ECONOMIC, SOCIAL AND CULTURAL ASPECTS OF STOCK ASSESSMENT FOR TROPICAL SMALL-SCALE FISHERIES

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I. Introduction

In his paper, Dr. Roedel (1979) presented us with a set of issues related to stock assessment for our consideration during this workshop. The aim of this paper is to help define, from a social science perspective, the nature of those issues facing us.

First and foremost, we should emphasize that under Title XII, the ultimate test of any research and development program for small-scale tropical fisheries is the extent to which it improves the well-being of small-scale fishermen and increases fish consumption among the malnourished segments of the population. It follows, therefore, that stock assessment involves a number of social, cultural and economic considerations as well as the conventional biological and ecological.

The remainder of the paper is divided into two major sections. The next section presents an economist's perspective on the issues before us, followed by a section on social and cultural aspects of stock assessment issues.

II. Economic Aspects

A. The Information Systems Paradigm

We would like to introduce you to a paradigm that has been developed to address an analogous set of issues in agricultural economics. It is the information systems paradigm developed by Bonnen (1975).

According to this paradigm, the small-scale fisheries development problem can be viewed as a fundamental problem of information processing.

To solve the fisheries development problem, we must first solve the associated implicit information system problem. That is, solving the fisheries development problem requires making decisions and making decisions requires information. Providing information, on the other hand, is primarily a problem of devising a system within which data are collected, analyzed, and acted upon by decision makers.

Every decision requires an understanding of some part of reality (see Figure 1). 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 identified phenomena are then observed and the variables measured. The resulting set of measured variables represents our data output. To this point, we have a "data system", for data are not information (see Figure 1).

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

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 processes, reliability is enhanced. In fact we can identify three types of reliability: measurement reliability, operational reliability and conceptual reliability.

It appears for present purposes, we should assess the measuremen operational and conceptual reliability of various approaches for producing stock assessment information. An inadequacy at any one stage can cause a breakdown in the information process. We should ask:

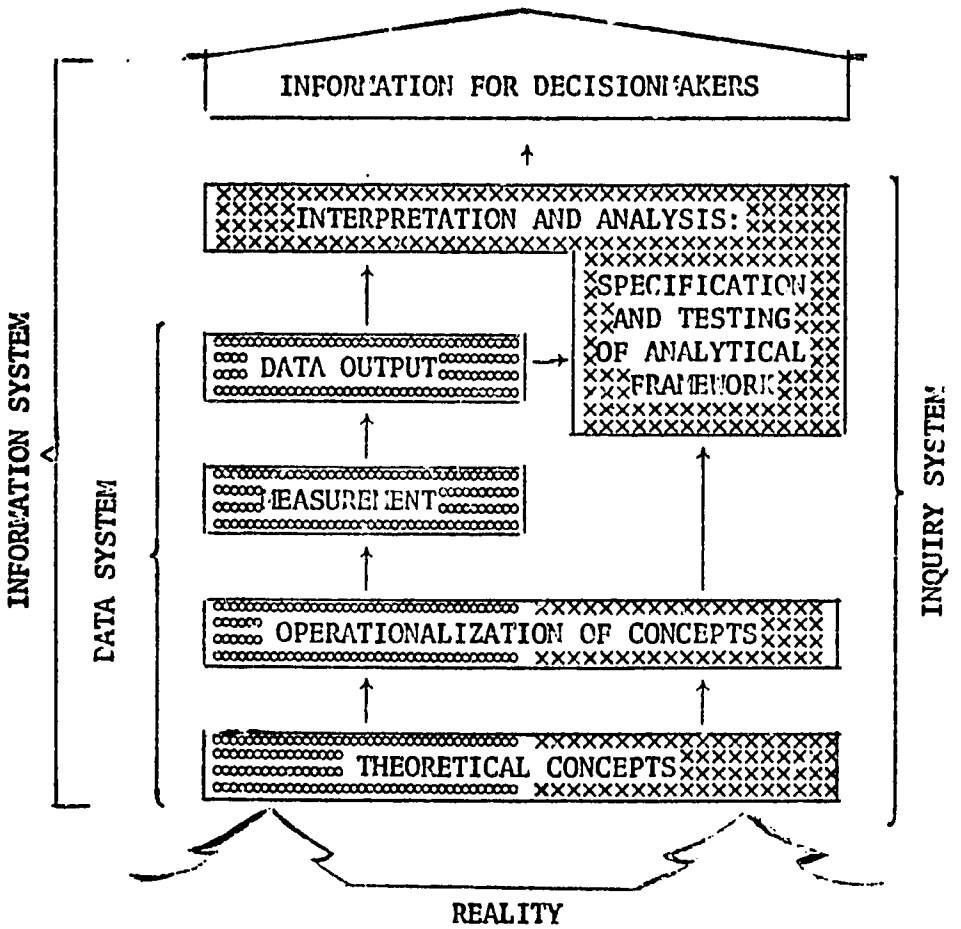
Where are the gaps; where is the information system breaking down?
Is it inadequate theory?
Is it lack of operationalized concepts?
Is it poor measurement?
Has the analytical framework been suitably tested and refined?

We also should ask: What is the nature of the information to be provided decision makers?

The information system can be viewed too 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.

At the abstract level, we see that the nature of the data desired by decision makers is derived from (i) the nature of the fisheries development problem they face and (ii) the nature of the decision-making process actually in effect. If we were to know the exact nature of fisheries development problems and the decision making process, we could "derive" the set of information that should be produced.

FIGURE 1


INFORMATION FOR DECISIONMAKERS
INTERPRETATION AND ANALYSIS:
SPECIFICATION AND TESTING OF ANALYTICAL FRAMEWORK
DATA OUTPUT
MEASUREMENT
OPERATIONALIZATION OF CONCEPTS
THEORETICAL CONCEPTS
INFORMATION SYSTEM
DATA SYSTEM
INQUIRY SYSTEM
REALITY

While we do not care to explore here the nature of fisheries development problems (as there is an extensive literature on the subject), we would like to share with you some thoughts regarding the decision making process.

B. Decision Making and Fisheries Development

At the outset we can view the problem of fisheries development in terms of a rational decision-making process. Rationality as used in the social sciences 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 can 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 or set of projects with highest net benefits is then selected for implementation.

Fifth, the project then is monitored and evaluated during implementation for the actual net social benefits realized from the project(s).

To the extent that this process is followed, one could derive a set of "information demands" at each stage. Quite clearly, it appears that stock assessment information would be involved at almost every 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 now 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 principals

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, maximize minimum benefits that can be obtained with some given level of probability.

3. Satisficing

Decision makers set an arbitrary level to attain (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 likely cannot supply information that effectively serves the fisheries development process.

C. Some Characteristics of a Stock Assessment 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. As described in the appendix, the fishery is composed of several components and is interconnected with other, non-fishery sectors. We should not, we believe, strive to construct a meta-model of this larger system, for if not infeasible, surely it would be impractical. Instead, it

seems most reasonable to focus on the closely related resource and capture subsectors of the small-scale fishery; to think in terms of an analytical framework that provides decision makers with information on these subsectors alone.

The part of reality focused on involves both the fishery resource and its habitat and man's exploitation of the resource. Much like the fishery resource, man's behavior is conditioned by his environment, an environment that consists of social, cultural, economic and other related elements. It seems clear, therefore, that in order to provide useful, reliable information to decision makers a stock assessment information system should take into account all of these elements of reality, as well as the nature of the decision-making process used.

The implications of such a bio-socio-economic approach may be quite significant for our study of stock assessment issues. Among other things, this implies (i) an integrated, interdisciplinary conceptual framework, (ii) a joint effort to systematize the collection and analysis of data on the behavior of the fishery resource and the human sectors, and (iii) a study and appreciation of the decision-making environment that exists. These seem to be some of the conditions necessary for an effective information system.

III. Social and Cultural Aspects

Beyond the economic and information system aspects, however, there are other social and cultural variables which impinge upon and can affect the relative effectiveness of stock assessment models. For example, many techniques rely on catch and effort statistics or return of tagged fish. Both of these types of data are practically impossible to obrain without cooperation of the fishermen. It is important to note that the need for this basic type of catch data was stressed in a report by Resources Development Associates (Craib and Ketler, 1978). Further, our knowledge concerning even the types of fish caught and utilized is so minimal in some regions that research preliminary to actual stock assessment could be rather costly. Here, we would like to stress that the biologist should 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 section of the paper will focus on aspects of obtaining data from local fishermen and the usefulness of the types of data they can provide.

Obtaining Data from Fishermen - The importance of using the proper approach for obtaining data from fishermen can be illustrated by a recent experience by one of the authors. In a recent 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 therefore 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 understanding 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,

spokesmen, 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 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 only have 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 1955, Lionberger and Copus 1971). 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 Paraguay 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, Deertz (1960) indicates that Javanese has three levels of speech, including honorifics which are related to the participants 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 agricultural 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 1979); 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 thei 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 coll ction 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 increaseng 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; Guy 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.

Useful Data Provided by Fishermen - Turning next to the role that small-scale fishermen can play in providing data of use of 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 finding indicates 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 the 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 north eastern Brazil; Morrill (1967) discussed 51 named varieties among small-scale fishermen of the Virgin Islands; and Pollnac (1979) 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 provided 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 dampling 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 (of 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 identifying 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 his credibility in the eyes of the local fishermen.

IV. Conclusions

In sum we have examined the interrelationships between stock assessment and selected aspects of economic and anthropological information, and data collection and analysis techniques. Several of the speakers who proceeded us noted the importance of these interrelationships, and we hope that our observations will stimulate further discussion and research on these matters.

Appendix

The Fishery and Related Sectors.

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

The industrial fishery sector is relevant to development of the small-scale fishery for a number of reasons. A major reason is 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 relevant to small-scale fisheries development since many, if not most, fishing families also raise crops and livestock. In some areas fishing is viewed as 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 administration and related agencies determines the efficacy of any development program. Other institutional and legal aspects which condition the process of fisheries development include interagency conflict and coordination, credit, subsidy and training programs (e.g. see Doucet, et. al. 1974; Crutchfield, et. al., 1974; Woodland, 1976).

To be effective, development planning must account for all aspects of the fishery and related sectors. If the fishery development problem is not addressed in this holistic manner, links necessary for successful development can be overlooked. It is our view that such oversights account for a large proportion of the failure in fisheries development efforts.

For stock assessment purposes, however, we may choose to carve out a portion of this vast landscape. For example, we may wish to focus exclusively on the resource and capture sectors of the small-scale fishery.

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