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Triennial Review of the Title XII Fisheries Stock Assessment Collaborative Research Support Program

by

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EXECUTIVE SUMMARY

The External Evaluation Panel (EEP) for the Fisheries Stock Assessment Collaborative Research Support Program (CRSP) was composed of Dr. Michael Sissenwine, Dr. Albert Tyler, Dr. Serge Garcia and Dr. Harlan Davis. Collectively, the EEP members have considerable experience in stock assessment research and are familiar with fisheries problems in developing countries.

The EEP believes that there is a pressing need for the stock assessment CRSP. Fish products are an important source of protein for developing countries. They are also an important export product. The demand for fish products is expected to increase and exceed the supply in the near future. Unless there is a scientific basis for rational use and management of fishery resources of developing countries, long term sustainable benefits will be wasted. There are many examples of fisheries development efforts that have failed because they did not have an adequate scientific basis.

The fisheries management problems of developing countries are exacerbated by the lack of suitable stock assessment techniques. Most stock assessment techniques were developed for temperate or boreal, single species, industrial fisheries. The stock assessment CRSP is aimed at developing the scientific basis for tropical, artisanal, multispecies fisheries.

The Fisheries Stock Assessment CRSP is organized into eight projects that are led by three U.S. universities. There is collaboration with two other U.S. universities and two host country universities. Table 1 lists the projects, principal universities, and collaborators.

The "Multiple Species Fisheries Research" project applies a systems approach to stock assessment problems. The emphasis is on (a) testing traditional stock assessment models, (b) developing new first principle models that are based on the interaction between individual organisms, and (c) an expert system to support stock assessment research and management decisions. The "Economic and Probabilistic Extensions of Standard Fisheries Models" project is closely related to the aforementioned project. The model extensions include a life cycle model with density dependence, and the application of a non-renewable resource model (for mines) to recruited fish populations. An optimization algorithm is used to determine the optimal series of annual catches when future recruitment is being explored as a decision support framework.

The project on "Sampling Catch and Abundance" has a very pragmatic objective of designing efficient strategies for collecting traditional fisheries data that is needed for many

Table 1. Stock Assessment CRSP Projects and University Participants

PROJECT	US UNIV.	HOST COUNTRY	HOST UNIV.	US COLLABORATORS
Multiple Species Fisheries Research	U. Md.	Costa Rica	CIMAR U.C.R.	U. Miami
Economic and Probabilistic Extensions of Standard Fisheries Models	U. Md.	Costa Rica	CIMAR U.C.R.	U. Delaware
Sampling Catch and Abundance	U. Wash.	Costa Rica	CIMAR U.C.R.	U. Delaware
Age and Size Dependent/Independent Modeling	U. Wash.	Costa Rica	CIMAR U.C.R.	
Age and Size Relationships and Consequences of Errors	U. Wash.	Costa Rica	CIMAR U.C.R.	
Shallow Water Hydroacoustics	U. Wash.	Costa Rica	CIMAR U.C.R.	
Empirical Analyses and Modeling	U.R.I.	Philippines	COF U. Phil.	ICLARM
Multispecies Field Studies	U.R.I.	Philippines	MSI U. Phil.	

stock assessment models. But collecting this data is a difficult problem for artisanal, multispecies fisheries. This project should translate statistical theory into solutions for the CRSP host countries, which will serve as examples for other developing countries.

Many, if not most, stock assessment models use information on the age of fish in a population of the catch. But it is more difficult to determine the age of a tropical fish. Therefore, it is appealing to use length as a proxy for age. The "Age and Size Dependent/Independent Modeling" project examines the sensitivity of the results of these length based assessments to errors in input parameters. Since the initial results indicate that length models are error prone, new models have been developed which incorporate some aging data. The "Age and Size Relationships and Consequences of Errors" project demonstrates that some tropical fish species can be aged.

The "Shallow Water Hydroacoustics" project assesses the feasibility of using hydroacoustics to measure fish abundance in shallow water where surface and bottom discontinuities make acoustic detection difficult. Studies of the vertical distribution and behavior of fish have demonstrated that this problem can be overcome. The problem of estimating target strength (i.e., the relationship between the reflected acoustic energy and fish weight) and species composition remains.

The "Empirical Analyses and Modeling of Multispecies Fisheries" project relates yield and fishing effort to species composition and stability of fisheries. Models indicate how much fishing has perturbed a system, how the system's species composition will evolve, and how rapidly it will evolve. The "Multispecies Field Studies" project is closely related; for example, in the long term it will provide the data used for empirical models. But it also (a) develops methods for clustering multispecies data in order to reduce the dimensionality of the system, (b) applies remote sensing in order to relate productivity to habitat type, (c) relates the timing of spawning to the appearance of new cohorts of fish, (d) develops methods for fishery independent surveys of coral reef fish communities, and conducts several other activities.

The EEP concluded that the results of the Fisheries Stock Assessment CRSP are generally sound. The research is scientifically valid and the approaches used are usually appropriate for the problem. The research is also relevant to the goals of USAID, the objectives specified in the funding proposals, and the needs of developing countries. The CRSP research projects collectively address most of the essential components of stock assessment research.

The EEP believes the stock assessment CRSP is likely to

succeed in yielding new, useful stock assessment approaches for developing countries. Some projects have already produced usable products. Other projects are addressing more fundamental problems. They are more long term in nature, and inherently more risky. But, the potential for advancement is greater for long term research. Overall, the CRSP has a balance between long term and short term research strategies.

One factor that will affect the overall value of stock assessment research is transferability. The results are being transferred through contact between scientists, presentation of results in scientific meetings, books and manuals, and user friendly software.

Another benefit of the stock assessment CRSP is that it helps to build institutions that will provide the expertise needed to conduct stock assessments and advise managers. Not only have host country universities been strengthened, but the pool of U.S. experts that are available to provide training and to consult has been increased.

The EEP concluded that the overall program management is one of the most perplexing problems of the stock assessment CRSP. This is inevitable since the CRSP was shaped from two divergent proposals into three co-equal research teams managed by a management entity without substantial technical involvement in the program. There has never been sufficient funding to allow the detailed communication, planning, and coordination that would be needed to overcome the inevitable problems.

On the other hand, the diversity of approaches and the capability of the three principle investigators have turned out to be strengths of the program. At this point in time, merging the three approaches into a single tightly coordinated program does not seem feasible, nor is it necessarily desirable. But more communication (including constructive criticism) between components of the CRSP is desirable.

The EEP has several specific recommendations on individual projects of the CRSP. Some of the more general recommendations are that:

1. A strategic plan be developed to identify interrelationships between components;

2. Communication be improved by preparing more detailed work plans, reporting work in progress in the working paper series, holding an annual research meeting, and providing more opportunities for site visits;

3. A "keystone" manual be prepared which includes an introduction to stock assessment approaches and CRSP

research, and directs the reader to more specific manuals describing CRSP outputs;

4. An outline of the "keystone" manual be prepared as soon as possible and responsibilities be assigned;

5. A list of more specific manuals be established as soon as possible;

6. More funds be made available for travel in order to improve communications and planning;

7. The scope of the stock assessment CRSP relative to the budget be evaluated;

8. The formula for allocation of funds among components of the CRSP be reviewed in light of recommendation 7; and

9. A three year extension be funded contingent on a detailed research plan.

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I. BACKGROUND ON THE EXTERNAL EVALUATION PANEL

The panel is comprised of:

1. Dr. Michael Sissenwine, Chief of the Fisheries Ecology Division, North East Fisheries Center, National Marine Fisheries Service, Woods Hole, MA;

2. Dr. Albert Tyler, Head of the Groundfish Stock Assessment Program of the Pacific Biological Station, Department of Fisheries and Oceans, Government of Canada, Nanaimo, British Columbia, Canada;

3. Dr. Serge Garcia, Chief of the Marine Resource Service, Fisheries Resource and Environment Division of the Fisheries Department, Food and Agriculture Organization, United Nations, Rome, Italy;

4. Dr. Harlan Davis, Deputy Director General of Inter-American Institute for Cooperation on Agriculture, San Jose, Costa Rica.

Dr. Sissenwine and Dr. Tyler are permanent members, since 1987, of the Fisheries Stock Assessment CRSP External Evaluation Panel (EEP). Dr. Garcia and Dr. Davis were added to the EEP on a temporary basis for the purposes of the Triennial Review. Dr. Sissenwine chaired the EEP during the review. Collectively, the EEP has considerable experience conducting and directing stock assessment research in support of fisheries management. Dr. Garcia is particularly experienced in stock assessment and fisheries management problems of developing countries. Dr. Davis is experienced in agricultural and economic problems of developing countries. He brings knowledge of AID, BIFAD and S&T/AGR to the EEP.

The members of the EEP are pleased to have the opportunity to participate in the Triennial Review because they believe (a) in the stock assessment CRSP as an investment in the future, (b) that research on stock assessment methods can make a significant contribution to conservation and rational use of renewable fishery resources, which are the largest single source of protein for human consumption, and (c) that the EEP can provide impartial advice that will enhance the CRSP. The EEP members also view the Triennial Review as an opportunity to learn from CRSP research.

While the EEP brings considerable experience and expertise to the review, it should be recognized that the brief period of time available for the review limits the level of detail for their report, and the degree of certainty with which they can make recommendations. The EEP's ability to make specific

recommendations is also limited by the lack of specificity of the objectives of the stock assessment CRSP and of terms of reference for the Triennial Review. But the EEP believes that the Triennial Review should help the stock assessment CRSP researchers to refine their work, and the review should provide a better perspective on the importance and overall quality of the research, which should help AID to make management and budget decisions that are solely its responsibility.

II. INTRODUCTION TO THE EVALUATION

A. EEP's Evaluation of the Need for the Fisheries Stock Assessment CRSP

Worldwide Importance of Fish. A rapidly growing population, rising per-capita incomes and shifts in consumer preferences are pushing world demand for fish to record levels. This escalating demand is expected to continue into the foreseeable future. By year 2000, FAO projects per-capita consumption at 15.1 kg. With world population estimated at over 6 billion, the annual world demand for fish (and fish-meal) will exceed 113 million metric tons.

Supply has so far kept pace with demand. During the decade of the 1950's fish landings grew at an unprecedented average of six percent per annum. The rate declined to slightly less than four percent per year in the 1980-1985 period in part because of resource limitations, particularly of marine fisheries. Many fishery scientists believe that most of the world's fishery resources have been discovered and are being fully exploited. In other words, increased production from new frontiers is no longer probable. In fact, with growing pollution, destruction of habitat, and overfishing, some experts doubt present production levels can be maintained in some regions.

The potential for fisheries to collapse is demonstrated by the Peruvian anchoveita where production declined from over 10 million metric tons per year in the 1970's to between 1.5-3.0 million metric tons today. The decline is a result of both environmental factors and overfishing. There are many other examples of collapses.

FAO estimated the worldwide maximum sustainable catch at about 100 million metric tons. This estimate was probably optimistic. With an expected demand of 113 million metric tons in the year 2000, there will be sharp pressures on price. While aquaculture and new confinement technologies may be able to ease somewhat these supply constraints, they are not likely to fill the gap.

Price rises will have the greatest impact on the poor, particularly the poor of developing countries. FAO estimates that over half of the population in developing countries obtain 40 percent or more of their total animal protein supplies from fish. On a world wide basis, fish are the largest single source of protein for human consumption. Moreover, fish meals are important sources of protein supplements for animal feeds, fertilizers, soap additives, pharmaceutical and other commodities. Fisheries resources are critically important to the

welfare of people, particularly the LDC's.

Need for Fisheries Research. The world fisheries production has leveled off at around 80-90 million metric tons. The total production will probably oscillate around the present level due to natural fluctuations in large pelagic resources off Peru, Japan, Mauritania, South Africa, Namibia, etc. Most resources are already fully fished or overfished, especially in coastal zones, and in many areas fishery resources need to be rebuilt.

The Law of the Sea gives developing (as well as developed) countries an opportunity to more fully benefit from their fishery resources, but has also increased their responsibilities for management. These countries can take advantage of the rising demand in the developed world and the rapid increase in prices. They also need to use fishery resources to help support their own growing populations. But the growing internal demand for protein with the pressure exerted by foreign fleets will result in serious threats to newly acquired resources.

Development agencies (e.g., World Bank, African Development Bank, UNDP, etc.) have recognized the very high rate of failure of fisheries development projects, and have agreed that a major problem has been the lack of understanding of the fishery resources.

In some cases of "successful" development, the uncontrolled growth of fishing effort has led to overfishing, ecosystem degradation, loss of resources quality and conflict and unrest. Many of the problems that are common for industrial fisheries are now affecting artisanal fisheries and increasing the threat to coastal resources. To avoid repeating past mistakes, development and management of artisanal fisheries must be scientifically designed. But developing countries face serious limitations, including insufficiently trained manpower, inadequately funded research structures, and lack of appropriate methodology for stock assessment and tropical fisheries analyses in general.

The Role of Stock Assessment. It should be recognized that stock assessment research is a necessary, but not sufficient, condition for fisheries management. Furthermore, the benefits of fisheries management cannot always be assessed in terms of increases in yield. Nevertheless, management based on scientific stock assessments almost always increases the benefits that can be gained from a fishery.

Additional benefits may accrue as a result of fisheries management when:

1. a stock assessment demonstrates that a resource is underutilized and the fishery is managed according to a development plan that is realistic relative to the long

term potential of the resource;

2. a stock assessment demonstrates that a resource is severely overfished and a management action is taken to reduce short term catch rates in order to allow the resource to rebuild and increase the catch in the long term;

3. a stock assessment indicates that a fishery could produce about the same yield with much less fishing effort, and management actions are taken to increase the profitability of the fishery;

4. a stock assessment indicates that a fishery is being properly exploited and management actions are taken to prevent overfishing which would be inevitable otherwise.

The benefits from fisheries management can be substantial. For example it is not unusual for stock assessments to show that the same amount of catch can be taken at half the cost (situation 3 above). This benefit is not a result of building more efficient fishing vessels. It results from having the correct number of vessels, which is determined scientifically.

B. Background on the Fisheries Stock Assessment CRSP

Background information about the Fisheries Stock Assessment CRSP is available in the "TRIENNIAL REVIEW AND CONTINUATION PROPOSAL" dated May 1988. Only a few important points are reiterated here.

The Fisheries Stock Assessment CRSP began on July 1, 1985 after several years of planning. The goal for the program is to develop stock assessment methodologies for use by fisheries managers in developing countries. Specific objectives for the program include the following:

1. Production of a Stock Assessment Handbook for fishery managers in tropical countries--a manual or manuals that will provide a "key" for optimal fishery stock assessment and management given the problem and available resources.

2. Testing and/or extension of existing methodology for stock assessment as it applies to tropical fisheries.

3. Development of new methodologies for stock assessment in tropical developing countries.

4. Developing and testing of multispecies fishery management assessment methods.

The Fisheries Stock Assessment CRSP formally involves about 60 scientists (many more have an informal, i.e., non-budgetary connection) located at the three principal U.S. universities (i.e., Maryland, Washington and Rhode Island), two collaborating U.S. universities (i.e., Miami and Delaware) and two host country universities (i.e., Costa Rica and Philippines). The research is organized into eight projects:

The University of Maryland-Center for Environmental and Estuarine Studies and the University of Costa Rica in collaboration with the University of Delaware and the University of Miami:

1. The Multiple Species Fisheries Research Project

2. The Economic and Probabilistic Extensions of Standard Fishery Models Project

The University of Washington and the University of Costa Rica in collaboration with the University of Delaware:

3. The Sampling Catch and Abundance Project

4. The Age and Size Dependent/Independent Modeling Project

5. The Age and Size Relationships and Consequence of Errors Project

6. The Shallow Water Hydroacoustics Project

The University of Rhode Island and the University of the Philippines in collaboration with the International Center for Living Aquatic Resources Management (ICLARM), the Research Institute for Marine Fisheries of the Agency for Agricultural Research and Development, the Republic of Indonesia, and the Division of Marine Fisheries of the Department of Fisheries, Thailand:

7. The Empirical Analyses and Modeling Project

8. The Multispecies Field Studies Project

The EEP believes that two historical aspects of the Fisheries Stock Assessment CRSP are pertinent to the Triennial Review. First, the initial budget target for the CRSP was nearly three times the contracted funding level. During the course of the planning phase the target was cut to $5,000,000 for a five-year program. The scope of the CRSP was aimed at this funding level. The actual funding level is about one third lower ($704,000 per year), although the scope of research has not been reduced significantly.

Second, it should be noted that the Fisheries Stock Assessment CRSP is a combination of two competing proposals that were submitted to AID for funding. What emerged was a research program led by three coequal principal investigators and managed by a separate management entity that is not involved substantially in the technical aspect of the program.

C. Approach to the Evaluation

None of the EEP had a great deal of opportunity to become familiar with the Fisheries Stock Assessment CRSP prior to the Triennial Review. The two permanent members of the EEP had made separate visits to the host countries (Dr. Tyler visited Costa Rica in February 1988 and Dr. Sissenwine visited the Philippines in March 1988). Their trip reports are Appendix 3.

Most of the information used as a basis for this report was gathered during the Triennial Review. The schedule of the review is given in Appendix 2. Unfortunately there was not sufficient time for the entire EEP to visit each of the participating universities.

The report of the EEP is divided into five sections. Following the section giving "Background on the EEP" and this "Introduction to the Evaluation" is a section (III) which evaluates each project separately. This is the most detailed and technical part of the report. There are recommendations for completion of the first five years on a project-by-project basis. The next section (IV) considers the overall program. The EEP identifies several factors it views as important: 1) Quality of Research, 2) Relevance, 3) Likelihood of Success, 4) Transferability, 5) Institutional Impact, and 6) Overall Program Management. The final section (V) makes general recommendations which apply to the overall program, including the EEP's impression of the proposed direction for research during a three year extension period.

The EEP regrets that there was not more time to prepare its report. The EEP did the best it could during a preparation period of about two days.

III. PROJECT EVALUATIONS

This section contains an evaluation of each of the eight projects that make up the Fisheries Stock Assessment CRSP. The reader will probably note a difference in length and degree of detail of each of the project evaluations. This usually reflects differences in "style" between the authors of each project evaluation. Length and degree of detail does not reflect the quality and/or importance of the projects.

A. The Multiple Species Fisheries Research Project

Project Name: MULTIPLE SPECIES FISHERIES RESEARCH

Host Country: Costa Rica

Host Country Lead Institution: The University of Costa Rica (UCR-CIMAR)

Host Country Principal Investigator: Dr. Manuel M. Murillo (UCR-CIMAR)

Other Participating Host Country Institutions: Ministry of Agriculture

Host Country Associate Investigators: Dr. Jose Garcia (UCR)
Dr. Joseph Varilly (UCR)
Jorge Campos (UCR)
Eduardo Madrigal (Ministry of Agriculture)
J. C. Briceno (UCR)

United States Lead Institution: The University of Maryland-Center for Environmental and Estuarine Studies (UMCEES)

United States Principal Investigator: Dr. Brian J. Rothschild (UMCEES)

Other Participating U.S. Institutions: The University of Maryland-College Park-College of Business and Management (UMCP-CBM)
The University of Miami (UMiami)

United States Associate Investigators: Dr. Bruce Golden (UMCP-CBM)
Dr. William Fox (UMiami)

United States Research Assistants: Cluney Stagg (UMCEES)
Gerard DiNardo (UMCEES)
Doug Levy (UMCP-CBM)
Hiren Trivedi (UMCP-CBM)
Jerald S. Ault (UMiami)
David Die (UMiami)
Victor Restrepo (UMiami)
Steven G. Smith (UMCEES)

Research Locations: UMCEES, UMCP-CBM, UMiami, and UCR

1. Objectives and Potential Issues

The objective of the project is to develop a better understanding of fisheries systems in order to provide a scientific underpinning for improved management of tropical, artisanal, multispecies fisheries. The intent is to incorporate what is learned, along with what is already known, into an expert system. The problem of tropical, artisanal multispecies fisheries has many dimensions. Resource species in the tropics are characterized by continuous spawning, which make age determinations difficult, and may invalidate models which were designed for discrete spawning populations. Most tropical fisheries are multispecies, which means interactions must be taken into account. Because of the large number of harvesting units in artisanal fisheries, it is difficult to collect fisheries data.

2. Approach

A systems approach is applied. The system includes multi-species fishery resources and their environment, the harvesting sector, research, and fisheries management. Three lines of research are pursued.

The first line of research starts with conceptualization of the system's architecture in order to develop first principle models of interactions between species and their environment. The fundamental elements of the system are organisms that interact tropically. The rate and efficiency of interactions is modulated internally by physiology and externally by environment. Collections of organisms form populations, which are variable in abundance on relatively short time scales (i.e., one year or so), but persist over much longer time scales. Mathematical models are used to formalize this conceptualization and to assess its completeness relative to the observed behavior of the fishery

system. Multispecies interactions have not yet been considered explicitly, but they are logically based on the same first principle models (i.e., based in individual trophic transactions).

The second line of research incorporates into simulation models some of the characteristics that distinguish fish populations in the tropics from populations of temperate and boreal waters. The most notable differences are more rapid growth and high mortality rates of tropical species, and continuous spawning throughout the year, although there are seasonal patterns. The models are used to simulate tropical species which are assessed using traditional methods that were developed for higher latitudes. The assessment methods are evaluated by comparing the assessed values to the simulated population. The same approach is used to examine modifications of traditional assessment methods to determine if they will perform better on tropical species.

The third line of research pursues a model of optimal fisheries management decisions through application of rapidly evolving expert system technology. An optimal fisheries management decision is based on "expert" decisions about what data to collect, how to collect it, how to analyze it, how to interpret the results relative to the past, present and future conditions, and what is the best action to take in order to achieve specific objectives. An expert system should integrate the expertise that is available for each component of the decision system. The particular expert system that is developed in this project is called CANOFISH. The first version incorporates expertise into modules called MONITOR, ESTIMATOR, OPTIMIZER, SIMULATOR, and ADVISOR.

3. Scientific and Technological Issues

Progress is being made on all three lines of research. The first line of research addresses fundamental problems of how ecosystems function at their most basic level. A great deal of innovation is required to attack the problem at its fundamental level and integrate the elements of the system to understand its behavior as a whole. By necessity, research of this nature is long-term, but tangible products which document advances in understanding, have been produced along the way. Some of the intermediate products are discussed below.

The effect of environment of trophic interactions between organisms can be expressed in terms of the effects of light and temperature on the efficiency of capture of prey and utilization of food as energy, and the effects of water motion on encounter rates between predator and prey. This conceptualization has been expressed mathematically. The results indicate that predators require a significantly lower prey density in a turbulent

environment than in a still environment which only exists in a laboratory experiment. Similarly, the potential effect of a predator on prey is greater with turbulence or other fluid motions that are on the appropriate length scale relative to the size of predator and prey.

Another approach to gaining understanding of ecosystems from their fundamental properties is application of physiologically-structured models. These models build on knowledge of the physiological limits of individual organisms. Potentially, physiologically-structured models could take account of the difference between individual organisms as a basis of "statistical mechanics like" models for populations; i.e., the physical analog uses the laws of thermodynamics to derive gas laws.

Since size (e.g., length) has more physiological significance than age, it is logical to construct length-based physiologically structured models. Since these models must conform to physiological principles, they have the potential for reducing the problem of under determination (i.e., not enough degrees of freedom in a statistical sense) that detract from most purely empirical analyses of fish length frequency data.

Some rigorously derived physiologically-structured models have already been constructed. They have the potential to enhance understanding of competition, cannibalism, life history strategies, and other elements of population regulation, but such advances are by no means assured.

The second line of research, which evaluates existing stock assessment models and possible modifications for application to tropical fisheries, has already progressed to the point where results can be used in developing countries. The research is not nearly as innovative as that described for the first line of research, but it is rigorous. It fulfills a need for assessment methods that can be applied now, while long-term research continues. A brief description of some products of the second line of research is given below.

Much of the stock assessment effort in developing countries is aimed at estimating parameters of simple models such as yield-per-recruit. But how precise do estimates need to be? One study addresses this question and concludes that the results of yield-per-recruit analyses are more sensitive to the fishing mortality rate than to the precision of demographic parameters such as growth and mortality rate.

But are yield-per-recruit analyses and other stock assessment models applicable to tropical fisheries? Based on a review of the spawning and recruitment patterns of tropical fish species, an appropriate recruitment pattern simulator was

developed and incorporated into a tropical fishery simulation model. Stock assessment methods were tested on the model resulting in a comprehensive evaluation of the applicability of various methods relative to specific biological and fishery characteristics of the system that is being assessed. These results are one source of expertise (i.e., which assessment method to use) that is ready to be incorporated into an expert system.

Since traditional stock assessment methods are frequently inappropriate, new models are being developed as possible alternatives. Abundance (or density) equations for age-structured, multi-cohort populations have been developed. The equations have a great deal of generality since the cohorts may be from one or more species. So far, the analysis is mathematically esoteric.

The third line of research has resulted in a prototype expert system called CANOFISH I. The system provides "expert" advise on how to sample a fishery (for catch and effort). It analyzes the data and estimates parameters of a simple production model. The production model is the basis for optimizing fisheries management strategies depending on management objectives. The expert system includes a simulator which can be used to examine the outcome of future management actions. Together the results of the optimization and simulations are the basis for fisheries management advice.

All of the modules of CANOFISH I are relatively simple and restrictive compared to the wide range of situations that exist in tropical, artisanal, multispecies fisheries. Emphasis has been placed on expert system design including the organization and interaction of the modules, not the content of the modules themselves. This is appropriate since the development of expert systems has been in parallel with other research developing new expertise (applicable to the tropics and elsewhere) for each of the modules.

In summary, the research for this project ranges from long-term investigation of the fundamental structure and properties of fisheries-systems to short-term solutions of practical problems. An expert system is seen as an eventual integrator of what is learned (within this project and throughout the stock assessment CRSP). Regardless of the time horizon of the research, all of the problems that are being addressed are relevant. The research is generally sound, and progress is being made along each line of research.

4. Logistics and Administration

The overall direction of the project is the responsibility of the University of Maryland, CEES. The University of Costa

Rica and the University of Miami are collaborators. There is an overall research strategy that serves to influence the direction of research without steering it to the extent that innovation is inhibited.

There is clear evidence of collaboration between U.S. universities and the host country. One of the key investigators from the University of Miami was in residence at the University of Costa Rica for about two months. During that time, he worked with host country scientists to exchange ideas and formulate specific research efforts. The University of Miami has worked with the University of Costa Rica to transfer computer software. The transferability of the software has been enhanced by translating it into Spanish.

Interaction between the University of Maryland and the University of Costa Rica has also contributed to the development of physiologically-structured models by the latter. During the early stage of the development of the expert system, the University of Maryland worked directly with the University of Costa Rica in order to design the MONITOR module so that it would be applicable to the Gulf of Nicoya, Costa Rica, artisanal fishery.

In spite of this evidence of interaction, all of the researchers involved in the project agree that more interaction is necessary, particularly as the results of each line of research reaches the point where they can be critically compared and appropriately integrated. It is also clear that more interaction between projects is necessary.

One option for enhancing communication between U.S. universities and the University of Costa Rica would be to place a U.S. scientist at UCR indefinitely. This approach might enhance collaboration with all of the universities that are involved in projects with UCR. It is clear that collaboration between the University of Rhode Island and the University of the Philippines has benefited from the placement of a U.S. scientist at UP.

On the other hand, placing a U.S. scientist at UCR might inhibit host country scientists from exercising their full innovative capability. In spite of its developing country status, UCR has the capability to take a leadership role in some components of the stock assessment CRSP. The scientists of UCR feel it would be more beneficial to enhance one-on-one communication between a large number of scientists than to become too dependent on a single U.S. scientist located at UCR.

It seems clear that the primary barrier to better communication, which will encourage collaboration, promote integration, and enhance the overall value of research, is financial. This is one of the most serious effects of reductions

in budget that have occurred since the project strategy was originally formulated.

Another serious consequence of budget reductions is that the future participation of the University of Miami is threatened. The University of Miami is the primary institution responsible for the second line of research that addresses practical assessment problems that require attention in the short-term. The researchers participating in the CRSP, from all of the U.S. universities and the University of Costa Rica, strongly endorse future participation of the University of Miami.

5. Recommendations for Completion for the First Five Years

Generally speaking, the proposal is for research during the next two years of the project to proceed along its current lines. CANOFISH will be revised (Version II) to include a more complete and flexible set of modules. Various assessment programs will be bench-tested against Gulf of Nicoya data. "First principle" models will be explored to determine their full potential. The EEP concurs with the proposal to continue along these lines. None of the research has been carried to the point where its full potential has been realized. It won't necessarily reach this stage at the end of the first five years, but by that point in time, the full potential should be better known.

The EEP is concerned about the role of the expert system in this project and the CRSP as a whole. There is a tendency to view the expert system as a "black box" that will in the end solve all of the problems of integration of the stock assessment CRSP research. The EEP thinks that a more specific integration strategy is needed. It is not clear that it will be either feasible or appropriate for all the CRSP stock assessment research to be incorporated into the expert system. Integration should not be an end in itself that inhibits innovation. But a menu of specific methods and expertise (more detailed than the names of the modules) should be designed and the source of the menu items (not necessarily always from within the stock assessment CRSP) should be identified.

The EEP concurs with the opinion of University of Costa Rica researchers that it is better to enhance communication by providing adequate funding for travel than to place a single U.S. scientist at UCR. The EEP also concurs with the consensus among participating scientists that it is important for the University of Miami to continue participating in the stock assessment CRSP.

B. The Economic and Probabilistic Extensions of Standard Fisheries Models Project

Project Name: ECONOMIC AND PROBABILISTIC EXTENSIONS OF STANDARD FISHERY MODELS

Host Country: Costa Rica

Host Country Lead Institution: The University of Costa Rica (UCR-CIMAR)

Host Country Principal Investigator: Dr. Manuel M. Murillo (UCR-CIMAR)

Other Participating Host Country Institutions: Ministry of Agriculture

Host Country Associate Investigators: Dr. Edison de Faria (UCR)
Jorge Campos (UCR)
Dr. Edwin Castro (UCR)
Dr. Ricardo Estrada (UCR)
Eduardo Madrigal (Ministry of Agriculture)

United States Lead Institution: The University of Maryland-Center for Environmental and Estuarine Studies (UMCEES)

United States Principal Investigator: Dr. Brian J. Rothschild (UMCEES)

Other Participating U.S. Institutions: The University of Maryland-College Park-College of Business and Management (UMCP-CBM)
University of Delaware (UDelaware) (Through year 4 only)

United States Associate Investigator: Dr. Lee Anderson (UDelaware)

United States Research Assistants: Cluney Stagg (UMCEES)
Chris Rogers (UDelaware)
Yang Gru (UDelaware)
Steven G. Smith (UMCEES)

Research Locations: UMCEES, UMCP-CBM, UDelaware, and UCR

1. Objectives and Potential Issues

The overall objective of the project is to extend standard fisheries models to increase their utility to managers of tropical, artisanal fisheries. The proposal for this project noted the importance of designing models that have modest data requirements. This project is closely related to the "Multiple Species Fisheries Research" project.

2. Approach

Research is pursued along three lines. The first line is the development of a probabilistic extension of fisheries models. The second line of research extends fisheries models to include economic variables. The third line explores new methods of using bioeconomic data to support decisions.

3. Scientific and Technical Issues

Efforts to extend fisheries models to include probabilistic elements have gone beyond the routine inclusion of random number generators and simulations based on well-known functions (e.g., equations that relate spawning biomass to recruitment). One product of the research is a new life cycle model that incorporates density dependence. Sophisticated mathematical algorithms are necessary to solve for the approximate behavior of the system. The model is useful to understand the trade-offs between density-dependent stabilizing mechanisms in various life stages. The mechanisms that promote stability, in spite of the tendency for the fluctuating environmental conditions to introduce variability, are the most important aspects of probabilistic extensions of fisheries models.

The second line of research applies an economic model that is applicable to non-renewable resource, such as mines for minerals, to fishery resources. In a sense, this is a probabilistic as well as an economic extension. The rationale for treating a fishery resource as a mine is that recruitment is usually unknown, so it is reasonable to optimize harvest of the existing resource down to a threshold level that is necessary to prevent recruitment overfishing. This rationale is similar to the rationale for yield-per-recruit analysis, which is a cornerstone of traditional stock assessment methods. Since the bioeconomic model is not explicitly self-generating (i.e., a renewable resource model) optimal steady state solutions are meaningless. Instead, the model is used to estimate an optimal harvest trajectory that can be used to provide short-term total allowable catch advice. More sophisticated optimization algorithms are being developed.

The third line of research attempts to develop new approaches to support management decisions. A bibliography of

optimization models that have been applied to fisheries was prepared. Another bibliography was prepared on applications of analytic hierarchy processes (AHP). Prior to the stock assessment CRSP, this decision support method had not been used to formulate fisheries management advice. The value of AHP was demonstrated for an important coastal temperate water fishery. The method is promising for tropical, artisanal, multispecies fisheries as well.

While progress has been made towards the goals of this project, it should be noted that none of the research is specifically directed at tropical, artisanal, multi-species fisheries. With the exception of the application of AHP to a temperate water fishery, the research has been theoretical. It seems reasonable that theoretical development and field testing on relatively well-understood temperate water species should precede application to the tropics.

4. Logistics and Administration

The overall direction of the project is provided by the University of Maryland (CEES). The University of Costa Rica and the University of Delaware are collaborators.

Many of the issues that are pertinent to the "Multiple Species Fisheries Research" project also apply to the project on "Economic and Probabilistic Extensions of Standard Fisheries Models." The opportunity for one-on-one communication between scientists has been hampered by insufficient allocation of funds for travel. In addition, budget restrictions threaten the future participation of the University of Delaware. Inadequate funding of the University of Costa Rica has also limited the collection and analysis of data for field testing economic models. It would be a step backward to formulate a fisheries management support system without explicit consideration of economics. It should be noted that the University of Delaware economic modeling effort is also part of the University of Washington project on "Sampling the Catch and Abundance."

5. Recommendation for Completion of the First Five Years

The proposal is to refine the current research approach and expand on it by developing a "METASYSTEM" for fisheries. The METASYSTEM would provide a means of filling information gaps for fisheries which are understudied (i.e., most tropical, artisanal, multispecies fisheries) by drawing on what is known about more thoroughly studied fisheries. Of course, the system must be designed carefully to avoid inappropriate inferences.

The External Evaluation Panel concurs with the proposal to refine the current avenues of research as well as to develop a METASYSTEM. The METASYSTEM is a step towards a practical

solution to the problem of sparse data and short time series that plague tropical fisheries. A METASYSTEM may be most easily developed for tropical shrimp fisheries. The METASYSTEM approach has parallels with spatial production models (based on classification of coral reef habitat) being developed in the Philippines (i.e., the project on "Multispecies Field Studies"). The interrelationship between these approaches should be clarified.

The EEP believes that more funds should be allocated to travel in order to improve communication and possible integration.

C. The Sampling Catch and Abundance Project

Project Name: SAMPLING CATCH AND ABUNDANCE

Host Country: Costa Rica

Host Country Lead Institution: University of Costa Rica (UCR-CIMAR)

Host Country Principal Investigator: Dr. Manuel M. Murillo (UCR-CIMAR)

Other Participating Host Country Institutions: Ministry of Agriculture

Host Country Associate Investigations: Juan Chavarria (UCR-CIMAR)
Eduardo Madrigal (Ministry of Agriculture)

United States Lead Institution: The University of Washington (UW)

United States Principal Investigator: Dr. Vincent F. Gallucci (UW)

Other Participating U.S. Institutions: The University of Delaware (UDelaware) (Through year 4 only)

United States Associate Investigators: Dr. Loveday Conquest (UW)
Dr. Lee Anderson (UDelaware)
Dr. Robert Donnelly (UW)

United States Research Associate: Robert Burr (UW)

United States Research Assistants: Shi Quan Liao (UW)
Jose Orensanz (UW)
Christopher Rogers (UDelaware)

Research Locations: UCR, UDelaware, and UW

1. Objectives and Potential Issues

This project develops a practical sampling methodology for the assessment of tropical fish stocks exploited by artisanal fisheries. More specifically, research focuses on the following objectives:

1) Evaluating and extending research on practical sampling designs;

2) Investigating intertidal and mangrove habitats to understand energy flows and recruitment processes;

3) Analyzing results of trawl and benthic surveys and integrating them into the ongoing stock assessment program; and

4) Incorporating these results into management models and management tools.

The project also has an economics component to evaluate the economic utility of current stock and recruitment models. This sub-activity is under the leadership of the University of Delaware.

2. Approach

Large amounts of catch-slip and other relevant data have been collected since the 1970's for the Gulf of Nicoya. This data, based on 2000-8000 vessel landings per month, may be the most complete record of a tropical, artisanal fishery available anywhere. It potentially offers tremendous amounts of basic scientific information, which, when analyzed and evaluated, could be utilized for improved management.

However, much of this data has not been transcribed, which is a prerequisite of analysis and evaluation. This project designs a subsampling strategy for transcribing and utilizing the data. It evaluates alternative sampling designs including systematic, strategic and probability proportional methods to evaluate the data and utilize it for a forecasting model for the fishery.

In addition, sampling methodologies and data evaluation are developed based on gill-net surveys. Sampling in the field independent of the artisanal fishing activity is taking place as well as that in conjunction with hydroacoustic surveys.

3. Scientific and Technical Issues

1) Quality of Research

Generally we believe the research that has been accomplished up to now is of high quality. We reviewed tentative findings and methodologies in both Costa Rica and University of Washington and were impressed with the approaches utilized and efforts underway.

2) Rate of Progress

The more significant progress has been in bringing together the historical data mentioned above and putting it into a useful format for sampling and further evaluation. Progress in this activity is perhaps not best measured in terms of what has been done with this data.

Three abstracts have been prepared based on this work for presentation to the 1988 American Fisheries Society Meeting by University of Washington and University of Costa Rica investigations. In addition a computer software project to assist a user in the selection and use of an optimal sampling design has been assembled and is in the final stage of completion.

Although activities are underway, there has been little concrete output on the assemblages, biological (recruitment and selectivity) and economics components of this project.

3) Usefulness of Products

The work completed on the formatting of the historical data series has been highly practical and useful but as mentioned above research now must be initiated on evaluating and analyzing this data for application. Transferability will be improved if microcomputer versions of software are prepared.

4. Logistics and Administration

1) Overall Management

If any criticism is to be made here, it is that only preliminary working reports have been published on

landing data, alternative sampling designs and historical landing data.

2) Status of Collaboration and Cooperation Among the U.S. and Host Country Researchers

This project which is highly practical and applicable in the short run enjoys close interaction among Host Country lead institution researchers and U.S. counterparts. University of Washington staff met with the University of Costa Rica on a regular basis to consult on methodologies and to take data back to the University of Washington for processing and analysis.

3) Funding and Host Country Funding

Progress has been hampered as a result of inadequate funding allocated among U.S. institutions and the University of Costa Rica.

5. Recommendations

This project should now begin to pull together results of data gathered and analyzed up to now and publish relevant working papers. Investigators should seek from the data any practical answers to fisheries problems that can be applied under tropical conditions, even though answers may be preliminary. The economics component should be more closely coordinated and results should be published, even if they are preliminary.

D. The Age and Size Dependent/Independent Modeling Project

Project Name: AGE-SIZE DEPENDENT/INDEPENDENT Modeling

Host Country: Costa Rica

Host Country Lead Institution: The University of Costa Rica (UCR-CIMAR)

Host Country Principal Investigator: Dr. Manuel M. Murillo (UCR-CIMAR)

Other Participating Host Country Institutions: None

Host Country Associate Investigators: Dr. Joseph Varilly (UCR-CIMAR)

United States Lead Institution: The University of Washington (UW)

United States Principal Investigator: Dr. Vincent F. Gallucci (UW)

Other Participating U.S. Institutions: None

United States Research Assistants: Han-Lin Lai (UW)
Jose Orensanz (UW)
Robert Burr (UW)

Research Locations: UCR and UW

1. Objectives and Potential Issues

Stock assessment techniques are based on demographic analysis of fish stocks which requires determination of the age composition of the populations. In the tropics, the inherent difficulty of determining age from scales or otoliths is compounded by the multiplicity of the pertinent species, and the limited number of researchers.

As a consequence, stock assessment techniques for the tropics have evolved towards using fish length as a proxy for age. This field of research developed rapidly and simultaneously in various parts of the world. An evaluation of the implications of simplifying assumptions of the earlier methods is needed along with innovative, improved methods.

The project is aimed at developing the "framework, methodology, and validation techniques for understanding and predicting the abundance and growth of selected fish and invertebrate stocks". This framework will allow the scientists elaborating advice for fishery management to address directly the problem of growth (and possibly recruitment) overfishing, to follow the status of exploited stocks and to predict the likely consequences of changes in fishing patterns such as changes in gill-net mesh size, fishing effort, seasonal or area closures, shifts in gear technology, etc. In so doing the project contributes to the long run objective of sustainable fisheries development and to the development of expertise in the associated host countries.

2. Approach and Expected Outputs

The approach used is three fold. On the one hand, the existing method of length cohort analysis (which is in reality an analysis of pseudocohorts, assuming equilibrium) is critically examined and the impact of errors in the input growth and mortality parameters, terminal fishing mortality and length intervals is reviewed.

On the other hand a "Catch at Length" equation is advanced, which allows cohort analysis in a mode similar to catch at age analysis. This relaxes the assumption of equilibrium and opens new avenues for the future hybrid models using length and age data.

It should be noted that a parallel innovative approach to analyzing length frequency data is underway at the University of Costa Rica. Their approach applies Physiologically Structured Models based on knowledge of the physiological limits of individual organisms. (Also, see comments on this activity under the "Multiple Species Research" project in Section IIIA.)

3. Scientific and Technical Issues

The research is of a high standard. Few research teams are addressing the issue in such rigorous terms (none in the tropical area). The approach is innovative and the results have very practical value.

The contribution of this project to tropical fishery science is very significant in that it offers a rigorous critical examination of "traditional" length frequency analysis (LCAN) and new integrating framework for such analysis through the catch-at-length equation and software (CASA).

The most straightforward part of the output related to classical length cohort analysis is already largely available and needs only refinements and improvements in the user interface of the programme LCAN. The more complex results of the research (the new catch at age model) is already in a fairly advanced stage of development and has been tested on field data sets.

Progress on this project has been rapid. It has been shown that parameter uncertainty in input parameters have a large impact on length cohort analysis and therefore that some age determination is necessary to complement the analysis and reduce the uncertainty. Progress along these lines should lead to optimize the cost of stock assessment in the tropics.

The length catch equation is an important advance in stock assessment methodology and brings the analytical framework of catch at length data to a level comparable to the framework for catch at age data on which most assessments and management techniques are based in temperate waters. The developed model reconstructs the abundance of populations and makes stochastic estimates of growth, fishing mortality, selectivity and recruitment fluctuations. It has been successfully applied to data from the Java Sea, Indonesia, Philippines, and Eastern Bering Sea. This model, however, has the same limitaticns as age cohort analysis because despite its elegance, it is under

determined, and progress will have to be made using ancillary information to reduce uncertainty (tuning), which is planned for future research.

Progress has also been made in developing unbiased estimators for Z/K using a framework for powerful estimation of growth parameters (K and L_∞) together with their joint probability density function using Cross Entropy Minimization. A similar approach is being developed to approximate age and size distributions and selectivity.

All these developments relate to the issue of uncertainty in population parameters used in the elaboration of management advice. They lead to a better use of available data in the tropics and to a better understanding of the robustness of biological advice. They also offer a readily usable base for extension towards bioeconomic simulation models which have widely recognized applicability for the analyses of management options. With additional information on fecundity this approach can lead to a better understanding of the impact of fishing on reproductive strategies of fish, giving some insight into the recruitment overfishing issue.

The transfer of the knowledge acquired is in progress. User friendly software has been written and tested (LCAN) although the CASA model is not yet available on microcomputer.

4. Logistics and Administration

The project is conducted by the University of Washington in close collaboration with the University of Costa Rica (CIMAR). The UW shares interests with the UMCEES in the Gulf of Nicoya and the results of this project will provide input to the Expert System/Decision Support System. There are obvious conceptual links and potential cross fertilization between the work done on length frequency at UW and parallel work done at University of Miami (by J. Ault and W. Fox, Jr.) and at the University of Rhode Island (by M. Castro, and K. Erzini). In addition, the UCR work on the Physiologically Structured Model is referred to in both UW and UMCEES reports.

Among the four components of the UW/UCR programme, this one has the lowest level of interaction with the host country as it is less tied to the field experiments in UCR. UCR scientists are pursuing similar objectives with a different approach. The EEP considers this a positive point but care should be taken to ensure sufficient contact between the two approaches to benefit from the pools of experience and skills working on the problem and to keep all opportunities for transfer open.

5. Recommendations for Completion of the First Five Years

The rate of progress is such that the likelihood to obtain the expected outputs is very high. Emphasis should be put on assuring transferability of the project findings and tools to developing countries. Presentation of papers to symposia or to refereed publications is insufficient to insure transfer to developing countries. Computer software, user guides and manuals are the preferred mean of transfer. It is therefore important that:

(a) the LCAN program (and documentation) be completed, tested and distributed;

(b) all efforts are made to prepare a PC version of CASA (for instance for a 80286 based computer) even if the price to pay is to reduce dimensions and to end up with a slow programme. A mainframe programme is unlikely to be widely used in most developing countries;

(c) all the converging approaches to length frequency analyses used in CRSP and by other research teams should be put in a unifying perspective in the manual (including, for instance, the work done by Fournier in UBC); and

(d) arrange for presentation of the results of this project at the next AFS symposium (Sept. 1988) and of the Latin American Symposium on Management of Small Scale and Artisanal fisheries (1988).

Extensions of CASA and LCAN to deal with multifleet problems would be extremely useful. Multigear interactions are prominent problems in artisanal fisheries management. Multigear interactions are tractable and useful for management in the short and medium term.

E. The Age and Size Relationships and Consequence of Errors Project

Project Name: AGE AND SIZE RELATIONSHIPS AND CONSEQUENCES OF ERRORS

Host Country: Costa Rica

Host Country Lead Institution: The University of Costa Rica (UCR-CIMAR)

Host Country Principal Investigator: Dr. Manuel M. Murillo (UCR-CIMAR)

Other Participating Host Country Institutions: None

Host Country Associate Investigator: Jorge Campos (UCR-CIMAR)

United States Lead Institution: The University of Washington (UW)

United States Principal Investigator: Dr. Vincent F. Gallucci (UW)

Other Participating U.S. Institutions: None

United States Associate Investigators: Dr. Han-Lin Lai (UW)

United States Research Assistants: None

Research Locations: UCR and UW

1. Objectives

The objective of this project is to determine the age distributions of selected sciaenid stocks, and to relate age to size of fish, maturity and fecundity. The EEP believes that the results are needed for assessment models, in particular for yield models, and to understand the influence of the fishery on reproductive capacity of the fish stocks.

2. Approach

The work is proceeding along two lines: (1) to develop a technical approach to age determination of two species of sciaenids in relation to fish size, and (2) to develop the means to characterize fish by maturity state, and determine fecundity of mature fish. The result will be information on size at age, growth curve parameters, age/size at first capture, age/size at maturity, survival rates, fecundity-at-age/size, and reproductive value of the stock. This information will be used in yield-estimation models considered in other projects for the CRSP.

3. Scientific and Technical Issues

Persons working on the project have shown that "apparent annuli" are present in the otolith of each of the species. Initial aging has been done. The ages can be read with a high degree of precision (repeatability). Validation of age readings is still needed. It was noted in the review, however, that sciaenids have been successfully aged in other areas of the tropics, and so continued success with this work is likely.

At present the surfaces of otoliths are read. Often readings of the cross-sections, or break and burn readings, will

show more "annuli" than surface readings, and so a fish will "gain age" by changing the method. This issue will be investigated during the next year.

The proposed microstructure analyses of otoliths will help to validate the aging method, since daily rings may be present. Also the investigators plan to carry out OTC injection of tagged fish to put a time mark on the otolith. This procedure is a necessary validation method for age determination, and should be carried out, as proposed.

Sampling for determination of maturity stages, spawning timing, and fecundity, will begin in year four. Preliminary work has been carried out in order to plan the sampling.

4. Logistics and Administration

Both age determination and fecundity sections of this project require close cooperation between UW and UCR. During the next year there should be increased field activity in Costa Rica by both institutions. Complete arrangements have not yet been made to take the samples, and to process them in the lab. The fecundity work requires a lab with fumehood for handling volatile preservatives. It may take 6 months to work out the procedures for handling the ovaries, separating the oocyte from the ovarian tissue, and conducting the egg counts. It is not clear what sampling schedule will be followed, but monthly samples are probably required.

5. Recommendations

We believe that the work proposed in this project is important to the estimation of yield potentials, and in gaining insight into the possible effects of the fishery on recruitment.

The validation of age determination is time consuming and should be started as soon as possible. It is likely that at least three years will be required for the work with OTC. The analysis of otolith microstructures will probably take two years to complete.

The scientists involved should proceed as soon as possible to develop procedures for the fecundity portion of this study. The work will likely take three years to complete, including a preliminary year. Sampling for age, size, maturity stage, and fecundity will be far more time consuming than sampling for age alone, and will require different lab space. We recommend that both length and weight of fish be measured for the fecundity data. Thought should be given to the number of jars that will be needed to hold the ovaries, and the soak-time required for freeing the eggs from the ovarian tissues.

F. The Shallow-Water Hydroacoustics Project

Project Name: SHALLOW-WATER HYDROACOUSTICS

Host Country Lead Institution: The University of Costa Rica (UCR-CIMAR)

Host Country Principal Investigator: Dr. Manuel M. Murillo (UCR-CIMAR)

Other Participating Host Country Institutions: Ministry of Agriculture

Host Country Associate Investigator: Jorge Campos (UCR-CIMAR)

United States Lead Institution: The University of Washington (UW)

United States Principal Investigator: Dr. Richard E. Thorne (UW)

Other Participating U.S. Institutions: None

United States Research Assistants: John Hedgepeth

Research Locations: UCR and UW

1. Objective

The objectives of this project are to develop hydroacoustic fish assessment techniques for shallow-water, multispecies environments such as the Gulf of Nicoya in Costa Rica. It has four components including: 1) Determine the distribution, abundance and behavior of the corvina-like fishes, evaluating variables such as tidal, diel, location, seasonal and annual; 2) Determine the effectiveness of artificial reefs in attracting fish; 3) Determine the efficiency of locally fished gill nets and other direct capture techniques; and 4) Introduce the results of hydroacoustic estimation as auxiliary input for artisanal fisheries catch and stock assessment analysis.

2. Approach

Measurements will be taken on abundance, vertical distribution and velocity of fish, as well as salinity and water currents.

Dual stationary transducers are used, one mounted at a slant angle on the bottom, the other deployed at the surface and

mounted at 90 degrees. A Simrad EYM echosounder is used. Computer software was developed to accompany a Summagraphics digitizing tablet to analyze fish targets from echopaper. By measuring current speeds and analyzing acoustic data it was found that fish move at about the same speed as the tidal current and that they are highly responsive to diel variation. Bias due to the sampling vessel's presence was also quantified to correct density estimates. Acoustic sampling in conjunction with drifting gillnets in night and day times is done for groundtruthing. A microcomputer-based system consisting of an analog-to-digital converter, signal processor for analysis of the tape recordings, and associated software is under development.

3. Scientific and Technical Issues

This project has completed the initial development, testing and application of hydroacoustic systems for fish detection and abundance estimation in shallow water marine environments such as those associated with most artisanal fisheries, thus adding a new dimension to stock assessment. It has also been shown that fish movement is about equal to current speed, suggesting tidal movement of fish, and the dependence of fish upon diel change. Further research will use these behavioral characteristics to help explain harvest susceptibility, spawning and feeding patterns, and in the interpretation of acoustic signals.

A substantial amount of data from the latest field effort is undergoing analysis. Five working papers have been written, and each will be or has been submitted for refereed publication. Two additional papers will be presented at the 1988 American Fisheries Society annual meeting.

These working papers form some of the essential documents for a short training course entitled "Shallow Water Hydroacoustics: Theory and Techniques" to be taught at the UCR in year four, 1989.

The results on fish behavior will benefit the interpretation of CPUE data and hydroacoustic measurements. The technological innovations will allow these methods to be applied in shallow waters and the data to be interpreted. The computer programs will facilitate analyses, remove some of the necessity for high levels of training in hydroacoustics, and assist in interpretation.

4. Logistics and Administration

a) Overall Management and Planning

We found the overall management and planning of the project satisfactory. Work has been completed on schedule and products have been forthcoming as planned.

b) Interaction With Other Components

The project personnel relate closely with other scientists from The University of Washington. Data generated will be utilized in the Sampling Catch and Abundance project and in the modeling project.

c) Extent of Collaboration With Host Country

Although the Costa Rican scientists rank this project relatively high, they are only marginally involved. The primary UCR counterpart has most of his time devoted to other activities. We see the need for greater host country participation in this activity.

d) Funding Adequacy

Funding appears to be inadequate for this project. The equipment that has been used was borrowed and is not ideal for the research that is underway.

5. Recommendations

The EEP is unclear on the role of hydroacoustics in the Fisheries Stock Assessment CRSP. In general, the products of the research to date have addressed ecological issues, but they have not provided a fishery independent measure of the population. The EEP urges that the role of hydroacoustics be clarified. In particular, how will the problem of target strength be addressed? This is of particular importance and difficult for multi-species fisheries.

G. The Empirical Analyses and Modeling Project

Project Name: EMPIRICAL ANALYSES AND MODELING

Host Country: Philippines

Host Country Lead Institution:
College of Fisheries, The University of the Philippines in the Visayas (UPVCF)

Other Participating Host Country Institutions:
International Center for Living Aquatic Resources Management (ICLARM)
Bureau of Fisheries and Aquatic Resources (BFAR)
Marine Science Institute, The University of the Philippines (UPMSI)

Host Country Principal Investigator: Dr. Efren Ed. C. Flores (UPVCF)

Host Country Associate Investigators:
Dr. Daniel Pauly, Senior Scientist (ICLARM)
Dr. Sonia S. Formacion, Senior Scientist (UPVCF)
Prof. Geronimo T. Silvestre, M.S., Scientist (UPVCF)
Prof. Nygiel B. Armada, M.S., Scientist, (UPVCF)
Prof. Glenn D. Aguilar, M.S., Scientist, (UPVCF)
Mr. Victor C. Sambilay, Research Assistant, (UPVCF)
Ms. Joanna M. Rongo, Research Assistant, (UPVCF)

Other Participating Country Institutions:
Research Institute for Marine Fisheries of the Agency for Agricultural Research and Development, Republic of Indonesia (Dr. Nurzali Naamin, Director)
Division of Marine Fisheries of the Department of Fisheries, Thailand (Boonlert Phasuk, Director)

United States Lead Institution: The University of Rhode Island

United States Principal Investigator: Dr. Saul B. Saila (URI)

Other Participating U. S. Institutions: None

United States Associate Investigators:
Dr. Janet McLeavey, Scientist (URI)
Dr. John W. McManus, On-Site URI Scientist, Philippines
Dr. Conrad Recksiek, Scientist (URI)

United States Research Assistants:
Mr. Karim Erzini, M.S., Research Assistant II (URI)

Research Locations: UPVCF and URI

1. Objectives and Potential Issues

Most fisheries around the world capture a mixture of species during fishing operations. There are interactions between gears and species. Species composition and economic value of stocks are affected by fishing pressure but the extent of such changes (or their real significance) is hard to scientifically measure. Moreover, the extent to which such changes can be predicted or controlled by management is unknown. Research avenues to tackle this problem include analysis and modeling of biological and gear interactions and of dynamics of assemblages of species.

This project follows the latter avenue and aims at "using fisheries data to contribute to the development of mathematical models and computer programs which address the relationship among harvest, fishing effort, species composition, and stability of

tropical fish stocks. A major emphasis is on the analysis and prediction of catch composition. It contributes to the development of relatively simple stock-assessment models which should provide insight relevant to management. More advanced (i.e., realistic) models may be developed in the long term."

An implicit objective is to contribute to sustainable development though ecosystem management, with optimal harvest and minimal ecological disturbance. Last but not least, the project also aims explicitly at the development of national capacity in multispecies resources assessment and management oriented research.

2. Approach

The project promotes the collection of data on species compositions of fish stocks and catch. It leads to the development of methods to analyze time series or space matrices of such data in order to objectively identify changes in species composition. In developing tactical (short term) models, the data are fitted with some known distributions and goodness of fit test are executed. The approach involves Monte-Carlo simulations of species assemblages to establish empirically derived probability distributions which are compared to the expected overlap of paired multispecies samples to identify changes in species composition in time or space.

In developing strategic (long term) models, the aggregated time series of research vessel data from the Gulf of Thailand (and North West Atlantic) are treated with Markov chain models using a transition probability matrix derived by quadratic programming. The matrices are projected to provide information about the stability and changes in multispecies assemblages.

The expected outputs include both tactical (short term) and strategic (long term) models to be produced by the end of the first five years of the project. Suitable software should be produced allowing for prediction of equilibrium species compositions (strategic models) as well as transitional states (tactical models). The methods that are developed should be applicable to data collected in the "Multispecies Field Studies" project.

3. Scientific and Technical Issues

At the time of the EEP review the project was in its first phase of development. However, it is very clear already that important tangible achievements are available and that the project is progressing rapidly towards its aim. The approach is fairly clearly established, the family of methodologies well defined, and important intermediate results are available:

(a) Data sets have been compiled and analyzed (Thailand, N.W. Atlantic) and steps have been taken to access new data sets (Samar Sea, Philippines);

(b) Tools to make critical statistical comparisons between multispecies assemblages have been developed (including software);

(c) A new empirical multispecies model for analysis of changes in catch ratios (species composition) over time have been developed, tested, and published;

(d) Aggregated time series of catch ratios were treated as Markov chain models after a transition probability matrix was derived from these by quadratic programming. The matrices were projected to provide information about stability and changes in multispecies assemblages;

(e) A study of the optimum reproductive value as a management target is underway.

Other results are available from the project which contribute to the overall objectives of the Fisheries Stock Assessment CRSP (although not specifically to this project):

(a) An excellent overview of the Philippine demersal fishery showing the effects of uncontrolled fishing;

(b) A methodology to define optimum mesh size selection patterns in multispecies trawl fisheries;

(c) A simple simulation model used for testing length frequency analyses programs;

(d) A contribution to the Extreme Value Theory, developed in the Philippines with only modest support from URI, and applied to the general problem of growth parameter determination;

(e) A user-friendly package of classical stock assessment programs (FSAS) with an excellent manual and user guide.

It is obvious from the above that the progress is good, in part, due to the fact that a large amount of field data were available even if not in a directly usable form. The research undertaken under this project is of high quality. It is relevant and addresses its objective. It is timely. The general approach has been recommended by international working groups and in papers on multispecies fisheries. The results should help scientists and managers address overfished reef resources in the

Philippines and in S.E. Asia. The outputs of the project are routinely submitted for broad review (Asian Fisheries Society Forum in June 87; the American Fisheries Society in September 1987 and September 1988) and they are published in peer reviewed journals.

4. Logistics and Administration

The project is consistent within the URI overall programme as there are common objectives with the project on "Multispecies Field Studies." The budget allocation between the two URI projects (about 30% for this project and 70% the other) is appropriate since field programs are usually more expensive.

Collaboration with the host country is excellent (as recognized by the counterparts themselves). The project collaborates with the Marine Science Institute (UPMSI), the Bureau of Aquatic Resources and Fisheries (BFAR) and with the International Center for Living Aquatic Resources Management (ICLARM). It is acknowledged by local authorities that the project has even fostered collaboration between national institutions and contributed to the success of the Bolinao field laboratory, and to the efforts of the U.P. to develop into a Regional Center of excellence for research and training.

The project is fairly independent from the projects undertaken by the other U.S. universities, although it should contribute to the elaboration of the Expert System/Decision Support System (ES/DSS) by UMCEES. It has, however, contributed to the general work on stock assessments (with an excellent software package) and on length frequency analysis.

The EEP did note the apparent lack of communication between this project and the "Multiple Species Fisheries Research" project of UMCEES/UCR-CIMAR despite obvious similarities in the project titles. This does not, however, lead to duplication of efforts since the approaches are different. For the moment the only projects that are primarily multispecies oriented are at the University of Rhode Island and the University of the Philippines.

5. Recommendations for Completion of the First Five Years

All the research activities pursued during the first three years should be continued to improve the methodology, test the results, prepare the handbooks required for transfer of the approach to the host country and to other tropical countries. In particular,

(a) The empirical model (aggregated time series of research vessel data reduced to transition probability matrices) should be expanded and tested on other field data sets.

(b) The computer software should be developed and fully tested for distribution to interested laboratories. Considering the length of time needed for development of user-friendly programs and proper debugging, this work should start on a priority basis if it is to be ready by the end of the fifth year.

(c) Since long time series of data of species composition are not very often available in developing tropical countries, the possibility of adapting the methodology from time structured to space structured data should be considered. The project is sufficiently advanced to believe that the extension of the empirical modeling of multispecies resources could progress significantly even within the first five years time horizon.

Another approach to multispecies assessments, with common features with the approach used in this project, is multispecies length frequency analysis. Explicitly addressing the length frequency domain in a community (or a group of communities with common exploitation trends) and analyzing how length composition evolves might lead to innovative approaches to multispecies assessments. A similar approach has been proposed for the analysis of primary and secondary production (plankton studies) as a means to circumvent the multispecies problem and the transfer of that approach to fisheries might at least be conceptually explored in this project. This might unify the work of CRSP on length frequency analysis of single species and multispecies.

Other practical recommendations for the future include:

(a) Transfer and test the results obtained in S.E. Asia to the Costa Rica area (and possibly to other tropical areas where adequate data are available), and

(b) Accelerate the exchange of data between UW, URI, UCR, and UP and field testing on length frequency analysis.

It should be noted that while some of these recommendations come from the EEP, most of the recommendations regarding extension of the present work were already explicitly made by the research team itself and are noted here to express the EEP's concurrence.

H. The Multispecies Field Studies Project

Project Name: MULTISPECIES FIELD STUDIES

Host Country: Philippines

Host Country Lead Institution:
Marine Science Institute, The University of the Philippines (UPMSI)

Host Country Principal Investigator: Dr. Edgardo D. Gomez (UPMSI)

Other Participating Host Country Institutions:
International Center for Living Aquatic Resources Management (ICLARM), Bureau of Fisheries and Aquatic Resources (BFAR), and College of Fisheries, The University of the Philippines in the Visayas (UPVCF)

Host Country Associate Investigators:
Dr. Daniel Pauly, Senior Scientist (ICLARM)
Mr. Wilfredo L. Campos, M.S., Research Associate (UPMSI)
Ms. Annabelle G.C. del Norte, M.S., Senior Research Assistant (UPMSI)
Mr. Philip A. Roa, Senior Scientific Programmer (UPMSI)
Mr. Ruben C. Garcia, Senior Scientific Engineer (UPMSI)
Mr. Cleto L. Nanola, Research Assistant (UPMSI)
Ms. Clarissa C. Arida, Research Assistant (UPMSI)
Ms. Mary Janeth P. Poot, Research Assistant (UPMSI)
Ms. Gemma Cecilia P. Yalung, Research Assistant (UPMSI)
Mr. Rodolfo Reyes Jr., Research Assistant (UPMSI)
Mr. Jerome P. Cabansag, Research Assistant (UPMSI)
Mr. Miguel P. Miguel, Research Aide (UPMSI)
Mr. Jesse Cabansag, Research Aide (UPMSI)

Also members of the U.S. AID/ASEAN Coastal Resources Management Project (CRMP) and the U.S. AID/Philippines Rainfed Resources Project are working with the CRSP.

United States Lead Institution: The University of Rhode Island (URI)

United States Principal Investigator: Dr. Saul B. Saila (URI)

Other Participating U.S. Institutions: None

United States Associate Investigators:
Dr. John W. McManus, On-Site URI Scientist, Philippines
Dr. Conrad W. Reckseik, Scientist (URI)
Dr. Janet A. McLeavey, Senior Scientist (URI)

Research Locations: UP and URI

1. Objectives

There are nine subprojects that together contribute to the goal of understanding the nature of the fishery in the Bolinao area and the assemblages in that area as well as in other areas in Southeast Asia. 1. Bolinao fishery statistics; 2. Fishery independent surveys of the Bolinao area; 3. Application of statistical techniques to the assemblage data from the Bolinao surveys; 4. Reproduction and recruitment timing study; 5. Remote sensing of fish habitats - satellite imagery; 6. Surveillance of fish habitats; 7. Study of gleaning/gathering fishery; 8. Modeling of multispecies mesh selection and application of standard yield models; and 9. Statistical analysis of other SE Asian assemblage time series.

2. Approach

This is largely a field oriented program to understand the fishery productivity of assemblages in a heavily exploited area of the Philippines, and to provide analyses of new and existing assemblage surveys using ordination and cluster analysis techniques.

3. Scientific and Technical Issues

The nine subprojects all show good progress and have produced useful results to date. Some of the subprojects seem to be nearing completion, so it may be an appropriate time to consolidate in some cases, and spend an increased proportion of the time on other subprojects.

1) The work in compiling the Boliano reef-fishery data is necessary to the understanding of the catches and fishing effort and to relate the artisanal fishery information to the assemblages. There are seven types of gear involved in the fishery, and the goal is to develop a catch per unit effort time series on each of these gear types. Each week a member of the team visits the fish buyer and gets the catch records in each of the villages. The work is on-going and shows good progress. There are 70-80 people fishing the reef flat and taking about 250 t per year. A total of 2700 people fish the Bolinao and Santiago Island areas. The work is coordinated with the Coastal Resource survey of the Bureau of Fisheries of the Government of the Republic of the Philippines.

2) Project members are carrying out fishery independent surveys of the areas in which the fishing is being conducted. The work is necessary to gain an understanding of the distribution of the total fish assemblage. Diving is carried out

on 18 sites with transect techniques, and on 12 sites with encircling net fishing. The work is ongoing and showing good progress in developing a local time series of assemblages.

3) Statistical cluster and ordination analysis is being applied to data from the above two sets of data to look at patterns in time and space. There are 70 - 80 species per site. A strong linkage between habitat and assemblage composition has been described. The work shows good progress and is ongoing.

4) Reproductive cycles and spawning timing are being studied by examination of gonads for maturity stages. The results indicate that some species have two peaks of spawning, while others have only one that corresponds to one of the two peaks of the double spawners. Continuous spawning is not the rule in this area. This sampling work seems to be in a finished state, and effort might be moved to one of the other subprojects, or expanded to include a histological analysis. Coordination with the University of Washington work on this same subject should be developed.

5) Remote sensing of fish habitats is being carried out using satellite imagery. Most of the effort has been put into developing software to filter and enhance the images, and excellent mapping has resulted. The maps show the distribution of sea grass beds, sandy areas, the reef-crest coral, and depth contours. The maps are invaluable in understanding the assemblage distributions because of the strong linkages between habitat type and species composition. It appears that personnel effort could now be directed toward other aspects of the project.

6) Surveillance of habitat and fishing effort is being done by a remote controlled model airplane, and by an ultra-light plane fitted with floats. Though there was considerable challenge at first in equipment development and learning to fly, the equipment is now operational. It is useful in mapping out the disposition of fishing effort, particularly the exact deployment of the stake-fishtraps. The direction of the opening of these traps shows the migration patterns of the fish being taken.

7) A study of the gleaning or gathering fishery of the shallows at low tide is in its early phases. This work is valuable to explore the nature of the invertebrate fishery being pursued simultaneously with the fish exploitation. The data are not yet worked up for statistical presentation.

8) A modeling study is being carried out of mesh selection and application of more traditional models for estimation of fisheries yields. The results are interesting, and are in a fairly finished state. The personnel time might be put toward other work in the near future.

9) Statistical analyses of a number of data series from other areas of SE Asia is well underway and is producing significant results. Much time has been spent on readying the data and preparing microcomputer software for the analyses. The software development is very valuable, since it is immediately transportable to other projects, for example those in Costa Rica. These analyses are necessary for the conduct of the Empirical Analyses and Modeling Project.

4. Logistics and Administration

The linkage between URI and UP is strong in that one URI scientist is permanently on the UP campus, and so he provides strong leadership to the research assistants and graduate students there. CRSP scientists have an excellent working relationship with ICLARM. They routinely exchange data and computer software, and they jointly conduct training. The project contributes substantially to the development of national capacity in the Philippines by:

1) Providing on the job training in sampling, ecological theory, computer programming, and analyses of multispecies resources;

2) Providing funds for graduate training (nine nationals from the Philippines); and

3) Contributing significantly to the development of a functional field laboratory in Bolinao

The CRSP personnel suffer from lack of space at UP, all individuals being crowded in one room. Work efficiency must be reduced because of this. The space problem should be solved during the coming year as building construction draws to completion, and new rooms are occupied.

There should be increased contact between the senior scientist in the Philippines and at the University of Rhode Island.

5. Recommendations

1) Because of the depleted nature of the fishery resource at Bolinao, it is difficult to get an appreciation of the possible state of the assemblages at low or zero fishing effort levels. Therefore, the possible directions of assemblage rehabilitation, and setting a protocol for evaluating rehabilitation, is problematic. To overcome this difficulty, we suggest that a second study site with similar physical characteristics and low fishing effort be selected for the purpose of comparative studies.

2) It would be valuable to explore the nature of the assemblages in the deeper water on the reef slope. Do the adults or larger individuals of reef flat assemblages inhabit these areas?

3) When the distribution of assemblages has been worked out, a food resource division study of selected assemblages should be conducted to determine trophic linkages within the assemblages. This would allow insight into whether some groups of species are connected in their productivity, and would allow modeling of patterns of rehabilitation.

4) Hypotheses should be developed regarding the causes of natural variability. The study at Bolinao is largely ecological in nature, and lends itself to the development of hypotheses regarding the effects of physical factors, and biotic influence.

5) Consideration should be given to the possible development of a special survey of juvenile fishes. The direction of possible assemblage changes might be best expressed in the abundance of the juveniles. High fishing effort likely inhibits the expression of these possible changes. Alternative time courses that might ensue if fishing effort were restricted might be modelled from juvenile data.

6) It would valuable to transfer the assemblage analyses techniques to the program in the Gulf of Nicoya.

IV. EVALUATION OF THE PROGRAM

Evaluating the overall stock assessment CRSP is a difficult task because of its broad scope, complexity and level of productivity. As an aid, the EEP constructed a diagram of component interactions (Figure 1 on page 42). It indicates that there is some overall coherence in the Fisheries Stock Assessment CRSP. But a coherent research strategy has yet to be articulated.

In this report the EEP considers the degree of balance achieved over the entire program as seen among the separate projects. To evaluate balance the EEP tried to consider all the elements that a complete stock assessment program should have, and then examined progress in the CRSP by constructing a series of dimensions over which balance might be attained for the different elements. For example, both short term and long term projects should be included in a research program to develop new methods in stock assessment. If the program were completely short term in its goals, one might expect applications to be ready within 3 to 5 years, but the methods might not be very different from existing methods, and most of the deeper problems of tropical, multispecies fisheries of an artisanal nature might be dealt with lightly. The other dimensions are:

1. Focused case history studies vs. general, wide ranging studies;

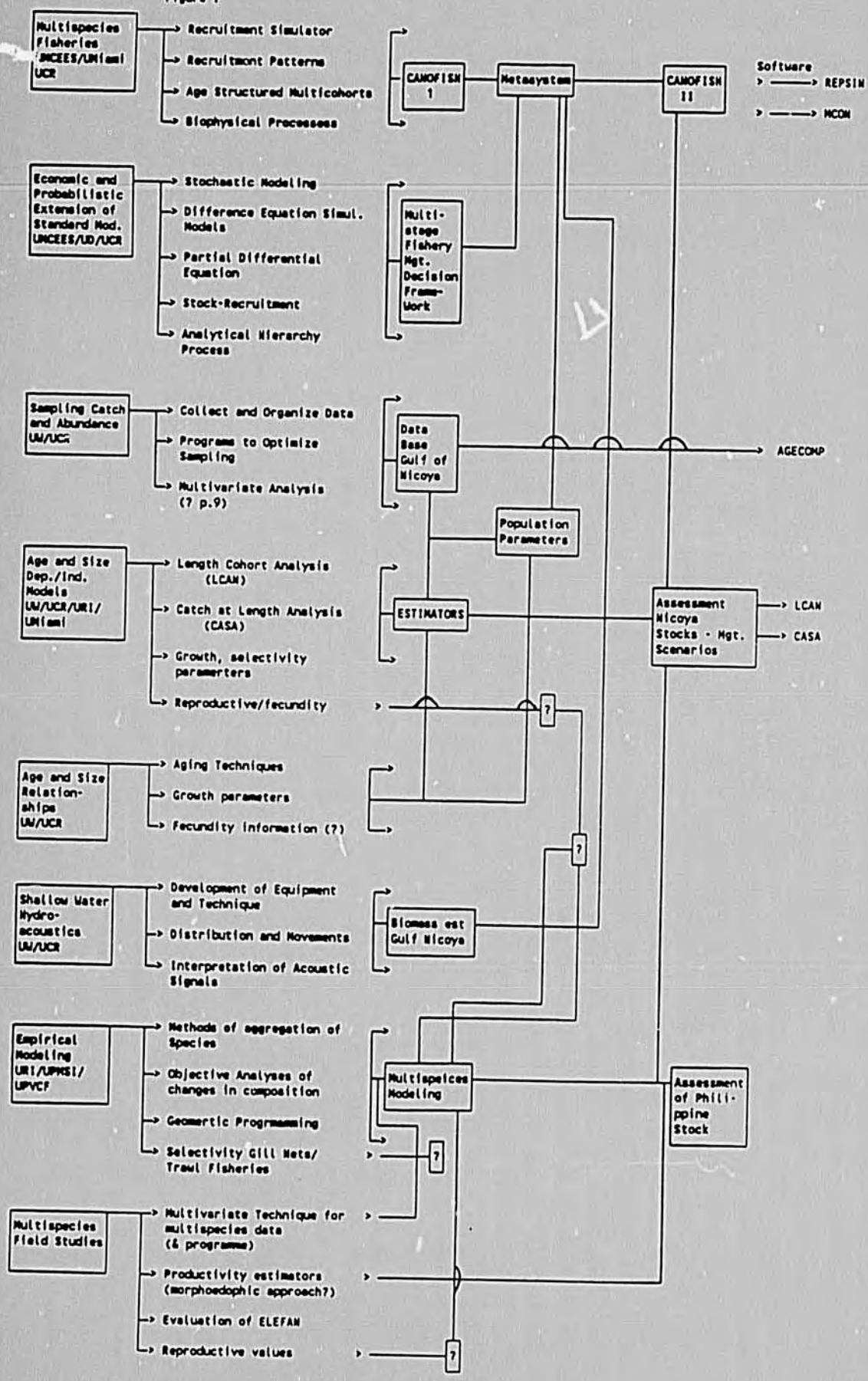
2. Basic vs. applied research;

3. Studies that relate strictly to assessment vs. ecological studies designed to give insight into causal mechanisms; and

4. A balance among the four categories: (a) field studies, (b) fishery statistics, (c) models for yield estimation, and (d) general theory that provides insight into recruitment and productivity.

Generally, stock assessment programs produce sets of yield options that fishery managers may choose among to develop a Fishery Management Plan. The yield options take into account social, economic and biological concerns. These yield options come from **yield estimation models** that, within limits, explore the effects of specified fishery activities and fishing effort levels on present and future catch, and the projected condition of the stock. Often **economics models** are combined into some of the yield estimation models. Biological aspects are explored in **productivity, biotic/abiotic effects models and models specifically treating reproduction and recruitment.** This collection of models is dependent on input from studies of **biological rate estimates (growth, fecundity, mortality)**, as well

Figure I


Multispecies Fisheries UMCEES/UMiami UCR
Recruitment Simulator
Recruitment Patterns
Age Structured Multicohorts
Biophysical Processes
CAMOFISH 1
Metasystem
CAMOFISH II
Software
REPSIN
MCON
Economic and Probabilistic Extension of Standard Mod. UMCEES/UD/UCR
Stochastic Modeling
Difference Equation Simul. Models
Partial Differential Equation
Stock-Recruitment
Analytical Hierarchy Process
Multi-stage Fishery Mgt. Decision Frame-Work
Sampling Catch and Abundance UW/UCR
Collect and Organize Data
Programs to Optimize Sampling
Multivariate Analysis (? p.9)
Data Base Gulf of Nicoya
AGECOMP
Population Parameters
Age and Size Dep./Ind. Models UW/UCR/URI/UMiami
Length Cohort Analysis (LCAN)
Catch at Length Analysis (CASA)
Growth, selectivity parameters
Reproductive/fecundity
ESTIMATORS
Assessment Nicoya Stocks - Mgt. Scenarios
LCAN
CASA
?
Age and Size Relation-ships UW/UCR
Aging Techniques
Growth parameters
Fecundity information (?)
?
Shallow Water Hydro-acoustics UW/UCR
Development of Equipment and Technique
Distribution and Movements
Interpretation of Acoustic Signals
Biomass est Gulf Nicoya
Empirical Modeling URI/UPMSI/UPVCF
Methods of aggregation of Species
Objective Analyses of changes in composition
Geomertic Programming
Selectivity Gill Nets/ Trawl Fisheries
Multispeices Modeling
Assessment of Phili-ppine Stock
?
Multispecies Field Studies
Multivariate Technique for multispecies data (& programme)
Productivity estimators (morphoedophic approach?)
Evaluation of ELEFAN
Reproductive values
?

as **time trends in catch, effort, catch-per-unit-effort, age composition of the stock/catch, and species composition.** There are five categories of data collection that any stock assessment program must have for accumulation of new information for the above statistical and modeling work: **biomass surveys and biological sampling at sea, laboratory work for exploring biological relationships, port sampling for development of catch and effort statistics, compilation of data on physical oceanographic variables, and fishery economics variables.**

The attached Tables 2 and 3 compare the dimensions of the research problem and the elements of stock assessment research to the eight projects of the stock assessment CRSP. These Tables are discussed further under subsections IVB and IVC.

The EEP evaluated the Fisheries Stock Assessment CRSP in more detail for six factors: quality and quantity of research, relevance, likelihood of success, transferability, institutional impact and overall program management.

A. Quality and Quantity of Research

The most important factor to be considered in evaluating a research program is the quality of the research. There are two dimensions to quality. They are:

1. Validity - are the results of the research correct, or if they are uncertain is the degree of uncertainty properly assessed?

2. Appropriateness - is the approach the best one to use to solve a specific problem or test a specific hypothesis?

During the course of the review the EEP did not identify any significant research results that were invalid. It did debate the appropriateness of some approaches, but this is to be expected, particularly since some of the research is very innovative.

The EEP believes that, overall, the Fisheries Stock Assessment CRSP research is sound. One piece of evidence is that a significant number of CRSP products have already been published in peer reviewed literature. This is unusual for research supported by a mission oriented agency. In part, this is because the stock assessment CRSP is funded by a grant instead of a contract. It also reflects the overall quality of the researchers. The CRSP is led by three outstanding, proven, fisheries scientists. Clearly, their overall capability is a major "strength" of the CRSP. The EEP feels confident that research conducted under their direction is very likely to be of high quality.

Table 2

TABLE of DIMENSIONS and the balance among dimensions to be found in the eight projects of the CRSP.

	1 Mutlispp Research, U.Md., U. Miami, U.C.R.	2 Econ & prob ext stand mod, U.Md., U.Del., U.C.R.	3 Sampl catch, abund, U.W., U.C.R.	4 Age & size mod. U.W., U.C.R.	5 Age/size relat, cons of errors, U.W., U.C.R.	6 Shallow hydroac, U.W., U.C.R.	7 Empir anal., & mod., U.R.I., U.P.	8 Mutlispp field studies, U.R.I., U.P.
Longterm	X			X			X	X
Shortterm	X	X	X	X	X	X	X	X
Focused Case History	X	X	X	X	X	X	X	X
General, wide ranging	X	X					X	
Basic/fundamental	X	X				X	X	X
Applied/practical	X	X	X	X	X		X	X
Strictly assessment	X	X		X	X	X		X
Ecological Field Studies	X				X	X	X	X
Fisheries Statistics	X	X	X		X		X	X
Yield Models	X	X		X	X		X	X
General Theory	X						X	

The quantity of research can be judged by the number of tangible products (e.g., reports) or the richness of ideas that are apparent within the research environment. Overall, the EEP rates the quantity of research as good. The quantity produced on some projects has been less than was anticipated, but this generally relates to budget problems, or logistic problems in gathering data.

B. Relevance

There are several interrelated dimensions to consider with regard to relevance. They are:

1. AID's goal for the Fisheries Stock Assessment CRSP;

2. The objectives of the CRSP as stated in the funding proposal; and

3. The needs of developing countries.

Together these dimensions could be used to sanction almost all fisheries research (and a great deal of oceanography, economics and operations research) or they could be interpreted such that only field work on tropical, artisanal, multispecies fisheries in developing countries is relevant. Either interpretation would be a mistake. Elements of both are necessary so that the overall research program has both immediate and long term relevance.

It is also important that the research program address key elements of stock assessment programs (see Table of Stock Assessment Elements, Table 3).

The EEP believes that, on balance, the research of the stock assessment CRSP is relevant. Some of the projects are addressing generic problems of fisheries science, while others are quite focused on issues of immediate importance in developing countries. There is at least one project addressing each of the elements of a stock assessment program.

The EEP did note that there is only one project (Multispecies Field Studies in the Philippines) that is simultaneously (explicitly) addressing all three of the characteristics that are typical of the fisheries in developing countries; tropical, artisanal, and multispecies. One aspect of these fisheries that does not seem to be receiving much attention is problem of gear and fleet interactions. For example, artisanal finfish fisheries and industrial shrimp fisheries in Costa Rica clearly interact. Understanding gear and fleet interactions may require alternative models.

Table 3

TABLE of STOCK ASSESSMENT ELEMENTS and the presence of elements for stock assessments in the various projects of the CRSP. All projects need not have all elements, but in total, the Program should, and does, address them.

	1 Mutlispp Research, U.Md., U. Miami, U.C.R.	2 Econ & prob ext stand mod, U.Md., U.Del., U.C.R.	3 Sampl catch, abund, U.W., U.C.R.	4 Age & size mod. U.W., U.C.R.	5 Age/size relat, cons of errors, U.W., U.C.R.	6 Shallow hydrosc, U.W., U.C.R.	7 Empir anal., & mod., U.R.I., U.P.	8 Mutlispp field studies, U.R.I., U.P.
Yield est. models	X	X		X			X	X
Economics models		X		X				
Productivity/ biotic/abiotic effects models	X			X	X		X	X
Recruitment models	X			X	X		X	X
Biological rate (parameter) estimates	X			X	X	X		X
Time trends in CPUE, age comp., species comp.	X	X	X	X	X	X	X	X
At sea bio-sampling, bio-mass surveys					X	X		X
Lab. stdules					X			X
Port sampling for catch/effort biosamples	X		X		X			X
Physical oceanogrpahic data/modelling	X				X			X
Economic data		X	X					X

C. Likelihood of Success

There is little doubt that the program will be successful in developing new stock assessment techniques that will be applicable to tropical, artisanal fisheries. The EEP approached the review by first considering whether there was balance in the program among selected dimensions that would provide guidance to a manager of any research program into stock assessment methods. Then we looked for the presence of elements of activity that should be a part of stock assessment programs anywhere (see Tables 2 and 3).

All of the eight projects have strong possibilities for short-term payoffs (within 5 years), while four are looking into questions that clearly required more time for completion (see Table of Dimensions, Table 2). This is not to say that longer term projects will not have important short-term findings as well. All projects show the activity of case history studies, while three have more general goals harder to pin down because the nature of the results is less certain. The EEP found that there was a good balance between fundamental research and applied research. Also, there was a fairly even spread between work oriented strictly toward stock assessment and research designed to give ecological insight. Again there was balance among field studies versus studies marshalling fishery statistics; versus yield models, and finally development of general theory.

In a similar way, the EEP found that the activity elements were spread through the eight projects (see Table of Stock Assessment Elements). In fact each host country was participating in a complete set of activity types. This distribution was more difficult to achieve in the Philippines than in Costa Rica because fewer persons and a smaller budget are available there.

Some activities could be made stronger. 1. Some of the projects lend themselves well to laboratory work, but only a small amount is being carried out. In the Philippines, this will be remedied via new facilities within two years. In Costa Rica most of the lab work is being done by CIMAR. The U.S. universities carrying out joint work there could step-up their lab efforts by redirecting some of their sub-projects. 2. It appears that econometrics data is not being compiled under the supervision of a professional economist in either host country. 3. There seems to be little attention given to exploring existing physical oceanographic or ocean weather time series. In addition there is no physical oceanographer working with the group to develop inexpensive ways to carry out the surveys needed to develop the relationships between biological responses and

abiotic factors, though in several places the program has set objectives involving relationships with these factors.

D. Transferability:

The result of the CRSP research should be, in the short term, applicable to the artisanal multispecies fisheries of the host country, as well as generally applicable to fisheries of developing countries. Means to enhance transferability include: contact between scientists, formal presentation of results, preparation of text books and manuals, and preparation of user friendly computer programs.

a. Contacts between scientists: This is needed for exchange of information, for on-the-job training, preparation of co-authored papers, and scientific supervision. There is a need for contact even (or possibly above all) when the work done in the US is of a global nature and loosely linked to the host country.

The general consensus is that these contacts have been too infrequent due to budget cuts and the resulting lack of communication was evident in many instances. It is recognized by the investigators themselves.

b. Formal presentation of results: The scientific results should be submitted for publication in scientific journals and presentation at relevant symposia (particularly those oriented towards research of artisanal fisheries analysis and management). There is a long list of papers and articles resulting from the CRSP. CRSP scientists have presented results at appropriate meetings to the extent that funding allows.

c. Preparation of manuals and text books: Manuals and text books are an integral part of transfer of knowledge to the host countries and, above all, to the rest of the developing world. These publications put the concentrated content of an often sophisticated paper in a more readily understandable and applicable form. The preparation of a manual (or many manuals) is a clear objective of CRSP. Draft parts of such manuals are already available as working papers but more effort will be needed in the last two years of the program.

d. Preparation of computer based methodologies: The computer programs and support material (user guides, test data sets, commented solved examples, suggestions for validations, help screens, etc.) are an important way to increase the general applicability of the CRSP products. The CRSP participants are obviously very conscious of this

fact and a major effort has been made to generate a very large number of computer programmes (CANOFISH, AGECOMP, PC Fish, REPSiM, FSAS, TACO, LCAN, and CASA to name but a few). These programs span across the whole domain of stock assessment. They are not yet fully operational and ready to be delivered. Efforts are still needed on the documentation and the user interfaces. Some of these programs are close to final completion (FSAS and PC Fish for instance). Others will be improved and are very likely to be available by the end of the first five years of the project (AGECOMP, LCAN, REPSIM and possibly CASA, for example). The more complicated nature of the expert system (CANOFISH) leads the EEP to believe it is unlikely that an operational version (suitable to stand alone in support of research and management decisions for a wide scope of situations encountered in developing countries) will be completed during the first five years of research.

e. Development of Regional Centers of Excellence: Host countries are already operating as regional centers of excellence and providing advice and training to scientists from the sub region (S.E. Asia; Central and Latin America). This role should be formalized.

E. Institutional Impact

The CRSP should contribute to strengthening the host countries' fisheries research institutions. Because of the budget limitations this is difficult, but there is some progress. The existence of CRSP has attracted very capable scientists of the host countries to work on fisheries problems. This has reinforced the scientific strength of the respective institutions.

CRSP has provided limited, but much needed, equipment such as computers and microscopes.

CRSP has promoted collaboration between local institutions, universities and fisheries departments in both of the host countries. It has contributed significantly to the development of a field station at Bolinao (Philippines) and field programs.

CRSP has contributed to the buildup of a data base on which fishery research can be done. This should lead to better management.

In both host countries CRSP has contributed to the development of a capacity to act as Regional Centers of Excellence, and to provide training to other countries.

F. Overall Program Management

The Fisheries Stock Assessment CRSP, by design, consists of three related but separate components being carried out by three principal U.S. universities with the cooperation of host country counterparts. The responsibility for coordination rest on the Board, Technical Committee, the Management Entity, and, to a lesser extent, AID, and coordination has been difficult. In essence, the three components have been only loosely coordinated. At the outset of the review, the EEP had some concern about this situation but, upon reflection, the EEP has concluded that, under the circumstances, it has been productive. It has allowed for creativity with some of the activities being highly academic and others more practical. The balance is appropriate.

Building and strengthening institutions at both the University of Costa Rica and University of Philippines have been significant contributions of the CRSP. Young scientists have been trained, materials and equipment have been acquired, libraries have built and there is a sense of "esprit de corps" among staff at both Costa Rica and the Philippines. Whether this momentum can be maintained in a post-CRSP era is an important issue. The EEP believes the answer to this question depends, in part, on the CRSP producing concrete, practical results that will directly benefit the host countries.

The EEP met with host country personnel in both the Philippines and Costa Rica to ascertain the relevance of CRSP to local policies and priorities. Fisheries are an important resource in both instances and host country personnel strongly support CRSP activities.

In Costa Rica, a Fisheries Department staff member is assigned to The University of Costa Rica team and works side by side with University researchers. He described the importance of fish in the Costa Rican economy and also some of the problems limiting production; e.g., aquatic pollution in the Gulf of Nicoya. He pointed out that the data base now being established with the assistance of the CRSP will allow the Costa Rica government to monitor more carefully the problems in the Gulf and manage the fishery resources.

In the Philippines, the Fisheries Department (BFAR) had been recently transferred to the Ministry of Agriculture. Policies, staffing and programs are in a state of flux, but government officials strongly support CRSP research underway in the University's College of Fisheries and the Marine Science Institute. Aquatic pollution, overfishing, and blasting are key problems in the Philippines which officials recognize and hope to

control with the information and data being generated by CRSP researchers.

The EEP met with AID mission personnel in Costa Rica and the Philippines. In both instances, Agriculture and Rural Development staff are responsible for backstopping CRSP activities. While we found recognition of the importance of the fisheries resources and support for the CRSP, in neither case was fishery activities a part of the Mission's current portfolio nor its long term planning (CDSS). USAID/Costa Rica offers a small amount of travel funding as an indication of its support for the CRSP in principle. Other vehicles for support are under consideration. USAID/Philippines were interested in some local support but could make no commitments because of the likelihood of a major change in senior Mission staff.

V. RECOMMENDATIONS

Specific recommendations for each project are made in Section III. In this section the EEP makes some general recommendations that apply to the overall direction of the Program in the future.

A. Communication, Coordination, Strategic Planning

The EEP is concerned about these aspects of the program. Many of the researchers involved in the CRSP expressed concern that there is insufficient opportunity for communication. Although each of the three principal US universities were able to give an overview of how their research fits together, the EEP was not given a substantive description of the overall coordination and strategic plan for the program. It is noteworthy that the EEP prepared its own diagram of interactions (Figure 1).

The source of the problem is two fold: 1) the stock assessment CRSP was put together from two proposals that had divergent approaches, and 2) travel funding has always been too limited to overcome some of the problems that were inevitable as a result of the decision to merge the two proposals.

It should be noted that the diversity in approaches that makes coordination and strategic planning difficult is also one of the greatest strengths of the program. It has resulted in a high level of innovation and productivity. Therefore, the EEP does not recommend coordination as an end in itself (which too often happens). But it does recommend that a strategic plan be developed (at a minimum Figure 1 should be prepared by the CRSP researchers, not the EEP) to identify the interrelationship of components of the CRSP.

The EEP also believes that communication among CRSP researchers should be improved. Part of the benefit of having diversity of scientific approaches is lost if there is no opportunity for constructive scientific dialogue and debate between the proponents of each approach. There are four important vehicles for communication: proposals and work plans, working papers, meetings, and site visits. The EEP recommends that:

1. Proposals and work plans be more detailed. This will allow CRSP researchers to know what approaches are being used throughout the program;

2. The working paper series be used to a greater extent to communicate work in progress;

3. An annual meeting to discuss research be held. The goal should be to improve scientific exchange and technical discussion among researchers below the level of the principal investigator;

4. There be more opportunities for site visits by individuals to allow closer cooperation or critical debate between researchers.

B. Recommendations On Transferable Outputs

Some routine (and important) outputs of the project will be:

(a) Increased competence of US and host country scientists on developing countries fisheries research problems;

(b) Scientific papers and communications to symposia;

(c) Computerized data bases on artisanal multispecies fisheries.

However, to ensure long lasting benefit from the program, the EEP recommends steps to ensure the production at the end of the first five years of:

(a) Adequate documentation on the national data bases and the software needed for their utilization.

(b) Specific manuals on particular aspects of tropical fisheries research such as: aging, analysis of multispecies resources, length frequency simulation and analysis, optimization of sampling programs, systems approach to fisheries management, hydroacoustic resource evaluation in shallow water systems, etc.

(c) Relevant software for fisheries analyses. This software should be integrated with the specific manuals and include a user guide. It should have a user-friendly interface, contain solved and commented examples, and suggested validation procedures. It should not be protected (i.e., copywrited), to allow free, rapid distribution of the information.

(d) An introductory book on stock assessment methods for developing countries. It is clear from the volume of results and the diverse approaches followed by the various components of the CRSP, that a single manual is not appropriate. However, if a series of manuals and software are produced (see c above), there is a need to put all these outputs in perspective within the overall CRSP program and stock assessment research in general.

The introductory book (referred to as a "keystone" book during EEP discussion) should give a panoramic view of developing country fisheries research issues, leading the readers to essential literature, and introducing them to the various families of methods and software available, including, but not limited to the ones produced by CRSP.

In order to unify CRSP outputs and increase their visibility, the volumes corresponding to points c and d could be prepared as a series with consistent presentation, volume I being the Introductory Book.

If these outputs have to be available at the end of the first five years (even provisional versions, but ready for distribution) their preparation must start immediately. In particular there should be an outline of the Introductory Book. Writing and editorial assignments need to be made. This is necessary to ensure that the book will be an integrated product and not a mere overlay of non-matching chapters.

Plans need to be made for publication, which may be costly. There might be an option to locate an outside (of the CRSP and AID) publisher.

So far, this section of the EEP report has discussed tangible outputs of the ME. But, there are important intangible outputs that result from interaction between scientists.

The EEP recommends that appropriate budget resources be allocated to develop direct contacts between scientists. These contacts are needed at various levels:

a) Between Principal Investigators, to increase coordination and synergetic effects;

b) Between Philippines and Costa Rica scientists to ensure cross-fecundation between the two field programs; and

c) Between all the CRSP scientists, for instance by participation in relevant symposia.

Full time presence of a URI CRSP scientist in the field has been very productive in the Philippines. Such presence may not be required in Costa Rica but more opportunities should be given to U.S. experts to travel to the field and also to host country scientists to work with their U.S. counterparts. This would foster collaboration and is particularly important when U.S. and host country research groups are following parallel but sufficiently distinct research groups and the risk of non communication is higher.

C. Budget

Funding for the Fisheries Stock Assessment CRSP in early planning stage was envisioned at about $3 million per annum; just before contracts were signed it was reduced to close to $1 million; and now it has been reduced to around $700 thousand per year. This situation has caused considerable uncertainty among the cooperating universities, LDC counterparts and personnel involved. It has involved reduction and elimination of some of the activities planned.

Has the budget been adequate? It seems clear that it is not adequate to fulfill the scope of what was originally proposed. The EEP recommends that a further narrowing of the scope be considered unless additional funding is possible.

When there have been budget cuts in the past, the Board made the decision to reduce all projects proportionately. This may have been a wise decision under the circumstances, but in any extension the EEP recommends more complete analyses.

The EEP recommends allocating more funds to travel, particularly for PI's and senior researchers in order to achieve better communication, coordination, and collaboration, especially as the CRSP moves toward more practical and applied activities.

The EEP believe that new budgetary allocations should be based on the new strategic plan discussed elsewhere in this report.

D. Three Year Extension

The University of Maryland and University of Rhode Island components of the Fisheries Stock Assessment CRSP propose to continue the research approaches of the first five years. The University of Washington proposes to compress its program into two components, reflecting progress anticipated from the first five years. The two components will be as follows: a) Management and Stock Assessment Sampling and b) Recruitment and Productivity. The hydroacoustics component will receive less effort, reflecting the progress in the first five years. The resources will be reprogrammed into the Management and Stock Assessment Sampling project. The development of a management strategy and understanding of fisheries productivity in a tropical estuary, in a more generalized context than the Gulf of Nicoya, will receive increased focus because of the scientific depth of the subjects and the potential value of new results.

The proposal for a three year extension is very general at this time, as might be expected. It is difficult to be specific

about what to do next before completing the work at hand (i.e., the first five years).

The EEP agrees with continuing some of the research avenues that are underway now. In some cases the value of the research will be very much enhanced by establishing time series of observations (e.g., Multispecies Field Studies in the Philippines). But the EEP also feels that after five years of research it will be time to pursue some new avenues. The proposal to develop a METASYSTEM might be one example of a profitable new avenue of research, although development of the system will begin during the initial five years of work.

The EEP is generally supportive of the University of Washington's proposal to consolidate its work, to make it even more relevant to management, and at the same time strengthen assessment methods by putting them in an ecological context. But the EEP cautions that it is important to maintain a clear distinction between assessments and the formulation of management policy, and fisheries management itself. It also feels it is important that ecological studies be clearly focused on information needs to improve assessments. Long term field studies of recruitment processes are probably too expensive and risky.

The EEP wonders to what degree host countries were involved in the preparation of proposals for the three year extension. It found little evidence of their participation during its visits to the host countries.

The EEP <u>recommends</u> that a three year extension be funded contingent upon development of a more specific research proposal. The proposal should be developed by both host country and U.S. universities. It should be detailed enough to allow a constructive scientific discussion <u>between</u> the researchers in the various components of the CRSP, as well as <u>within</u> the components. The permanent members of the EEP should also participate in the discussion.

E. Concluding Remarks

The EEP commends AID for its support of research which is a long term investment in rational utilization of valuable fishery resources of developing countries. In spite of various criticisms of the Fisheries Stock Assessment CRSP that are contained in this report, the EEP strongly supports the program and recommends its continuation. Additional funding would be money well spent.

ACKNOWLEDGEMENT

The EEP thanks Fisheries Stock Assessment CRSP participants for their cooperation and hospitality during the site visits. The University of Washington provided much needed support during the two days of report preparation. Special thanks to Katherine Peterson for typing the first draft of the report and to Patti Nitowitz and Sarah Dooling for preparing the final version.

VI. Appendix

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Appendix 1. Triennial Review Scope of Work

Triennial Review Scope of Work

I. Criteria for Project Reviews
II. Criteria for Program Review

I. Criteria for Project Reviews: (one review for each of eight projects)

A. Scientific and Technical Issues:

What progress has been made and what problems have been met in relation to specific project objectives and expected outputs, as set forth in the specific project plans? Address the following issues:

1. The scientific relevance of the project to the global research program? The contribution to the program goals?
2. The quality of the scientific work and accomplishments to date?
3. The consistency with the work plan specifications?
4. The acceptability and timeliness of the rate of progress?

B. Logistic and Administrative Issues:

1. What is the status of the collaboration and cooperation among the U.S. and host country researchers?
2. What is the status of the collaboration and cooperation among the principal U.S. institution researchers and the (non-host country) sub-subcontractor researchers?
3. Is the dissemination of data, research findings, and other information (e.g., to other CRSP researchers, to the general fisheries management research community, etc.) satisfactory?
4. Is the planning process and management of the project satisfactory?
5. Is the project satisfactorily funded? Is the host country funding adequate?

C. Recommendations:

1. Should the project be continued, continued with specific modifications in objectives, approaches, funding, or management, or discontinued?

II. Criteria for the Program Review:

A. Scientific and Technical Issues:

1. Is the program achieving its goals?
2. Are the scientific and technical coordination and interactions among the projects, institutions, and program participants satisfactory? (E.g., Are data, information, research plans, and scientific output being exchanged routinely and in a timely fashion?)
3. Are the scientific efforts being appropriately integrated into a comprehensive program, consistent with the program proposal, as exhibited in the development of project work plans, in the research plan implementation, etc.?
4. Are the potential contributions of the program to U.S. and LDC fisheries management ample and sufficient?

B. Logistic and Administrative Issues:

1. What is the status of each of the following:
   a. The relationships among U.S. and host country participants, e.g., in collaborative research, in training activities, and in institution building activities?
   b. The relationship between CRSP participants (U.S. and host country) and USAID Mission staff?
   c. The relationship of CRSP participants (U.S. and host country) and representatives of other in country programs and projects?
   d. The relationship between the project personnel and the program management (e.g., Management Entity, Board of Institutional Representatives, Technical Committee, and the AID Project Manager).
2. Are the following CRSP management institutions effectively serving programmatic needs:
   a. The Management Entity?
   b. The Board of Institutional Representatives?
   c. The Technical Committee?
   d. The AID Project Manager?
3. Is the reporting to the Management Entity and to USAID satisfactory?
4. Is the program funded adequately to attain its objectives in a timely manner consistent with the program proposal and project work plans?

C. Recommendations:

1. Is the CRSP making reasonable progress toward meeting its initial objectives within the initial five year grant period?
2. Are there suggested modifications for the program (e.g., regarding research objectives, the structure of the research projects, funding for specific activities or institutions, management issues, etc.) for the remaining two years of the initial grant period?
3. Should the CRSP be extended for an additional three years beyond the initial five year grant period?

Appendix 2. Triennial Review Site Visit Schedule

Fisheries Stock Assessment CRSP
Triennial Review Meeting and Site Visit Schedule

June 16	Meeting with AID and BIFAD, 9:00 a.m. - 5:00 p.m., in USA Today Building, Room 1600A, 1100 Wilson Blvd., Rosslyn, Virginia (at corner of Lynn Street and Wilson Blvd., across from AID/S&T office; near Rosslyn Metro stop).
June 17	Meeting with CRSP Board, Technical Committee, and Program Director, 9:00 a.m. - 5:00 p.m., in USA Today Building.
June 20	Site visit at UMCEES, including UMiami representative. (Davis, Garcia, Sissenwine, Neal, Trott, Rowntree)
June 21	Site visit at URI. (Garcia, Sissenwine, Neal, Rowntree)
June 23-26	Site visit at UCR. (Garcia, Sissenwine, Rowntree)
June 23-25	Site visit at UP, including ICLARM representative. (Davis, Tyler, Trott)
June 28	Site visit at UW. (Davis Garcia, Sissenwine, Tyler, Trott, Rowntree)
June 29-30	Meeting of review team in Seattle, WA to discuss evaluation and draft report.

LIST OF PARTICIPANTS
STOCK ASSESSMENT CRSP MEETINGS
JUNE 16-17, 1988

Management Entity

Dr. John Rowntree, University of Maryland

Board of Directors

Dr. Gerald Donovan, Chair, University of Rhode Island
Dr. Spiros Constantinides, University of Rhode Island
Dr. Kenneth Tenore, University of Maryland
Dr. Robert Stickney, University of Washington

Technical Committee

Dr. Brian Rothschild, University of Maryland
Dr. Vincent Gallucci, University of Washington
Dr. Saul Saila, University of Rhode Island
Dr. Efran Flores, University of the Philippines
Dr. Manuel Murillo, University of Costa Rica
(likely to be absent, due to illness)

External Evaluation Team

Dr. Michael Sissenwine, National Marine Fisheries Service, Woods Hole, Massachusetts
Dr. Albert Tyler, Nanaimo Biological Laboratory, British Colombia, Canada
Dr. Serge Garcia, FAO, Rome, Italy
Dr. Halan Davis, IICA, San Jose, Costa Rica

Administrative Management Review Team

Dr. Richard Neal, AID/S&T/AGR, Chair
Dr. John Stoval , BIFAD

Agency for International Development

Mr. David Bathrick, Director, Office of Agriculture
Dr. Tejpal Gill, Chief, Renewable Natural Resources, Office of Agriculture
Dr. Lamarr Trott, Senior Fisheries Advisor, S&T/AGR/RNR

June 8, 1988

STOCK ASSESSMENT CRSP
WASHINGTON, D.C. REVIEW/MEETING SCHEDULE

The following schedule details meetings to take place in Washington, D.C. during the CRSP triennial review.

Participants	Meeting	Room	Time
Thursday, June 16, 1988			
AID/ BIFAD EEP/ME	Welcome, Orientation	1600A	9:00-10:30
ME, Neal, Stovall	Management Review	420 SA-18	10:30-12:00
EEP, Trott	Scope of Work Review	1600A	10:30-12:00
All	LUNCH		12:00-1:30
EEP, Rowntree	Review with ME	1600A	1:30-2:30
EEP, Trott	Outline, assign tasks	1600A	2:30-4:30
	EVENING FREE OR DINNER TOGETHER		
Friday, June 17, 1988			
All	Welcome ME and TC Presentations	1600A	9:00-11:30
Board, ME	LUNCH at State Cafeteria		12:00-1:00
All others	LUNCH		12:00-1:00
Board, ME	Meeti g with N. Brady	4942NS	1:00-2 00
EEP, TC, AID	Questions on Presentations	1600A	1:00-2:30
EEP, Board	EEP Review	1600A	2:30-3:30
AID, BIFAD, TC	Management Review	1600B	2:30-3:30
EEP, TC	EEP Review	1600A	3:30-4:30
AID, BIFAD, Board	Management Review	1600B	3:30-4:30
Board, TC, EEP	Separate Meetings as Needed	1600A, 1600B	4:30-5:00

AID (S&T/AGR) = Neal, Trott; welcomes by Bathrick
BIFAD = Stovall
ME (Management Entity - University of Maryland) = Rowntree
Board = Donovan, Constantinides, Stickney, Tenore
TC (Technical Committee) = Rothschild, Gallucci, Saila, Flores, Murillo
EEP (External Evaluation Panel) = Garcia, Davis, Tyler, Sissenwine

LBT, AID/S&T/AGR

AGENDA FOR JUNE 20 TRIENNIAL REVIEW MEETING, SOLOMONS, MD

Meeting Location: Solomons Island Yacht Club

9:00-9:15 Introductory Remarks (5-10 min. each)

John Rowntree
Ken Tenore

9:15-10:00 Presentations of Accomplishments

Brian Rothschild - Fishery Management Systems.

10:00-10:10 Coffee Break

10:10-12:00 Presentations of Accomplishments

Cluney Stagg - CANOFISH: An Expert System for Fishery Management. (30 min.)

Bill Fox - Tropical and Multispecies Stock Assessment Techniques. (40 min.)

Bruce Golden - A Density Dependent Model for Prediction of Adult Population Size in Fisheries Management. (40 min.)

12:00-1:30 Lunch

1:30-3:00 Presentations of Accomplishments

Lee [illegible] and Chris [illegible] - Development of the Fish-as-a-Mine Model. (40 min.)

Ed Wasil - Innovative Applications of the Analytical Hierarchy Process (AHP). (15 min.)

Gerard DiNardo and Doug Levy - Applications of AHP to Fisheries Management. (15 min.)

Steve Smith and Cluney Stagg - The Beginnings of Metasystem Development for Stock Assessment. (10 min.)

Ai-Ling Chai - Applications of Time-Series Analysis to Fisheries Stock Assessment. (5 min.)

3:00-3:10 Coffee Break

3:10-3:30 Future Research, Years 4-8

Brian Rothschild

3:30-5:00 Discussion with Review Team

The University of Rhode Island, Kingston, RI 02881-0804, USA
International Center for Marine Resource Development: ICMRD
126 Woodward Hall

ITINERARY

FISHERIES STOCK ASSESSMENT CRSP
TRIENNIAL REVIEW TEAM

Dr. Serge Garcia, Food and Agriculture Organization, Rome
Dr. Michael Sissenwine, National Marine Fisheries Service, Woods Hole, MA
Dr. Richard Neal, U.S. Agency for International Development, Washington, DC
Dr. John Rowntree, University of Maryland, College Park, MD

June 20 - 22, 1988

Monday, June 20

9:59 pm - Pickup of Review Team at airport by Dr. Donald McCreight (ETA Piedmont, Flight No. FY 90.

- Register at Dutch Inn, Galilee

Tuesday, June 21

8:00 am - Pick up of Review Team at Dutch Inn by Dr. Donald McCreight.

8:30 am - Breakfast meeting at the University Club. Introductory remarks to the CRSP review team by URI President, Dr. Edward D. Eddy. Everyone invited.

9:30 am -12 noon - Presentations of URI CRSP Activities & Plans
URI Main campus, Library, Conference Room A.

. Overview of the day's activities by Dr. Spiros Constantinides, Deputy Director, International Center for Marine Resource Development.

. Opening remarks by Dr. Gerald Donovan, Dean, College of Resource Development and Director, International Center for Marine Resource Development.

Review of CRSP guidelines and objectives and highlights of URI - CRSP accomplishments and activities by Dr. Donald McCreight.

Technical accomplishments, current efforts and future plans of the Empirical Modeling & Analysis Project and Multispecies Field Studies Project by Dr. Saul Saila, Principal Investigator, Professor, Graduate School of Oceanography & Department of Zoology.

Demonstration of the Fishery Science Application System by Dr. Conrad Reckseik, Associate Investigator, Associate Professor, Department of Fisheries, Animal and Veterinary Science.

Cable Address: RIMARDEC Telex: 6974611RI ICMRD Telephone: 401-792-2479/2997 MCI 244-1258

ITINERARY (Cont'd)
FISHERIES STOCK ASSESSMENT CRSP
TRIENNIAL REVIEW TEAM

June 20 - 22, 1988

Tuesday, June 21 (Con'd)

. Video presentation of Dr. John McManus, Associate Investigator (on-site URI Scientist Philippines) Professor, Department of Fisheries, Animal and Veterinary Science on Multispecies Field Studies Project in the Philippines.

. Discussion of gillnet selectivity studies by Karim Erzini, Graduate Research Assistant (Doctoral candidate in Oceanography from Morrocco).

. Open Forum: questions and discussion with Review Team.

12:00 noon - 1:00 pm-

Lunch - at The University Club. Review Team, Dr. Saila, Dr. McCreight, Dr. Constantinides.

1:30 pm - Continuation of URI - CRSP Activities and Plans, Narragansett Bay Campus, Graduate School of Oceanography, Challenger Room, Pell Library.

. Introduction to Bay Campus Activities by Dr. Margaret Leinen, Associate Dean, Graduate School of Oceanography.

. Further development of the Markov Empirical Model by Dr. Janet McLeavey, Lecturer, Department of Mathematics.

. Current research plans on Tactical Models (short term forecasts) by Dr. Saul Saila.

. Results of Field Studies in Bolinao, Philippines by former Masters graduate students (Ralph Turingan from UPVCF, Philippines and Alejandro Acosta from Venezuela) by Dr. Conrad Recksiek.

. Extension of work on Simulation Models by Margarida Castro (Doctoral candidate in Oceanography and Master's candidate in Statistics from Portugal).

ITINERARY (Cont'd)
FISHERIES STOCK ASSESSMENT CRSP
TRIENNIAL REVIEW TEAM

June 20 - 22, 1988

Tuesday, June 21 (Con'd)

1:30 pm

. Comments on the benefits of CRSP Philippine activities to UP MSI by Annette Junio (Doctoral Candidate in Zoology & UPMSI Senior Research Assistant).

. Open Forum: Questions and Discussion with Review Team.

5:30 pm - Cocktails and reception for Review Team at the residence of Dr. Spiros Constantinides, Deputy Director, ICMRD. Everyone Invited.

6:15 pm - Dr. Richard Neal, USAID/Washington departs for Washington.

8:00 pm - Dinner at the Spain Restaurant. Review Team, Dr. Saila, Dr. McCreight..

Wednesday, June 22

7:10 am - Departure of Review Team. Dr. Spiros Constantinides will pick up Review Team from the Dutch Inn at 5:40 am.

UNIVERSIDAD DE COSTA RICA
CENTRO DE INVESTIGACION EN CIENCIAS DEL MAR Y LIMNOLOGIA (CIMAR)

AGENDA FOR JUNE 23 FSA/CRSP TRIENNIAL REVIEW MEETING

Meeting location: Vicerrectoría de Investigación

Participants:

a. Dr. John Rowntree, Program Director

b. Dr. Michael Sissenwine, National Marine Fisheries Service, Woods Hole, Massachusets

b. Dr. Serge García, FAO, Rome, Italy.

c. UCR/CIMAR STAFF:

Jorge Campos
Edwin Castro
Juan Bta. Chavarría
Edison De Faria
Ricardo Estrada
Omar Lizano
Eduardo Madrigal
Manuel M. Murillo
Joseph Varilly

09:00-09:30 Introductory Remarks

John Rowntree
Michael Sissenwine

09:30-10:00 Overview of CIMAR activities under the FSA/CRSP

Manuel M. Murillo

10:00-10:15 Coffee Break

10:15-14:15 — Presentation of Accomplishments: CIMAR's Contribution

A) UCR (CIMAR)/UH (CEES) Collaborative research:

i) Multiple Species Fisheries Research.

ii) Economic and Probabilistic Extensions of Standard Fisheries Models:

10:15-10:30	Joseph Varilly
10:30-10:45	Jorge Campos
10:45-11:00	Juan Bta. Chavarría
11:00-11:15	Ricardo Estrada Edison De Faria Edwin Castro

11:15-12:00 — B) UCR (CIMAR)/UW (CQS) Collaborative research:

i) Sampling Catch and Abundance

ii) Age-Size Dependent/Independent Modelling

iii) Age-Size Relationships and Consequences of Errors.

iv) Shallow Water Hydroacoustics:

11:15-11:30	Juan Bta. Chavarría
11:30-11:45	Joseph Varilly
11:45-12:00	Jorge Campos

12:00-14:00 — Lunch

14:00-14:15 — Future Research, Years 4-8

Manuel Murillo

14:15-16:00 — Discussion with Review Team

16:00-17:00 — Visit to CIMAR.

OTHER ACTIVITIES FOR THE REVIEW TEAM:

24 June:

~~13:00~~ 12:30 Meeting with Dr. Primo L. Chavarría, Vicerrector for Research (UCR)

15:00 Visit to AID Mission

25 June

06:00-16:00 Visit to Marine Laboratory at Punta Morales.

ITINERARY

CRSP/PHILIPPINES TRIENNIAL REVIEW PART II

June 23-25, 1988

June 23

7:45 Pick-up at Hotel
8:00 Tour of ICLARM
8:40 Depart for UP
9:20 Arrive College of Science Meeting Room (SLAB)

9:30 Introduction to CRSP Philippines -- E. Gomez
9:35 Show College of Fisheries film on Philippine fisheries
9:50 Coffee break

10:05 Field Project objectives and overview -- J. McManus
10:15 Bolinao fishery status and sampling -- W. Campos
10:30 Community analyses, a first glimpse -- C. Nanola
10:45 Reproduction-recruitment study plans -- A. Del Norte
11:00 Remote Sensing of fish habitats -- P. Roa
11:15 R/C Plane & Stereo analysis system -- B. Garcia
11:30 Thesis study on gleaned communities -- S. de Guzman
11:45 Future work in the Field Project -- J. McManus

12:00 Depart for lunch at ALAVAR
1:45 Return to College of Science meeting room

2:00 College of Fisheries presentations -- S. Formacion
-- G. Silvestre
-- N. Armada

4:00 Coffee break

4:15 Comparative studies S.E. Asia -- J. McManus
4:30 ESP, TACO, SKEWORD, packages -- J. McManus
4 45 Discussion
5:30 Depart for Hotel

June 24

8:00 Pickup at hotel
8:30 Pickup at Coral Building
8:45 Depart for Bolinao
1:00 Lunch at Suasalito, Sual
2:00 Arrive Bolinao
2:30 Boat trip to far side of reef flat
5:30 Return
6:30 Supper at Cascante "Beach Resort"

June 25

6:00 Breakfast at Cascante
6:30 Pickup at Cascante
7:00 Ultralight demo - weather permitting
Open: return to Manila (5 hours)

SITE REVIEW - AGENDA
Location - MSB 123
28 June 1988

INTRODUCTION

	9:00	Introductions - Vincent F. Gallucci Welcome - G. Ross Heath, Dean, College of Ocean and Fisheries Science Comments - John Liston, Chair, Institute for Food Science and U of W Title XII Representative
	9:45	Break, Coffee, discussion, etc.

YEARS 1-5: Past and near future

	10:00	Introduction to the projects, associated students and related research
Component 1	**10:15**	Shallow-water Hydroacoustics, Richard Thorne/ John Hedgepeth
Component 2	**11:00**	Sampling Catch and Abundance, Loveday Conquest/Robert Burr/ Robert Donnelly
	11:45	Lunch, Catered
Component 3	**1:00**	Age and Size Relationships, Han-Lin Lai
Component 4	**1:45**	Age and size Dependent/Independent Modeling, Vincent Gallucci
	2:30	Break, Coffee, discussion, etc.

YEARS 6-7-8: The far future

Component 1	**3:00**	Recruitment and Productivity, Han-Lin Lai plus others
Component 2	**3:30**	Management and Stock Assessment Sampling, Vincent Gallucci plus others
	4:00	Review and Questions
	4:30	END OF PRESENTATIONS
	4:30-5:00	Closed Meeting of Board Member, Technical Committee Member, AID Representative, ME and EEP.
	6:00	Dinner, Faculty Club

Appendix 3. External Evaluation Panel Reports

Title XII Collaborative Research Support Program
Fisheries Stock Assessment

TRIP REPORT

Traveler: Dr. Albert V. Tyler, EEP member

Institutional Affiliation: Pacific Biological Station
Canada Department of Fisheries and Oceans

Dates of Travel: February 2 - 7, 1988

Trip Origin and Destination: Nanaimo, B.C., Canada to San Jose, Costa Rica

Itinerary:

February 2. Arrive in San Jose, Costa Rica

February 3. Morning. Met with Principal Investigators, Program Director, and AID representative on UCR campus to discuss coordination issues of the Fisheries Stock Assessment Program.
Afternoon. Continued the meeting with the Principal Investigators on the next part of the agenda: An overview of research being carried out at each institution.

February 4. Morning. Continued meeting to finish the overview of research.
Afternoon. The meeting reconvened at CIMAR on the UCR campus. At this point Associate Investigators and graduate students of UCR joined the group and gave a somewhat more detailed presentation of the work that they were engaged in. Their presentations involved not only the research supported by the CRSP, but also related work supported from other sources.

February 5. Day trip to UCR marine laboratory on the Gulf of Nicoya, led by Dr. Murillo. Most of the day was spent on CIMAR's small research boat, observing the artisanal fishery, and the ports of landing.

February 6. Time was spent in familiarization with San Jose, and ecological features of lands to the east, led by Dr. Murillo.

February 7. Depart San Jose for home.

Brief Description of Accomplishments:

I have met all of the Principal Investigators in relation to other programs, and so it was a pleasure to sit down with this group of fishery scientists and discuss a research program in common. I was impressd with the innovations being applied to the Costa Rican and Philippine fishery situations under study.

My time spent with the CIMAR group convinced me that important work was being done by those scientists and students. CIMAR and the Costa Rica Fisheries Agency are already in a good position to carry out meaningful stock assessment work, and so I feel confident that the legacy generated by the CRSP research will be well used.

As a result of the meeting I now have a good grasp of the directions and goals of the research being conducted by each institution represented at the table. Unfortunately, Dr. Anderson was not able to be present, but I am sure I shall be able to catch up on his research at a later time. My familiarization tour with the fishery was valuable and will be of general assistance in my participation in the Triennial Review.

Comments on Travel Arrangements:

Travel arrangements were made in an efficient manner. Accomodations were comfortable and clean, though not as attractive as might be. The breakfast menu at the Apartotel Yose was unfortunately limited to one choice - eggs, fried or scrambled. It was useful to be close to the University, but not necessary since there were always two or more who could have shared a taxi to start out in the morning. A member of CIMAR sometimes took us home, thus savings could have been made on transportation even if a hotel a little farther from the University were used.

Signature:

Albert V. Tyler

FISHERIES STOCK ASSESSMENT CRSP

REPORT ON COORDINATION ISSUES
Meeting held at CIMAR, University of Costa Rica,
February 3, 4 1988

A. V. TYLER, EEP member

1. Connectivity in the research

As our meeting unfolded, it became clear that the various sub-projects were intrinsically interrelated because of the initial selection of subjects - all revolving around the central theme of new stock assessment methods in multispecies fisheries. Questions that I had regarding coordination arose because some of the project descriptions and work plans were set out as only a sentence or two, and in general terms. I have made some suggestions below regarding communications. As investigators described and discussed their goals and findings during the meeting the ambiguities disappeared.

Many of the research results can be installed, as soon as they are completed, within the Decision Support System (DSS) software being developed by the University of Maryland - University of Miami group; for example the models and fishery data bases. Other subprojects will provide insight on subjects important to multi-species fisheries concerns, but the results may or may not fit directly into the final DSS product. For example, the techniques being developed for age determination, or hydroaccoustic biomass-estimation (U.W.), are themselves important research findings. These findings will not themselves be entered into the DSS, but the result of applying these techniques will be a quantification of age-class structure that will in turn be handled by the DSS. Also multivariate assemblage analyses being conducted with data on Indonesian or Gulf of Thailand fisheries (U.R.I.) will not be entered as such in the DSS, but will provide important insights on assemblage structure that could lead to a new type of model that would in turn become part of the DSS.

The proposed research is innovative, and is tackling head-on many of the problems of multispecies research. It would be hard to find a better team of scientists to deal with the problem.

2. Coordination by improved communication

Part of the advantage of a large research program is that, by its very nature, it will involve scientists of different backgrounds, and with a variety of

ideas. When individuals of the group interact, a creative process engages automatically, and new shades of understanding emerge that lead to better results. The students involved will find stimulation in the interaction, and because of this will have a higher rate of learning. However, because of the widely separated locations of the participants of this project, additional attention should be given to communications. Not only will better communications lead to synergistic process, but better coordination in the use of findings will result. A few suggestions regarding communications follow.

a. Proposals and workplans.

When I read the proposals and work plans, I sometimes had only a general idea of what the investigators would attempt to accomplish, particularly in some of the modeling tasks. I recommend that investigators be far more specific in their descriptions of objectives. For any one task an additional 3-4 sentences would allow an external reader, another investigator, or student within the program to grasp the perception of the person working on the task. These extra details should apply to the objectives for the year. A breakdown by quarter of the year is generally superfluous, and should be discarded. Principal Investigators have recognized this, and have often filled up the quarterly descriptions with prose that seems to be filler. When a particular event occurs in only a selected quarter, this could be mentioned in the task objectives for the year. Some reorganization in this manner will lead to better understanding and fewer pages.

I also suggest that the student and faculty names be included as a by-line with each sub-project. In this way authors can be more readily associated with the work they are doing. The extent of the work being done by CIMAR was not obvious by reading the proposals. A separate listing of the objectives and results for CIMAR would be helpful.

b. Working papers.

The working papers are at present the main venue for communicating research findings. The annual report is written in part in too abbreviated a manner to convey technical information to a fishery worker , or reviewer, and also it is distributed 6 or more months after the results have been

achieved. On the other hand, some of the working papers carr as much detail as a draft of a primary publication. While thes extensive drafts play an important role, I suggest that some working papers might be written in the future as more of an extended abstract or summary. In this way findings might be released within 1 or 2 months after a significant milestone has been reached. I believe that a project of this complexity and duration can not be thoroughly reviewed, or understood across institutional boundaries if summaries of this sort are not written.

c. An annual meeting for exchange of scientific information.

Because of the natural integration of the research topics, faculty and students stand to develop their ideas further by presenting scientific findings to each other at least once a year. The symposium being planned by the group for the annual meeting of the American Fisheries Society is one way that this function can be carried out. A more informal gathering at one of the campuses, or in a location such as the University of Washington's Friday Harbor Lab, will also serve this function. By holding an annual science workshop on one of the campuses and rotating the meeting among participating Universities, all students and associate investigators will in turn be able to interact with the principal investigators. I believe that scientific exchange on a personal basis among participants in the program is absolutely essential to the development of the research as a cohesive product.

TITLE XII COLLABORATIVE RESEARCH SUPPORT PROGRAM
FISHERIES STOCK ASSESSMENT

TRIP REPORT

Name of Traveler: Michael P. Sissenwine

Institutional Affiliation: Northeast Fisheries Center, Woods Hole, MA

Dates of Travel: March 3-13, 1988

Trip Origin and Destination: Wellington, New Zealand to the Philippines and return.

Brief Description of Accomplishments: The purpose of my visit was to become more familiar with the state of fisheries and related research in the Philippines in general, and with specific activities that are supported (directly or indirectly) by the CRSP. I am satisfied that I achieved my purpose.

The Philippines have a tremendous fishery potential, but inshore areas are already overfished. In spite of the magnitude and importance (as a protein source of an impoverished population) of fisheries, research efforts have been minimal. The CRSP is already making a contribution and it has the potential to contribute more. It is characterized by an enthusiastic team of young scientists with a wide range of skills. They have established a good working relationship with the appropriate marine science community in order to maximize their efforts under severe budget constraints. They have initiated a substantial number of interrelated programs, perhaps more than is realistic. It is not clear how all of the components will fit together, or whether the allocation of effort is correct; e.g. is too much effort be put into censusing of fishing effort and not enough into measuring catch per unit effort? These potential problems reflect inexperience.

Itinerary:

March 3-5. I traveled from Wellington, New Zealand through Sidney, Australia, to Manila, the Philippines. I stopped over in Sidney for an extra day for personal reasons.

March 6. Since it was a Sunday, no formal activity was planned. I spent most of the day reviewing CRSP-related documents. I met with Lamarr Trott who briefed me on the situation in the Philippines and his review of ICLARM which he was just completing. I also met with John Copeland (Australian Centre for International Agricultural Research). He was reviewing ICLARM with Lamarr. Discussions with Dr. Copeland also added to my education about Philippine fisheries.

March 7. The visiting team (i.e. John Rowntree, Lamarr Trott and myself) spent the morning at ICLARM headquarters where Dr. Rowntree and I were given a demonstration of the latest version of ELEFAN. Originally, ELEFAN was a method of analyzing a sequence of fish length frequency data to estimate growth parameters. It was developed by Dan Pauly for application to fast growing tropical fishes which are difficult to "age" by traditional methods. Since then, ELEFAN has grown into a package of stock assessment programs. The programming is excellent, it is user-friendly, and the graphic output is impressive. ELEFAN is widely used in developing countries, partially because of the positive influence of Dan Pauly and ICLARM. Its widespread application attests to its value. But it should be noted that ELEFAN is an ad hoc method without mathematical or statistical foundation. Since there are rigorous statistically based methods available, it seems to me that the main attraction of ELEFAN is that it is user-friendly. But this doesn't mean that users understand it. I discussed ELEFAN with ICLARM's scientific programmer. It became apparent that the program sometimes needs to be tricked into using a different smoothing function (i.e. running averages) of the original data, but typical users wouldn't even realize that this was occurring.

The afternoon of March 7 was spent at the University of Philippines Diliman Campus. After lunch we toured the Marine Science Institute (MSI) and the College of Fisheries. The existing facilities have inadequate space, and as a result the CRSP is squeezed into one room. But MSI has a new building almost complete on the Diliman Campus. The College of Fisheries will move to a new campus near Iloilo.

Following the tour we were briefed by CRSP participants on what they are doing. The activities range from traditional population modeling to remote sensing to development of classification algorithms.

The review was informative. Geronimo Silvestre reviewed the application of traditional assessment models (dynamic pool and surplus production) to demersal resources of the Philippines. He showed that the optimum mesh size for the multispecies demersal fishery depended on whether or not mesh selection was modeled as "knife edge" or "sigmoid".

Nygiel Armada reviewed an ambitious list of future studies to be undertaken by the College of Fisheries. These studies included further compilation and analysis of existing fisheries data, analysis of length frequency data, literature reviews in order to compile growth parameters for Philippine species, possible application of virtual population analysis, food web studies, and the preparation of several manuscripts. There was also some discussion of possible approaches to studying the effects of blast fishing.

Wilfredo Campo described sampling of the Bolinao fishery. There are seven types of gears. The CRSP is attempting to measure catch per unit effort from each. He also described fishery independent surveys which used encircling nets at 12 sites and visual censuses at 18 transects.

Annabelle Del Norte reviewed her work on the annual cycles of spawning and settlement. At one time it had been presumed that spawning was continuous in the tropics. Analysis of length frequency samples indicate that one or two distinct cohorts are produced each year. These cohorts could result from seasonal patterns in survival rate, or seasonal periods of spawning. Preliminary analysis of Del Norte's results indicate the latter.

Rubin Garcia reviewed efforts to develop a remote controlled aircraft to carry a camera in order to photographically survey coral reefs. He has made significant progress, but there are a number of problems and issues still to be resolved.

John McManus reviewed the use of an ultra-light aircraft to survey fishing effort and reef habitat. He is convinced that the method is unsurpassed in terms of the amount and quality of data that can be collected. But there are a number of practical considerations such as safety and reliability. In addition, its unclear what questions are actually being addressed by aerial data collection methods (e.g. the ultra-light or remote controlled airplanes).

Dr. McManus also addressed several other topics including classification algorithms for multispecies fisheries, comparisons of Southeast Asia demersal fish communities, computer packages, and joint programs.

March 8. The review team and several members of the CRSP traveled to Bolinao. It was informative to drive through the town in order to gain some appreciation of population density and standard of living. The obvious overfishing (at least in a growth sense) of the coral reefs in the vicinity of Bolinao is understandable in light of population density and economic conditions.

Once in Bolinao, we toured the Marine Science Institute's laboratory. The laboratory is only partially complete. It is well-located for ongoing studies of the coral reefs.

We spent the late afternoon touring the reefs by boat. It was an opportunity to observe experimental areas that are being used for seaweed and giant clam culture. We spent a brief period diving on the reef. The small size of fish on the reef (relative to reefs I am familiar with elsewhere) was striking evidence of the level of fishing intensity.

March 9. We spent the morning touring by boat, in the vicinity of the One Hundred Islands area. This estuarine environment is congested with fish traps.

Most of the afternoon was spent traveling back to Manila. Upon our return, we met with Geronimo Silvestre and Nygiel Armada and others from the College of Fisheries for further discussion of CRSP assessment activity. This informal discussion proved to be most useful. I raised a number of concerns about the potential misinterpretation of the economic analysis of the Philippine demersal fishery. We discussed several possible refinements of the multispecies mesh size optimization analysis. And we considered alternative approaches to studying blast fishing.

March 10. We traveled from Manila to Iloilo. We made a courtesy visit with the Chancellor of the University of the Philippines at the Visayas, Rogelio Juliano. We then proceeded by road to the Southeast Asia Fisheries Development Centre which is a short distance from Iloilo. The Centre is supported by a regional treaty with Thailand, the Philippines, Malaysia, and Japan as sponsoring members. There are four research stations in the Philippines with a total of 600 personnel.

Our next stop was at the new campus of the University of the Philippines in the Visayas. The new campus is about a 45 minute drive from Iloilo. It is essentially uninhabited. We were given a tour of various laboratory buildings and the library. The physical plant is nearly complete. The plan is for the College of Fisheries to move to the new campus within a few months. It should be noted that this plan has been postponed several times before. While the physical plan is impressive, and there is a substantial amount of equipment available, the University faces a serious problem in having sufficient funds to maintain the new campus.

March 11. We had a morning meeting with Dr. Sonja Formacion. She is a UPV statistician associated with the CRSP. We discussed a wide range of issues related to stochastic problems in fisheries science. In particular, I provided her with some immediate feed-back concerning her study "on the statistical distribution of the largest lengths of fish". We also discussed problems of sampling contagiously distributed random variables (such as coral reefs). I suggested the possibility of using an "encounter-response" strategy. I also suggested that CRSP scientists review the literature on the statistical design of hydro-acoustic surveys.

At mid-day we traveled from Iloilo back to Manila. Late in the afternoon we met with Robert Resseguie of the Agriculture Division, Office of Rural and Agricultural Development, of the AID mission in the Philippines. The discussions were wide-ranging. Most importantly, it is clear that Mr. Resseguie is sympathetic towards the goals of the CRSP and recognizes the importance of AID supporting more fisheries related projects in the future.

March 12. We had an informal meeting with Dr. McManus and Dr. Gomez (Director of the Marine Science Institute) to recap events of the week. I departed Manila later that day and arrived back at my temporary home in Wellington late in the afternoon the following day (March 13).

Appendix 4. USAID/Manila Mission Statement on the CRSP

ACTION COPY

Department of State

INCOMING TELEGRAM

PAGE 01 MANILA 16660 260238Z 5405 058225 AID0501 MANILA 16660 260238Z 5405 058225 AID0

ACTION AID-00

ACTION OFFICE ST/AG-02

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FM AMEMBASSY MANILA

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FOR L. TROTT, ST/AGR

E.O. 12356: N/A

SUBJECT: TRAVEL CONCURRENCE - FISHERIES STOCK ASSESSMENT CRSP

REF: STATE 160639

1. USAID/MANILA CONCURS WITH PROPOSED VISIT OF FSA REVIEW TEAM AS PROPOSED IN PARA 2 OF REFTEL.

2. MISSION COMMENTS ON CRSP PROGRESS AS FOLLOWS:

A. VALUE TO HOST COUNTRY

ONLY THE FSA CRSP PROVIDES GOP RESEARCH INSTITUTIONS WITH CONTINUING RESEARCH ON FSA METHODOLOGIES AS INPUT TO DESIGN AND IMPLEMENTATION OF FISHERY RESOURCE MANAGEMENT POLICIES AND LEGISLATION. NO OTHER ACTIVITY EXISTS OR IS PLANNED IN THE NEAR/INTERMEDIATE FUTURE. GOP VIEWS FSA AS AN IMPORTANT ACTIVITY FOR FUTURE FISHERIES DEVELOPMENT.

B. EFFECTIVENESS OF COLLABORATION

STRONG PROFESSIONAL LINKAGES/INFORMATION EXCHANGE AMONG URI, UPVCF, AND UP-MSI RESEARCHERS EXIST. MOREOVER, CRSP ACTIVITIES HAVE FOSTERED DIRECT/INDIRECT COLLABORATION AMONG GOP INSTITUTIONS, E.G., UPVCF, UP-MSI, AND BFAR.

C. PERCEIVED VALUE OF CRSP IN GENERAL

ASIDE FROM ESTABLISHING A STRONG RESEARCH BASE, GOP FISHERY SCIENTISTS AND RESOURCE PLANNERS PARTICIPATE IN CRSP ACTIVITIES AS FORUM FOR INFORMATION/TECHNOLOGY EXCHANGE, PARTICULARLY FOR CRSP STUDIES WHICH ARE APPLICABLE FOR POLICY FORMULATION.

D. PROBLEMS ENCOUNTERED

MISSION UNABLE TO CITE SPECIFIC CASES BUT BELIEVE REDUCED LEVEL OF FUNDING FOR FIELD ACTIVITIES MAY HAMPER CRSP RESEARCH OBJECTIVES, GIVEN HIGH EXPECTATIONS OF GOP SCIENTISTS AND OTHER USERS OF CRSP FINDINGS.

E. SUGGESTIONS/RECOMMENDATIONS AND CONSIDERATIONS OF MISSION BUY-INS

MISSION UNABLE TO MAKE STATEMENTS AT THIS TIME BUT WILL DISCUSS POSSIBILITIES WITH REVIEW TEAM UPON ARRIVAL.

PLATT