given to each response
fish ranked 1st	5
↓	4
	3
	2
fish ranked last	1

Tastes and Preference Index = Summation of Points from Questions 14 and 36.

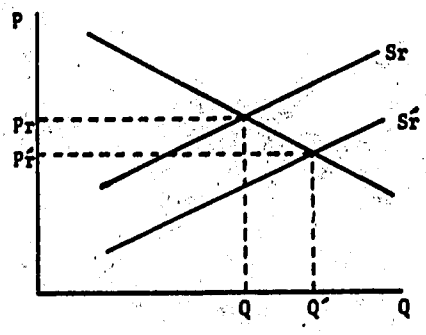

Figure 1

CHAPTER 27 PLANNING AND ADMINISTRATION OF SMALL-SCALE FISHERIES PROJECTS IN COSTA RICA: THE PARADOX OF COMPREHENSIVE DEVELOPMENT PLANNING

BY T.M. Hennessey

This study concerns administrative aspects of the development process as these relate to program weakness and failure. It critically examines the design and operation of a thirteen million dollar fisheries development project in Costa Rica which essentially failed to meet most of its program goals. The research, however, is not simply a case study of Costa Rican fisheries but rather uses this particular experience to examine a series of hypothesis drawn from the theory of collective action. These are tested via a set of interviews with eighteen program directors from the several governmental agencies involved in the program.

Since World War II, billions of dollars have been spent on development projects. Such projects have met with decidedly mixed results. Yet comparatively little money and effort has been expended in attempting to systematically evaluate the sources of program success and failure. However, certain lessons, have been learned and are emphasized in the development literature (Montgomery and Siffin, 1966; Blase 1977).

Perhaps the most fundamental lesson is that successful "development" must include a solid Institutional base. The institutional approach emphasizes that the innovations needed to enhance development extend beyond purely technical considerations to require significant changes in institutions, attitudes and behaviors. These changes are embodied in organizations which attempt to introduce and protect such changes in their society. When building such organizations, linkages with other groups and organizations are essential. Moreover, this process of extending an innovation involves learning, accommodation and conflict among the groups involved. William Siffin, one of the most astute students of development, emphasizes that the institution-building approach should use a combination of an organization and a set of linkages with its environment. Key features of the organization are leadership, doctrine, program, resources and internal structure (Siffin, 1975, p 2).

It should be clear that development today has progressed beyond skills training and transfer of basic technology. The less-developed countries increasing need to know how to deliver new technological improvements to a large number of people quickly. They also need to know how to develop and administer delivery systems so as to increase economic efficiency and or improve social welfare through the use of new knowledge. All of these problems involve many organizations and complex social and political structures. To accomplish these goals requires the appropriate administrative structure to coordinate, organize and manage programs. The latest thinking in development administration therefore emphasizes that development programs should be comprehensive, involving many groups and organizations in order to maximize overall social welfare.

Finally, and most important for the Costa Rican project, little research has been done on the administrative aspects of marine resource management with the notable exception of the South China Seas Project (Crutchfield, et al., 1974; Moore, et al., 1976). The analysis which follows represents a relatively new sector of inquiry.

With this background in mind, it is important to note that Costa Rican officials and the lending agency, the Interamerican Development Bank, rejected a narrow, technical approach to fisheries development in favor of the comprehensive, institutional approach favored in the development literature referred to above. This comprehensive approach emphasizes linkages between relevant social, economic and governmental groups. And since the government

is the engine of change, it seeks to relate these particular groupings to each other for development purposes by coordinating several government agencies with diverse functional responsibilities. Such development programs usually fall outside the usual responsibilities standard operating procedures of most of the agencies. Therefore some organizational mechanism must be found to direct the overall program. In this sense, a new organization must be fashioned from existing agencies in order to coordinate and direct the program. Such coordinating structures are critical to the success of development projects although most development specialist tend to underestimate the difficulty of creating and operating such organizations.

The problem of establishing and operating such an inter-governmental coordinating mechanism at optimal levels is central to this study. Our theoretical point of departure consists of a series of working assumptions drawn from the Public Choice literature on decision making and institutional design. This approach assumes that public agencies operate in their own self-interest so as to assure the survival and "health" of their agencies with respect to budget and personnel. Using these assumptions as a point of departure, we argue that inter-governmental coordination is a strategic opportunity for agencies to reduce their particular contribution to the overall welfare function represented by the development project. And every agency is expected to have an incentive to behave accordingly.

Following Mancur Olson (1965), we view the interagency coordination problem as one of creating a "manifest" group from a set of "latent" elements drawn from a variety of agencies. Olson has demonstrated that when there are a significant number of actors involved in collective action which is largely voluntary we can expect each to take advantage of the situation by "free-riding" at the expense of the others involved. And since in our case each agency has a similar incentive to minimize contributions, the overall level of contributions will be suboptimal and project goals damaged. This will be the case unless selective incentives or coercion are used to bring the contributions up to required levels. If these latter conditions do not obtain, we can expect such a free rider phenomenon whereby contributions will be lower than are required for successful operation and the program thereby critically weakened.

These observations lead us to the formulation of what we shall call the paradox of comprehensive development planning. The literature clearly indicates that a comprehensive approach to the development process is to be preferred to a limited technical transfer situation. Nevertheless, comprehensive development programs require high degrees of interagency coordination as a necessary condition of successful operation. But this requirement in turn creates conditions with a high potential for strategic behavior on the part of participating agencies and departments, especially when appropriate coercion and selective incentives are not employed. If these latter mechanisms are not employed we can expect agencies to minimize their contributions as we indicated above. Thus we hypothesize that the potential for "free riders," so basic to collective action problems, is inherent in the dynamics of intergency coordination and hence to comprehensive development planning. The paradox is that in so far as one attempts to be comprehensive, which requires the optimal contribution of a number of agencies, one also creates the conditions for strategic interaction in terms of which suboptimal contributions can be expected and which in turn weaken the possibility of a successful development program.

We shall argue that this does not have to be the inevitable outcome of comprehensive programs but that such failures can only be avoided if certain analytic approaches and their correlative management principles are heeded. For example, the concept of selective incentives can refer to increases in

budget and personnel to the cooperating department or agency, while coercion can be established through processes of program control and evaluation. If these management procedures are not observed in designing the comprehensive program, however, the probability of success is reduced accordingly.

In light of this potential paradox, the determination of administrative feasibility must be an essential feature of development planning. Administrative coordination should not be seen as largely exogenous to development goals as it often is. Instead, administrative considerations must be seen as endogenous and directly related to final development objectives. Indeed, as we shall see in the Costa Rican example, a heavy social cost can be attributed to the paradox of comprehensive development if these administrative considerations are not carefully observed.

With these considerations in mind, this paper contains the following sections: I. Theoretical Approach and Working Assumptions; II. The Small Scale Fisheries Development Project: Organizational Structure and Objectives; III. The Hypotheses: Results of the interviews; IV. Implications of the Study.

I. Theoretical Approach and Working Assumptions

Students of government behavior have traditionally assumed that bureaucracy functioned to serve an overall societal welfare function known as "the public interest." The different functions performed by individual agencies were presumed to contribute to this general goal. It was further assumed that government leaders could plan, direct and control the bureaucracy in an efficient, effective manner.

But just as the behavioral theory of the firm led to a fundamental revision in our understanding of business behavior, recent writings on bureaucracy have revised our understanding of government behavior. This new thrust, which we shall term the political economy approach, has proven to be useful in generating empirically testable hypotheses regarding the behavior of complex public bureaucracies. The approach is exemplified in the writings of Graham Allison (1969), Randall Bartlett (1973), Warren Ilchman and Norman Uphoff (1969), Charles Lindblom (1978, 1965, 1963), William Niskanen (1971), Mancur Olson (1965), Vincent Ostrom (1973), Herbert Simon (1955, 1958, 1957), Caiden and Wildasky (1974), and Gordon Tullock (1965).

These scholars operate with roughly similar assumptions although they apply their arguments to a variety of different problems. The fundamental approach which each shares, however, and which we will employ in the study which follows, is the composite method of economics which develops hypotheses about social behavior from models of purposive behavior by individuals. The agency or bureau leader is the principal figure. He is assumed to be both a chooser and a maximizer. He faces a set of possible courses of action or opportunities in terms of which to maximize his agencies' benefits. Such choices are made in the face of constraints such as imperfect information, uncertainty and risk. Moreover, the larger environment, including other agencies and departments with whom he interacts, constitutes another set of constraints.

Agencies and departments are viewed here as complex organizations with diverse goals and divided responsibilities. There is no larger "public interest" apart from the behavior of individual agencies which pursue their self-interest in the context of the political system. Under no condition is there a "collective preference" which all agencies share. Each department acts independently to maximize "security" (Bartlett, 1973) or "organizational health" (Allison, (1969) for their agency or department through the acquisition of more personnel and budget and other resources.

In this approach, following Allison, overall government behavior reflects the independent output of a number of government agencies. Each agency

perceives problems and performs a variety of activities in quasi-independence, within broad statutory constraints. Because of this quasi-independence the relationship of agencies to each other has to be negotiated. According to Allison these relationships are regularized by 1) An agreed upon budget split, 2) agreed upon areas of responsibility, and 3) established conventional practices (i.e., standard operating procedures) (Allison, 1967, pp. 701-702). The dilemma is that while government leaders cannot control and direct the operation of a number of departments with diverse goals and responsibilities, the complex demands of public policy require some form of coordination in order that specific tasks be accomplished.

Interagency Coordination as a Collective Action Problem. We have already noted that a comprehensive governmental approach to public problems requires interagency coordination in order to obtain the necessary functional inputs from various agencies and departments. And despite the fact that such coordination is rarely forthcoming at the prescribed level and is a cause of weakness and failure in development programs, this process of coordination is not often seen as an important problem. It has traditionally been viewed as a simple matter of directing and encouraging the participating agencies to carry out a set of activities which, when aggregated, will be sufficient to provide goods and services at appropriate levels. Unfortunately, this has proven to be a naïve approach because it assumes that each agency views the problem from a roughly similar perspective; that is, each agency will somehow attach an equivalent value to the outcomes of the project as well as to their costs for participating in it. But our model explicitly rejects such an approach by specifying that each agency is expected to value the outcomes differently owing to different resources, priorities, preferences and standard operating procedures.

Given the assumption that agencies will act in a semi-independent manner and value the goods and services differently, we shall conceptualize the problem of inter-governmental coordination in comprehensive development programs as essentially a collective action problem in which government leaders must induce project participants to participate at prescribed levels via the use of various forms of coercion and selective incentives. After setting out the basic elements in the theory of collective action we shall use this approach to examine the Costa Rican small-scale fisheries project.

Groups of individuals with common interests are expected to act on behalf of their common interests much as single individuals are expected to act on behalf of their personal interests. This is the view which pervades much of sociology and political science. But Mancur Olson (1965) has demonstrated that groups of individuals with common interests will not necessarily attempt to further these interests. In other words, if members of some group have a common interest or objective (i.e., a development program and its social benefits), and if they would all be better off if that objective were served, it has been thought to follow that the individuals in the group would if they were rational and self-interested, act to achieve that objective.

But Olson has shown that this is simply not the case. He proves that "unless the number of individuals in a group is very small, or unless there is coercion or some other special device to make individuals act in their common interest, rational, self-interested individuals will not act to achieve their common or group interests (Olson, 1965, p. 2). And,

> ...they will not advance common interests unless there is coercion to force them to do so, or unless some separate incentive, distinct from the achievement of the common or group interest, is offered to the members of the group individually on the condition that they help to bear the costs or burdens involved in the achievement of the group objectives. Nor will such large groups form organizations to further their common goals in the absence of the coercion or the separate incentives just mentioned. These points hold true even when there is unanimous agreement in a group and

> methods achieving it . . . thus the customary view that groups of individuals with common interests tend to further those common interests appears to have little if any merit.
>
> (Olson, 1965, p. 2)

According to Olson the reasons for this seemingly puzzling phenomenon lie in the propensity of individuals to minimize their contributions to the attainment of the group objective while reaping the benefits. In small groups such cost minimization is difficult because those who do not bear their share of the burdens are immediately noticeable and subject to ridicule and sanction. But in large groups the contributions of each are difficult or even impossible to monitor: the larger the group, the less the noticeability. And the less noticeability, the greater the opportunity to "free-ride" on the contributions of others while minimizing one's own. Thus, the larger number of group participants, the greater the tendency for each to "free-ride," and the greater the probability that the goods and services in question will be provided at a suboptimal level unless coercion and/or selective incentives are employed in a creative fashion. Fundamentally, then, the issue is a question of the costs and benefits of alternative courses of action open to individuals in groups of different sizes faced with providing public goods.

When we turn to a consideration of these analytics in relation to comprehensive development projects we are referring to a group process of participating agencies which is usually apart and distinct from the everyday activities and responsibilities of the agencies. Whereas in routine day to day responsibilities each agency has a relatively clear-cut set of functions and standard operating procedures, comprehensive development programs require a set of activities and objectives which are not routine or clearly defined. In essence, when we formulate a development project we are, in a sense, creating a "new group" made up of already existing agency elements but assembled in a new configuration. In Olson's terminology, in development projects we are creating a manifest group from a latent group. But in order to accomplish this, the new group must be mobilized.

As Olson observes,

> When there is no preexisting organization or group and when the direct resource costs of a collective good it wants are more than any single individual could profitably bear, additional costs must be incurred to obtain an agreement about how the burden will be shared and to coordinate or organize the effort to obtain the good. These are the costs of communication among group members, the costs of bargaining among them and the costs of creating, staffing and maintaining any formal group organization. (Olson, 1965, p. 47)

When several government agencies are organized for development purposes it is obvious that the costs of organizing will be less than if one were starting from scratch, but such costs will by no means necessarily be negligible, particularly the costs of bargaining and coordinating. Indeed, as we shall see there is a general tendency to underestimate the "true" costs involved in such joint, interagency endeavors.

Therefore while acknowledging that the problem of inter-governmental coordination is not equivalent to the establishment of a group by voluntary individuals, it is nevertheless the case that the public good in question requires the participation of quasi-independent agencies which act much as individuals do. The public good, therefore, may be provided at suboptimal levels in comprehensive development projects owing to the tendency for individual agencies to minimize their costs or contributions to the effort. Each has an incentive to "free-ride" on the contributions of other agencies

and the result is suboptimal provision. And the larger the number of participating agencies, the greater the potential for free-riding and, consequently, suboptimal provision of the good.

There is, of course, a potential for responsible authorities to recognize the nature of the problem represented by such strategic interaction and, in light of this, to employ coercion or selective incentives so as to obtain the required level of contributions. To the extent that this approach is utilized, we can expect latent groups to become what Olson terms "mobilized" latent groups: "Groups are thus called 'latent' groups because they have the latent power or capacity for action, but that potential power can be realized or mobilized only with the aid of selective incentives" (Olson, 1965, p. 51).

Students of development administration have not approached the problem in this manner. Instead, they have usually seen the problem of coordination as a simple matter of getting the appropriate agencies "together" and then exhorting them to participate together to attain "the public interest." In this sense, administrators seem to ascribe some collective preference to the agencies involved. And since it is assumed that all agencies have roughly the same objectives in mind, this renders what we have observed as the overriding self-interest of the agencies irrelevant, inappropriate, or even unethical. But since participating agencies have a number of responsibilities in addition to the development project, minimizing these contributions to this particular project may help them be more effective in another area. As Lindblom notes, "To omit is to make manageable!" (Lindblum, 1965, p. 26.)

In comprehensive development projects the notion of a collective preference derived from a diverse set of agencies is unrealistic and analytically unjustified. Indeed, there are a large number of dimensions along which the participating agencies may be expected to differ. Consider for a moment the following "typical" differences which might apply to agencies participating in development projects:

1. Agencies have normal responsibilities which are quite different from each other and their particular responsibilities in the comprehensive development program differ as well.

2. Agencies will assign different values to the costs and benefits of the program in question.

3. Agencies with the greatest interest in the goals of the program do not necessarily have the requisite political power to accompany this interest.

4. Agencies have different program requirements which require differing levels of resource allocation.

5. Agencies have differing levels of experience with respect to program areas.

6. Within and across agencies the specification of executing units may differ in power and status from agency to agency. That is, in one agency the operating unit may be at the highest executive levels while in another agency, middle management has program responsibility.

In light of these six points and our previous discussion, let us turn to the paradox of comprehensive development noted in the introduction. Attempts to be comprehensive require the participation of a large number of agencies. The larger the number of agencies the less noticeable their individual contributions will be and the greater the probability of "free-rider" behavior. The more free-rider behavior which is present in the interaction between agecies the lower the probability that the public goods and services will be delivered at optimal levels. Hence, the more comprehensive the

development project is in terms of participating agencies, the lower the probability that development goals will be achieved.

This paradox can only occur if the leaders of the program do not take advantage of the means at their disposal (i.e., selective incentives and coercion) to mobilize what is essentially a latent group for development purposes. In management terms this requires the creative use of rewards via the budgetary process, promotion, prestige, etc. Coercion can be utilized by employing central procedures and the clear specification of objectives, timetables and sub-objectives for each particpating agency. But the creative use of coercion and seletive incentives or, more properly, their management correlates, was not employed in Costa Rica as we shall see in what follows.

II. The Costa Rican Small-Scale Fisheries Development Project: Organizational Structure and Objectives

In January, 1973, the Costa Rican government secured a loan totalling thirteen million dollars from the Interamerican Development Bank (BID) to establish a program for the enhancement of small-scale fisheries on the Pacific Coast. The project was directed to the long range goals of a) nutritional improvement among the general population through increased consumption of fish protein and b) an improvement in the lot of the small-scale fishermen, their families and communities.

The program was designed to deal with a full range of fish-related activites ranging from capture through processing and marketing to consumption. Accordingly, the program undertook activities related to several subprojects. These were the development of:

1) an artisinal fishing fleet;

2) a fishing port in Puntarenas, including a terminal and processing equipment;

3) a commercial network for marketing and selling fish; and

4) the building of an industrial fleet for shrimp capture.

In 1974 a commission was created to coordinate the large number of institutions, both public and semi-public, which were to participate in the program. The commission was established to coordinate the participation of these several institutions and to establish the structure required to initiate, execute and evaluate the program.

The commission was presided over by a representative of the President of the Republic with the Banco Anglo Costarricense as the principal executor and financial institution. There were three coexecutors: 1) Consejo National de Producion (CNP); 2) Instituto Costarricense de Puertos del Pacifico; and 3) Cooperativa de Pescadores de Puntarenas (COOPEPES). Four support institutions were involved: 1) Instituto Fomento Cooperativo (INFOCOOP); 2) Instituto National de Aprendizaje (INA); 3) Ministerio de Agricultura (MAG); and 4) Ministerio de Trabajo y Seguridad Social (MTSS). The Ministerio de Economia, Industria and Comercio (MEIC) and Oficina de Planificacion National (OFIPLAN) were also involved in the program.

The BAC was the executive organ for the program and was to: a) administer the loans from BID; b) serve as an interface between BID and the participating institutions; and c) serve as the economic comptroller for the program. But even though these important functions were assigned to BAC, it did not have the necessary overall authority to serve as director general of all the institutions involved. Its role was more that of coordinator and manager of

the loan funds but not a chief executive in the usual operational sense. As we shall see, a director general was never actually established and the program was unable to sustain the momentum required for successful operation.

The CNP was charged with the installation and operation of the fish terminal as well as the promotion of fish consumption among the general population. INCOP was to do the actual studies and the physical construction of the fishing port required by the program. COOPEPES was charged with the absolutely essential task of enhancing artisanal fishing itself, as well as establishing, promoting and strengthening the cooperative of small-scale fishermen so as to fulfill fishing contracts.

The support institutions also had a variety of responsibilities. INFOCOOP was to assess and then design and support a strong cooperative organization. INA was to provide the technical training for the fishermen affiliated with the COOP, while MTSS was to work with the local families and community groups to build the strong social infrastructure required for a successful artisanal fishing community. Finally, MAG was to give technical assistance in order to increase fishing capacity and promote the fishing enterprise in general and specify the regulations for the best use of the fishery.

MEIC was to give general advice on negotiating and structuring the program, while the representative of the president was to serve as the liaison between the commission and the executor as well as general overseer of the program for the president. OFIPLAN was to play an important role initially in coordinating the participation of the various institutions during the negotiation of the loan with BID and was also expected to help facilitate the relationships between participating institutions on a regular basis.

The following figure #1 indicates program objectives and timetables. It was prepared by representatives from the participating agecies listed with the technical assistance of the Instituto Centro Americano de Administration Publica. It is important to note that even though the program was authorized in 1974 this planning meeting did not take place until February 1976.

Despite what would appear to be a careful planning process which specified objectives and timetables for project completion, objectives were not met. This conclusion was reached at a conference entitled "Seminario de Evaluation del Programa de Desarollo Pesquero de la Veriente del Pacifico," held on the 13th of October 1977. There participants from each of the agencies concluded that essentially none of the substantive program objectives had been completely met.

It was the consensus of the participants that problems in the program were of two types: 1) errors in the initial formulation of the program; and 2) legal and institutional difficulties.

With respect to the first of these, they noted that the establishment of the program and the construction work on the port raised such unrealistically high expectations in Puntarenas that it became difficult to build the basic social and economic infrastructure required there.

Originally, it was considered important to obtain funds from BID for a tuna operaion but this was rejected after some negotiations. For some reason, however, plans for such tuna operations remained in the final, approved, program.

The financing for the industrial fishing fleet was limited by depletion in the shrimp fishery and the langostinos and galateirdos did not turn out to be adequate as substitutes in terms of which to justify the fleet.

It was also assumed in the plan as a matter of priciple that the Cooperativa de Pescadores de Puntarenas would have the expertise to adequately direct and carry out its obligations as specified in the plan. This did not prove to be a realistic expectation owing to a lack of training, leadership and financial sophistication among the fishermen. In fact, the whole program was predicated on the existence of a viable Coop in Puntarenas. Yet when the project began, the Coop was in its embryonic stages and was not capable of carrying out program responsibilities. That is to say, the program was

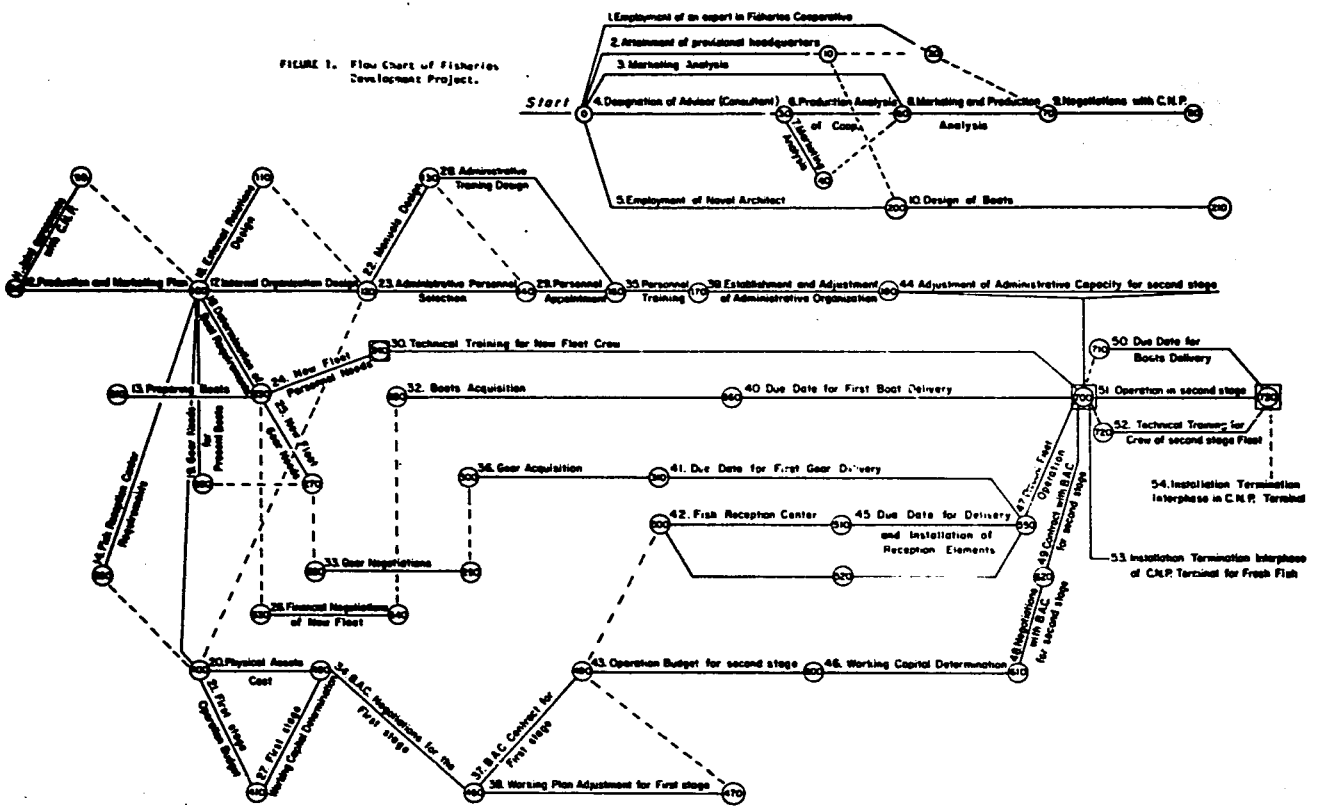

FIGURE 1. Flow Chart of Fisheries Development Project.

dependent upon an institution, the Coop, which had not actually been established before the program was underway.

Perhaps the most difficult problems in the program proved to be of a legal-institutional character. The most serious of these concerned accessibility to loan capital for utilization by the individual agencies and departments involved in the program. The loan had to be guaranteed by the state but the size of the loan exceeded the guarantees permitted under Costa Rican law. This required a revision in the statutes and while these were being revised the bulk of the capital required to get the program moving was not available. This resulted in a one and one half year delay in the program.

Moreover, funds were not provided in the original plan for the operation of support institutions such as MAG, MTSS, INA and INFOCOOP. It was assumed that such support activities were to be financed out of their agency budgets or that funds would be acquired through some other means as the program moved forward. Some funds were forthcoming from other sources via OFIPLAN but these were provided only after significant delays which severely handicapped operations.

The institutional problem concerned 1) inadequate specification and assignment of authority for directing the entire program, and 2) failure to clearly identify lines of responsibility to agencies for particular tasks. BAC, for example, was the institution charged with the primary responsibility for all financial aspects of the program while, at the same time, it was to be the primary executor of the program. Not only did BAC have inadequate authority to move the program forward, it had little experience or inclination to do so, and often assumed a cautious attitude when a bold decision was required in order to minimize delays. This difficulty was further exascerbated by the fact that BAC, as a largely independent, semi-public agency was not related operationally to the state, as the other participating agencies were, and therefore found it difficult to control and direct the public agencies toward program goals. These limitations on BAC meant that there was essentially no chief executive to coordinate, execute and evaluate the program. This circumstance severely limited the capacity of the program to adjust rapidly to changing circumstances and needs.

The report concluded that because of a lack of direction and a clear cut set of operational objectives, the level of participation by the various departments and agencies varied considerably. There was no consistency within and across agencies to assure that participants in the program came from roughly similar status positions and responsibility levels in their respective departments. As a result, the responsibility for making program decisions in one agency might be at the highest levels whereas in another it might be at the middle level while in a third it would be at a relatively low level. This led to status inconsistency, conflict and the problems of coordination and control which accompany these.

It was hoped that some of these problems would be alleviated by having senior MAG official made the executive director of the program responsible to the Commission. This appointment was made but the operational problems persisted because the program structure remained unchanged: the executive director was not given the powers of a chief executive in terms of which to direct the program. All financial control and actual overshight responsibility for operations continued to rest with BAC. This forced executive director to resign in frustration toward the end of 1978.

By the summer of 1979 when this investigator was completing two years of research on the fisheries development program, few of the original goals had been achieved and the program had been taken over by a presidential commission. The fishing fleet had yet to be built and there was some indication that the Mexican firm to whom money had been allocated for this purpose, did not intend to complete the project. The failure to deliver the fleet was a critical element and the most tangible measure to the fishermen

of the government's commitment to the program. When the fleet did not materialize the program lost credibility among the fishermen and the general community.

By 1979, the COOP in Puntarenas had a new building and had hired a manager to run the operation. Things were by no means stabilized however. There was continual infighting within the Coop and between the Coop and the agencies participating in the program, particularly MAG. The failure to provide the boats simply served to exascerbate these stained relationships. Indeed, the Coop only began to approach a mature organizational status in 1979, or shortly before, yet a great deal of the burden for project success was placed on the Coop when it was in an embryonic state of organizational development an therefore incapable of carrying out the assigned duties. Thus the timing was faulty because the program was built on the presumption that a mature Coop existed in Puntarenas. But the Coop had to be organized and staffed as development program went forward and it is not surprising therefore that the program would experience implementation difficulties at the level of the fisherman.

A series of marketing studies were to be conducted to determine the potential market for fish and then programs for marketing designed accordingly. But as late as 1979 these studies had not been completed and no systematic information base existed in terms of which to plan marketing strategies.

By the summer of 1979, progress had been made on the construction of the fishing port but all the necessary processing equipment was not in place. Moreover, the concept of the industrial fleet for shrimp fishing, although included in the plan, had been abandoned owing to depletion in the shrimp fishery.

The greatest amount of progress had been made in the construction of the port, no progress had been made in boat construction and the fishing coop was just beginning to achieve the first stages of organizational maturity. The picture then is decidedly mixed, with some critics claiming the program to be a failure. This investigator wishes to withhold judgments of failure but to focus instead on some of the sources of program weakness so that lessons can be learned concerning the management of renewable natural resources. If some of these sources of weakness can be identified in a theoretical framework they will have the power of generalizability to other projects of a similar nature.

We have seen that the Costa Rican government, in conjunction with BID, adopted a comprehensive approach to small-scale fisheries development. They attempt to avoid the negative economic, social, and political externalities associated with narrow, technology transfer projects. The small scale fisheries project sought to enhance the welfare of Coast Rica via nutritional benefits to the general population as well as improving the well-being of the artisanal fishermen. In this sense, the project correctly directed attention to the social and economic infrastructure within which the goals of the project were to be achieved and in terms of which the developmental thrust was to maintained via the establishment of sound institutional structures (i.e., cooperatives, family suppport systems, etc.).

This comprehensive approach, which stressed the importance of socioeconomic infrastructure and institution building was to be carried out by a combination of several semi-public and public agencies. The BAC was the sole semi-public agency involved in terms of which ten public agencies were to be organized and energized to achieve the goals of the project. Indeed, almost every major agency in Costa Rica was involved in either the development or execution of the project.

Because the project was comprehensive and multifunctional it had to utilize a multiple-agency operational format. This approach assumed that agencies can be adequately coordinated if sufficient rational for the program is provided and is supplemented by a periodic prodding and encouragement at the highest level of government. Yet we have seen that in Costa Rica and in

other development settings the major cause of project weakness would seem to been institutional in character (Osrom and Hennessey, 1974; Blase, 1973; Katou, 1972; Honey, 1968, 1970; Mann, 1975).

It is clear from the seminar report that the major constraints on the operation of the program until 1977 were institutional and organizational in nature. Adequate authority was never established to move the program forward on a day by day basis. Neither the Coordinating Commission nor the BAC had the authority to act as chief executive. As a result, individual agencies did not seem to know the quantity or timing required for their particular contributions. This permitted individual agencies to operate according to their own schedule of priorities. And because individual agencies' responsibilities for the fisheries project were often at different levels in different agecies this led to status conflicts, delays and jealousies among and between agencies.

All of these factors undoubtedly contributed to excessive delays in critical program activity. To the extent that this was the case, the resulting social cost can be directly attributable to the improper design of the project and the failure to establish a system of rewards and/or punishments for failures by agencies to comply with program schedules. But according to the reports on program progress, neither adequate coercion or selective incentives were built into the program. Departments could minimize their contributions in order to pursue goals in other government programs to which they also were assigned responsibility. This may have proven beneficial to some agencies because by omitting a commitment of resources to fisheries they may have been able to manage more effectively other responsibilities more effectively.

III. Hypotheses and Results of the Interviews

Collective Action Analytics and Project Management. The seminar report discussed earlier revealed that serious management problems existed in the program. We have discussed some of these problems using a theoretical orientation drawn from public choice theory, in particular the theory of collective action. Such a theoretical perspective does not, however, yield management principles which relate directly to the tasks faced by agency heads and program leaders. But the basic collective action concepts do have rather clear management analogues. Here we shall specify some of the management analogues of collection action analytics. We shall then identify hypotheses using these management concepts which we test through interviews with the eighteen agency officials directly involved in one way or another with the design and operation of the Costa Rican Small-Scale Fisheries Project. This approach permits us to examine the perceptions of many of the key actors in the program using a theoretical approach cast in management language.

We have already noted the necessity of using coercion and/or selective incentives to minimize free-rider behavior. The concept in management which most closely approximates coercion is control. Controlling is regulation of the organization to insure the achievement of program objectives and plans. Fundamental to control is performance evaluation based on a set of standards previously specified in the planning process. Evaluation insures that the quality and/or quantity of goods and services are up to expectations and, if there are deviations, to bring the program back into line with the original plan. It is imperative that plans specify program objectives down to the lowest level of execution so that each manager regardless of his or her level of responsibility, is clear about precisely what is expected from his or her operational unit.

Seeing that these performance goals are achieved is the task of the chief executive who most use an appropriate schedule of sanctions and rewards in order to keep the unit leaders performing at required levels. Such rewards are obviously such things as promotion, increases in budget, personnel, prestige, etc. On the sanctions side they might include reprimand or transfer.

The key feature of the relationship between planning, evaluation and unit performance is accountability. The creative use of evaluation for identifying levels of performance permits the organization to remain "on course" so to speak, by making whatever adjustments are necessary to get "back on track." In this sense, acountability contributes to organizational flexibility and permits creative adaptations to changing environmental conditions.

The use of timetables, objectives, and unit goals to evaluate performance permits such accountability, and accountability is the management analogue of noticeability which is the key element in the failure of collective action. As groups get larger, noticeability declines because each individual can not automatically monitor the behavior of others. This decline in noticeability creates the necessary conditions for free-rider behavior.

Accountability then is a management mechanism in terms of which to "advertise" such noticeability by revealing the contributions of individual unit leaders to the overall goals of the organization. Evaluation serves to relate levels of individual contribution to rewards and punishment.

Control therefore requires planning, evaluation and ultimately accountability. These are closely related to the collective action analytics of noticeability, coercion, selective incentives and free-ridership.

We hypothesize that these basic management principles were not used in the planning and implementation of the small-scale fisheries project and this significantly contributed to project weakness. In particular we hypothesize that the program was severely weakened by an unclear specification of objectives and timetables to accomplish these. This left decisions regarding the amount of participation largely up to the individual agencies. Moreover, there was no permanent system of evaluation and control which provided information on the state of the program. Finally, there was no chief executive who could function so as to assure that program planning, organizing and controlling were carried out in the most effective manner.

The 1977 seminar suggests that some of these conditions may have been present but their existence must be directly determined through interviews in order to see if they existed from the inception of the program and from 1977 until the summer of 1979 during which our interviews were conducted.

In order to examine these hypotheses we conducted a series of interviews lasting up to one hour, during the summer of 1979, with eighteen present and former government officials who were involved in the small-scale fisheries program in Costa Rica. We interviewed at least one individual from each of the following departments and agencies:

1) Banco Anglo Costarricense (BAC)
2) Consejo Nacional de Produccion (CNP)
3) Cooperativa de Pescadores de Puntarenas (COOPEPES)
4) Instituto Nacional de Aprendizaje (INA)
5) Ministerio de Agricultura y Ganaderia (MAG)
6) Ministerio de Trabajo y Seguridad Social (MTSS)
7) Oficina de Planifacion National (OFIPLAN)
8) Casa Presidential
9) Instituto Fomento Cooperativo (INOCOOP)
10) Instituto Costarricense de Puertos del Pacifico (ICPP)

We were unable to obtain an interview with officials in the Ministerio de Economia, and Industria y Comercio (MEIC). This was simply a scheduling problem and did not indicate a reluctance on the part of these particular agency to be interviewed.

We also interviewed officials of the lending agency, Banca Interamericano de Desarallo (BID) both in San Jose and Washington, D.C. We interviewed several former agency and department heads who had participated in the program. Finally, we conducted interviews with owners of private fishing and fish processing firms in Costa Rica.

In order to assure candor and cooperation from the interviewees, we agreed that they would remain anonymous in the report. The data, therefore, will not be reported by agency, group or individual but will be totalled for all respondents.

Initially we asked our respondents to indicate whether they considered the program to have failed. Table 1 indicates that the overwhelming majority thought the program had failed to meet its objectives. Table 2 reveals that an even larger percentage of the respondents attributed the problems to institutional factors.

In order to examine the degree to which accountability was perceived to be present in the program in terms of the specification of objectives and the evaluation of results, we asked three questions of our respondents. The results are shown in Table 3. It is clear from this table that over three-quarters of the respondents felt that the program did not contain a clear specification of the objectives and a timetable to accomplish them for each of the participating agencies. Obviously this is a fundamental problem and simply underscores our earlier discussion of the necessity of clearly specified objectives if agencies are to be held accountable and noticeability enhanced in order to minimize free-ridership.

The results of question two in Table III indicate that the role of each agency in the program was not clear and this left the decision concerning level of involvement up to the individual agency. The results of question three indicate that this lack of specificity in program responsibility led to a situation in which some agencies participated fully while others did very little. Indeed, in question 2 and 3 over 85 percent of the respondents agreed that these problems were present in the program.

In sum, then, it seems clear that program participants felt that one of the principal causes of program weakness derived from the failure of the program to specify performance objectives for participating agencies. This permitted them to decide on their own level of participation which may have caused uneven levels of participation and the inability to hold the participating agencies accountable for their performance.

Moreover, Table 4 reveals that respondents felt that there was no permanent system of evaluation and control in terms of which the state of program objectives could be determined and responsibility assigned for successes and failures. The level of agreement with this statement among the respondents at 94.4 percent is the highest level of agreement in all of our interviews. Obviously, the lack of such an evaluation system minimized the possibility of control and made it extremely difficult to allocate rewards and/or punishments for program performance.

But systems of control which enhance accountability require appropriate authority to direct the entire operation. The evaluation seminar conducted in 1977 suggested that authority was one of the fundamental problems with the program from its inception. In our interviews we investigated this problem of authority through a series of three questions contained in Table 5.

Over 80 percent of our respondents felt the Commission lacked the authority to make decisions and that this led to a failure to adjust to changing conditions. Over 60 percent felt that BAC, as the executor, had a difficult time moving the program forward owing to its inability to operate in the public sector and the constitutional limitations placed on loan guarantees. All of these factors may have limited the authority of both the Commission and BAC to control, direct and move the program forward. Obviously, these results indicate that a number of of the problems involved the specification of authority. The latter is, of course, most fundamental

TABLE 1

"The small-scale fisheries program has failed to achieve its major objectives."

Agree	86.0%
Disagree	14.0
	100.0

TABLE 2

"The major problems in the program were institutional in nature."

Agree	88.0%
Disagree	12.0
	100.0

TABLE 3

I. "There was no clear specification of objectives and a time table to accomplish these for each of the participating agencies."

Agree	77.8%
Disagree	22.2
	100.0

II. "The participation of the various supporting agencies was not clearly specified in the program, leaving the decision regarding the amount of their participation to each agency itself."

Agree	88.9%
Disagree	11.1
	100.0

III. "Because of unclear specification of authority and specific objectives some agencies participated fully while others did very little."

Agree	85.0%
Disagree	15.0
	100.0

TABLE 4

"There was no permanent system of evaluation and control that maintained information on the state of the program."

Agree	94.4%
Disagree	5.6
	100.0

TABLE 5

I. "The original coordinating commission was made up of individuals that had limited authority to make decisions. This caused a failure to adjust to changing conditions."

Agree	83.3%
Disagree	16.7
	100.0

II. "As the chief executor BAC had a difficult time operating among public sector agencies since each participating agency had its own sources of funding and other responsibilities and jurisdictions."

Agree	61.1%
Disagree	38.9
	100.0

III. "There was undue delay in the implementation of the Artisanal Fisheries Plan because of constitutional limitations on loan guarantees by BAC."

Agree	66.7%
Disagree	33.3
	100.0

since control must emanate from a source which has adequate authority. In addition to basic management problems it had been suggested by the evaluation seminar that some of problems of the program centered around 1) the lack of personnel with expertise in artisanal fisheries as well as 2) a general lack of personnel to carry out the program and 3) insufficient funding for the support agencies. In table 6, which follows, we examine the degree to which our respondents agreed with the seminar participants in these questions.

The respondents overwhelmingly agreed that personnel specializing in artisanal fisheries were lacking within the program. A smaller but still substantial agreement was expressed regarding the fact that not all of the agencies had full-time personnel assigned to the program.

The 1977 seminar noted that for a variety of reasons there was insufficient funding available for the supporting agencies such as INFOCOOP, INA, MAG and MTSS. Surprisingly, this was not seen as a problem by our respondents, as Table 7 indicate with 77.2 percent disagreeing with that statement. Obviously, between 1977 and 1979, the flow of financial support for supporting agencies, which had been interrupted initially, had become adequate at least as perceived by our respondents.

Finally, it was originally hypothesized that the development plan had overestimated the capacity of COOPEPES to implement the plan: the necessary experience and expertise was presumed to be unavailable. Table 8 supports this hypothesis. We find the majority of our respondents were in fundamental agreement that the development plan overestimated the capacity of COOPEPES to implement the plan.

In sum, these data support our argument concerning the centrality of evaluation, accountability and institutional design for successful program operation. But the shortage of expert personnel was also a problem. We should emphasize, therefore, that the program was quite complex, involved a number of actors and interrelationships among more than a dozen agencies at a variety of levels. Given such complexity, explanatory power should not be attributed to any one argument apart from other potentially important variables which may have not been identified or measured. This study then is a preliminary step toward uncovering what are potentially significant contributors to program weakness and failure and much systematic work remains before one can be confident that the paradox of comprehensibility has a firm empirical foundation.

IV. Summary and Implications

We began our inquiry by suggesting that a potential paradox might be present in comprehensive approaches to development. We argued this would be the case owing to the tendency for comprehensiveness to require multi-agency input to the project. This multi-agency format, in turn, necessitates some coordinating and directly mechanism in order to insure optimal contributions to the overall program by participating agencies. Drawing on Mancur Olson's work on voluntary organizations and collective action, and applying it to agencies, we argued that without such coordination there would be powerful general incentives for agencies to "free-ride" on the contributions of other agencies. If this tendency were strong, the supply of required goods and services would be suboptimal.

We then formulated a series of hypothases stated in management terminology but drawn from and informed by collective action theory. We proceeded to use these to construct a series of questions which we used to interview eighteen agency participants and outside experts regarding the operation of the Costa Rican small-scale fisheries project.

The results of the interviews offer some support for our argument. There did seem to be propensity for free-riders among the participating agencies. Coercion and selective incentives were not used in a creative fashion to

TABLE 6

I. "The agencies charged with implementing the Fisheries Development Plan lacked personnel who specialized in artisanal fisheries."

Agree	94.4%
Disagree	5.6
	100.0

II. "Not all of the agencies executing the program had full-time personnel assigned to the program."

Agree	77.8%
Disagree	22.2
	100.0

TABLE 7

"There was insufficient funding for the supporting agencies involved in the plan (i.e., INFOCOOP, INA, MAG and MTSS)."

Agree	10.8%
Disagree	72.2
DK/NA	17.0
	100.0

TABLE 8

"The development plan overestimated the capacity of COOPEPES to implement the plan."

Agree	72.2%
Disagree	16.7
DK/NA	11.1
	100.0

create a viable intra-agency group from which adequate levels of participation could be either stimulated or extracted.

Judging from the interviews, the program did not have adequate control mechanisms and performance evaluation systems were not in place. Without these factors, accountability for the performance of individual agencies could not be established. This permitted agencies to determine "voluntarily" the levels of participation they would undertake. Such a tendency probably contributed significantly to program weakness.

How much the interagency collective action problem contributed to program problems is, however, difficult to determine. Other factors which we identified in our discussion of the project undoubtedly were significant as well. Perhaps foremost among these were the legal constraints placed on the flow of loan capital to the operating and supporting agencies. The particularly deleterious role played by the Banco Anglo (BAC) was another significant factor. How much of the variance in program support can be attributed to each of these factors is beyond the scope of this paper. This paper simply sought to highlight the potential importance of collective action pheonomena in an arena where this approach is not traditionally used; namely in development administration.

The reasons for this may lie in the tendency for development specialists to treat interagency coordination and control as a simple problem which is exogenous to program goals. We have tried to demonstrate that such mechanisms or lack of them is endogenous to program goals. Indeed, to the extent that such administrative feasibility is not incorporated into the original program design there is the potential for significant social cost.

Jack Byrd, Jr. in his book Operations Research Models for Public Administration (1975, pp 1-3) makes a distinction which is particularly useful in this regard. He notes that lower level actions involve day-to-day administrative matters and there are well defined single objectives. These are 1) operational actions. A second type of action involves multiple and often conflicting objectives but an established overall policy which narrows the focus to the choice of alternatives for implementing the policy. These are 2) strategic actions. The third type of action involves conflicts in both objectives and guiding policies. These are referred to as 3) policy actions.

It is at the second or strategic level and not the operational or policy level that the Costa Rican project appeared to have its greatest problems. One suspects that it is perhaps often the case that such strategic actions receive the least attention in program design but in fact constitute the critical level in assuring some modicum of program success. We have suggested that a political economy approach may be particularly appropriate a set of analytics for investigating phenomena at this level.

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CHAPTER 28 INFORMATION ACQUISITION: SOME CONCLUSIONS AND RECOMMENDATIONS

BY J.G. Sutinen, R.B. Pollnac, and D.K. Stevenson

The purpose of this chapter is to summarize our conclusions and recommendations regarding the acquisition of data on small-scale fisheries in LDCs. Our conclusions and recommendations are limited in several aspects; perhaps the most important limitation is that our results are based on only a single or a few field tests concluded in a relatively small region of the third world. Nevertheless, we believe that the results obtained can provide useful guidance to researchers and other analysts working on small-scale fisheries development problems in LDCs.

Perhaps the single most important step in the data acquisition process is the specification of the quantity and quality of the data to be collected. Specifying the best data set, however, is often elusive in practice.

Time plays a major role in the entire data acquisition process, and particularly affects the specification of the data set. For most purposes, we can categorize the time horizon for data acquisition efforts into short-run (less than three months), intermediate-run (about a year), and long-run. Obviously, the less time available for collecting and processing data, the less the quantity and quality of the data that can be produced. But even in the long-run, e.g., in a continuous data acquisition program, re-specification of the data needs will occur as the management problems change and as the decision entity changes. Also, regardless of the time horizon, the objectives of the decision makers often are not clear, or there is little agreement on the objectives.

To overcome these problems some practitioners have identified a data set that could serve a range of objectives and problems over time. Too often, however, this approach results in attempts to collect data sets that are too large in the sense that the limited resources devoted to data collection and processing are spread too thinly to produce data that are reliable and readily accessible.

For fisheries development, the most important information for decision-makers is a reliable estimate of potential yield from the fishery. Potential yield may be estimated from catch and effort data collected over a relatively long period of time, or from certain biological characteristics (e.g., growth and mortality rates) which are estimated from short-run data collection procedures. We tested alternative methods for collecting catch and effort data, and since these were combined with additional economic data the conclusions drawn are summarized later.

The efforts to estimate growth and mortality rates consisted of a biological survey of length frequency data and a tag and recapture study. Our conclusions:

1) Tag and recapture studies should not be attempted unless it is possible to tag large numbers of fish with reasonably little expense and difficulty, and unless a major commitment is made to recover tagged fish from fishermen. Estimation of the proportion of unreported tags is essential.

2) While the design and implementation of sample surveys to obtain biological data (e.g., lengths) can be independent of economic surveys, a careful integration of the two is appropriate. Many of the same items are sampled by both biologists and economists (e.g., catch and effort). Also, to be reliable, catch and effort information should be collected on a random basis--though in this study the biological surveys were not randomized.

3) Before making a major commitment to a biological survey, a preliminary evaluation of the length composition of exploited populations is recommended. A preliminary sample of commercial landings over a few months is especially appropriate in LDCs where very little is known about the basic biological characteristics of exploited resources (e.g., taxonomy, species composition in

landings, length, weight). Clearly, this preliminary survey would provide a sound basis for a more complete biological survey.

4) Resource assessment techniques (for estimating potential yield) based either on growth and mortality rates or on catch and effort data require accessory biological data which only can be obtained by direct sampling at sea. Future efforts to assess fish resources in LDCs should include such a sampling program.

5) Before making a commitment to a method for assessing the resources, a thorough examination of the existing data and collection procedures in LDCs should be conducted. It may be possible to adapt a resource assessment method to data that already exist or, at least, to compile a minimum amount of additional information to supplement what already exists.

6) A source of biological data that often is overlooked is the fishermen themselves. We have presented techniques used to develop classificatory criteria and taxonomies of fish known by fishermen. The analysis shows which fish are important to fishermen and how they classify fish in their own minds--useful information for designing an information system, as well as for enhancing interaction between the fishermen, researchers, extension agents and administrators.

In addition to catch and effort data, the economic surveys sought to collect data on costs and earninga in the capture sector. Two economic survey methods were tested: a self-enumeration method and a personal interview method. The self-enumeration method involved individual boat owners maintaining bookkeeping records on all fishing related activities; the personal interview method involved interviewing the highest ranking crew member at the time the catch was sold. Our general conclusions regarding the economic surveys are as follows:

7) The self-enumeration method appears to be superior to the personal interview method. For observations on 50 or fewer items, the self-enumeration method is less costly. With careful planning we believe the self-enumeration method would yield a sample that is as representative of the population as would a randomized personal interview program. For short-term surveys, however, the personal interview method probably is the only feasible alternative for obtaining costs and earnings information.

8) Measurement reliability is likely to be low regardless of the sampling method employed. Our analysis shows that the attempted random sample of landings did not produce statistically reliable micro-data.

9) Data on a trip basis is not very useful for analysis unless it can be reliably related to an interval of time. That is, catch and effort estimates are not meaningful for analysis if the number of trips per month (or some appropriate interval of time) is not known. For most analytical purposes, we desire an estimate of catch per period. Even if the length of a fishing trip is fixed (e.g., one day), the interval between trips typically fluctuates widely. Therefore, deducing the catch per period from an estimate of catch per trip can be unreliable.

10) Collecting data that can be reliably used to compute returns to labor is particularly complex. First, as is almost universal in fisheries, fishermen are paid a share of the catch value. Since the crew often are not paid until after the interview, the system for calculating the shares must be obtained. And the systems in use to calculate the shares can be quite numerous. An additional complication is the presence of family members in the crew. If the crew consists of a father and his two sons, the total labor income goes to their household and cannot be divided by three to obtain the return to a single laborer.

11) For survey purposes, the unit of analysis should be the household or family. The principal reason for this is that economic activities are organized within the household or family. Salient constraints, such as on labor, are defined by the nature of the household or family. The operation and behavior of several boats organized within one household or family likely

will be different than for an equal number and kind of boats operated independently. An additional reason, is that fisher households tend to be stationary, making them easy to locate for data collection purposes.

12) In the capture sector, all survey activities (biological, economic, anthropological and others) should be coordinated if not fully integrated. We have shown that anthropological surveys can effectively obtain biological and economic data, and that largely economic surveys can obtain useful biological data for resource assessment analyses. The point is not that only one instrument or survey method should be used, but rather that duplication and measurement error can be reduced by a well thought out, multidisciplinary approach to collecting data.

Several methods are available for surveying fish freshness. The methods include subjective evaluations using the senses of sight, smell, taste and touch, and objective chemical and microbiological tests. The field research to data has not yet identified a superior set of methods for assessing fish freshness.

The economic surveys of the marketing, distribution and consumption sectors encountered no major difficulties. The random samping programs tested were relatively low cost and produced fairly reliable data. We are confident the methods used in Central America could be readily adapted and applied to other LDCs.

The survey of fisheries administrators revealed two significant difficulties. The first difficulty involved operationalizing the theoretical concepts to be used in the analysis. In effect, this step required translating the concepts into terms that administrators could understand. The problem was resolved by employing managerial terminology familiar to most administrators. The second difficulty was that many of the government administrators lacked sufficient technical knowledge to answer adequately survey questions. While they significantly affect the fisheries development process, some administrators are too removed from the fisheries sector to possess a good understanding of the industry.

Other sectors related to the small-scale fishery were largely ignored in our surveys. Perhaps one of the most important sectors ignored was the industrial or large-scale fisheries (e.g., shrimp), which can have important implications for small-scale fisheries especially where their by-catch is a large fraction of the local market. Agricultural and other economic activities in the coastal belt may also affect the possibilities for small-scale fisheries development. No survey would be complete without information on the relationship between the small-scale fishery and the other sectors in the coastal belt.

CHAPTER 29 SOME POLICY IMPLICATIONS OF THE ANALYSIS

BY J.G. Sutinen, R.B. Pollnac, D.K. Stevenson, and T.M. Hennessey

The purpose of this chapter is to present in summary form some of the principal implications for fisheries development policy that emerged from our analyses. These conclusions are by no means comprehensive, for our methods for acquiring data did not generate a complete set of data on the fishery and related sectors. While the data are from Central America, we believe our conclusions are not peculiar to Central America alone.

A. Resource Assessment

The principal objective of the resource assessment analysis was to estimate vital statistics (growth and mortality) for the fishery resources. These statistics can be used in a modified dynamic pool model to provide estimates of potential yield from the fishery. The dynamic pool model is particulary well-suited to small-scale fishery assessments where usually no historical data exist on catch and effort. In ideal circumstances, the dynamic pool (or yield per recruit) model can be applied quickly and allows for more flexible development and management strategies.

Length-frequency results. Despite collection of over 40,000 length measurements for a dozen species over a full year, growth rates were able to be estimated for only two species. And these were based on a small subset of the available data. Total mortality could only be estimated from length data using known growth rate estimates (i.e., for the same two species). No natural or fishing mortality rates could be estimated from the data.

Tag and recapture results. No conclusive results were obtained, owing more to technical problems than to problems inherent in the method.

Alternatives to the dynamic pool model for resource assessment include (i) the surplus production model which requires time series data on catch and effort, and (ii) empirical yield models designed to use existing or readily collectible data. Surplus production models (Pella and Tomlinson; Schaeffer) are widely used for large scale and developed fisheries where reliable historical data exist on catch and effort. Since such data do not usually exist for small-scale fisheries in LDCs, these models cannot be used until the data are generated. There are other problems with applying this method to tropical small-scale fisheries: catch data are frequently collected for groups of species with identical market values but different biological characteristics (e.g., growth and mortality rates); and highly imprecise effort measurements. Given these and other problems, however, it still may be possible to obtain rough but useful estimates of potential yields.

A few empirical approaches to resource assessment have been developed, e.g., morphoedaphic indices of yield in lakes. Assessments of small-scale fishery resources could be modeled after known physical and environmental factors which correlate with biological productivity. However, this still is a new and untested approach in the marine environment.

One implication of the failure of conventional assessment models is that small-scale fisheries development and policy is being implemented on a trial and error basis. Without solid, objective yield estimates, planners tend to inflate potential yields and develop a harvesting capacity that tends to rapidly deplete the stocks, produce low sustainable yields and waste limited capital resources. Numerous cases can be cited where this has occurred (e.g., Gulf of Thailand).

The tendency to over-develop in the face of uncertainty regarding potential yield may seem puzzling to some. That is, uncertainty normally

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induces conservative or cautious behavior. A rational individual faced with choices that produce uncertain gains and losses, gives greater weight to an extra dollar lost than an extra dollar gained. Therefore, he tends to pursue a safer or more conservative course of action. In the fisheries development context, a rational individual uncertain about the potential yield would increase his harvesting capacity in modest or small increments, and would allow time to assess the effects of his actions before moving on.

The motives and methods of bureaus, however, are different from those of the rational individual. Niskanen (1971) persuasively argues that bureaus act to maximize their budget allocations. Consider then, a bureau charged with fisheries development. The magnitude of the bureau's development effort--and hence its budget--depends, among other things, on the estimate of the potential yield from the fishery. With no certain, reliable and objective measure of potential yield, the bureau will find it to its advantage to accept a high rather than a low estimate of potential yield. Using the high estimate, of course, translates into a large budgetary allocation--over the short-run at least.

Over the long-run, the consequences may be (and usually are) negative. But bureaus typically are managed by individuals with short-term horizons who discount heavily long-run consequences since they attempt to be rapidly upward mobile. Therefore the individual bureaucrat perceives little risk of loss from using a high estimate of potential yield from the fishery.

If Niskanen is even partially correct, and if our meagre ability to assess yields persists, the prospects for fisheries development are grim.

B. Capture Sector

From the evidence available, the fishing firms in the Gulf of Nicoya are efficiently allocating capital and labor in the fishery. That is, no reallocation of these resources to other areas, species, etc., would result in greater returns to the industry. This is not to say there is no excess fishing. Since this is an open access fishery (i.e., individuals do not possess exclusive rights to exploit the fishery resources), we can say there likely is excess fishing in an economic sense. That is, greater returns could be realized in the future by reducing the level of present catches in the Gulf. Aside from this, the proverbial fisheries management problem, the industry possesses substantial economic vitality. And the important point for policy is that this economic vitality should be nurtured, not hindered.

Two papers dealing with investment orientations among small-scale fishermen concluded that situational constraints affect the relationship between economic gratification orientation and other variables, suggesting that development programs should be involved with creating environments favorable to deferred gratification orientations if they are to succeed. It is only through an orientation that results in reinvestment of reasonable amounts of profit for equipment replacement and repair that development projects will be sustained into the future.

Other papers dealt with perceptions of the occupation of fishing. All of the analyses reached the conclusion that knowledge of fishermen's likes and dislikes concerning their occupation can be used to structure change programs for maximum effectiveness.

It was also reported that kinship plays an important role in crew structure and occupational succession among small-scale fishermen in the Gulf of Nicoya. This suggests that any program of planned change which would affect the structure or recruitment of work groups among these small-scale fishermen must account for the effects these changes would have on the traditional role of kinsmen in fishing.

C. Marketing and Distribution

An examination of fishermen's perceptions of the much maligned middleman resulted in rather important findings. Although almost one-half of the fishermen emphasize prices as an important factor in selection of buyers, 45 percent stress other forms of assistance, such as loans, picking up parts, etc., indicating that institutions proposed to replace the middleman must also provide these services if they are to succeed.

Fishermen's cooperatives are often proposed as one alternative to the private middleman. One paper, however, points out that establishment of a successful cooperative is not a simple matter. It must take into account psychocultural characteristics of the fishermen, as well as what fishermen expect from such institutions. Further, it was suggested that it is important to screen and train potential cooperative members before providing them with sophisticated equipment. Another paper dealing with beliefs about cooperatives indicated that there is considerable variation from community to community concerning perceived benefits of belonging to a fishermen's cooperative. It was found that a positive relationship exists between number of fish buyers in a community and perceptions of lack of benefit of belonging to a cooperative. The fewer the number of dealers, the more fishermen were likely to perceive a cooperative as useful. The analysis also indicated that in the different communities different combinations of individual level variables (e.g., boat ownership, kinsmen involve in fishing, education) influenced attitudes towards cooperatives. Overall, the analysis suggests that programs related to cooperative formation must take into account diversity between and within communities. Finally, we found that an important aspect of the fishery in the Gulf of Nicoya, that of income variability, is related to optimism among the fishermen.

An economic analysis of the marketing sector suggests there may be considerable room to improve marketing efficiency. It appears that several marketing firms are not operating where unit costs are minimized. If policies could be found and implemented to induce firms to operate at a minimum optimal scale, both fishermen and consumers could be made better off by reducing the margin between ex-vessel and retail prices.

D. Fish Handling

Two reports show that fish handling and sanitary conditions in the artisan fisheries of Costa Rica and Guatemala could be improved. This is true throughout the distribution process from conditions on the boat at capture, to the holding areas on shore, to the trucks used in transport and to fish storage and display at the fish market. While there are anomalies in results that can only partially be attributed to the use of different methods (for example, the number of coliforms in fresh fish samples), general conclusions can be made.

Potable water is needed in more abundance so that washing may be done more often and more thoroughly. Boats, containers, utensils and all surfaces coming in contact with ice or fish should be washed with mild detergents and rinsed well. Ice should be of good quality and should not be reused. Pressure on the fish is a major cause of deterioration. This results from piling the fish too high and using ice in pieces so large they bruise or pierce the fish during storage and transport. Flake ice in stacking boxes would help solve his problem. Improved handling and sanitary practices can benefit the fisherman and the distributor, the processor and the consumer. Thus fisherman and distributor would have fewer losses due to spoilage. The processor would have fish of high quality needed to ensure good results in his products. The consumer would have fish more available to use at lower cost in appetizing meals with less risk of food poisoning.

One problem not easily tackled is the lack of enforcement of the regulations that exist regarding the handling and distribution of fish and other perishable commodities. Adequate facilities may be provided but no corrective action is taken by authorities when these facilities are misused. Standards of hygiene may be enacted but until enough importance is accorded these standards, little will have been accomplished.

Improved handling might come about if the consciousness of the general populaton is raised through an intensive campaign by government and universities on radio and television about fish and its value. It would be helpful to have a survey of current practices in fish handling and consumer use so that the correct emphasis can be made in later work. An appropriate technology for all areas of the fishery--capture, processing and distribution--would thus serve to effectively improve fish entering the market.

E. Consumption

The analysis of fish consumption in Guatemala City revealed that the quality of fish is not significantly related to the consumption of and expenditures on fish. If, as this suggests, consumers are not concerned about fish quality, then more hygenic marketing conditions may have little or no impact on fish consumption.

A large number of the consumers surveyed did not know the names of fish species nor the market prices of fish. There appears to be a considerable lack of knowledge about the market for fish and consumer education programs may be necessary before increased availability and lower prices can induce increased consumption of fish.

Further analysis revealed that income is positively related to fish consumption and expenditures. Unfortunately, no price elasticities of demand could be estimated from the data collected. Therefore, the extent to which consumption may increase with lower prices remains unknown.

F. Fisheries Development Administration

The principal finding of our study of fisheries development administration is empirical support for the paradox of comprehensive planning. The paradox is that while comprehensive development programs require high degrees of interagency coordination, this in itself creates a high potential for strategic behavior whereby each agency attempts to take advantage of the situation by minimizing his contribution by free-riding at the expense of the others involved. This results in a suboptimal level of overall contributions and a failure to meet project goals. A study of a Costa Rican small-scale fisheries development project found a propensity for free-riding among the participating agencies. Since no coercion or selective incentives were used, agencies were permitted to voluntarily determine their own contributions. This probably contributed significantly to the program's weakness.

Other factors undoubtedly also contributed to the program's weakness, such as legal constraints on the loan capital. Unfortunately it was not possible to quantify the extent to which each factor contributed to the program's problems.

REFERENCES

William A. Niskanen, Bureaucracy and Representative Government (1971).