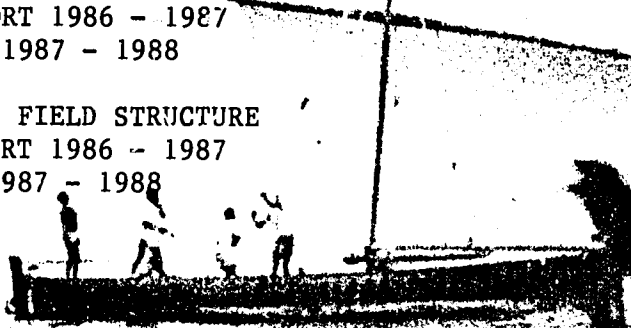


ADWAB 113

FISHERIES STOCK ASSESSMENT
TITLE XII
COLLABORATIVE RESEARCH SUPPORT PROGRAM

EMPIRICAL ANALYSIS AND MODELING
ANNUAL REPORT 1986 - 1987
WORK PLAN 1987 - 1988

MULTISPECIES FIELD STRUCTURE
ANNUAL REPORT 1986 - 1987
WORK PLAN 1987 - 1988



ICMRD



**INTERNATIONAL CENTER FOR
MARINE RESOURCE DEVELOPMENT**

126 WOODWARD HALL UNIVERSITY OF RHODE ISLAND
KINGSTON, RI 02881 USA

July 20, 1987

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The Fisheries Stock Assessment CRSP (sponsored in part by USAID Grant No. DAN-4146-G-SS-5071-00) is intended to support collaborative research between U.S. and developing countries' universities and institutions on fisheries stock assessment and management strategies.

These Reports have been produced by the University of Rhode Island research component in collaboration with the University of the Philippines and in association with the International Center for Living Aquatic Resources Management. Additional copies are available upon request.

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ANNUAL REPORT 1986 - 1987

Project Name: EMPIRICAL ANALYSES AND MODELING

Host Country: Philippines

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

Host Country Principal Investigator: Dr. Sonia S. Formacion (UPVCF)

Host Country Associate Investigators:

ICLARM:

Dr. Daniel Pauly Senior Scientist

UPVCF:

Prof. Geronimo T. Silvestre, M.S. Scientist
Prof. Ricardo R. Federizon, M.S. Dept. Head
Mr. Victor C. Sambilay Research Assistant

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: 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. Conrad Recksiek URI Scientist
Dr. John W. McManus On-Site URI Scientist, Philippines

United States Research Assistants:

Mr. Karim Erzini, M.S. Research Assistant II
Mr. James McKenna Research Assistant II

Research Locations:

University of the Philippines in the Visayas College of Fisheries
University of Rhode Island

Project Objective:

To use existing 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.

Specific Objectives of 1986-1987:

1. Development of stochastic models to provide information on the predictability of catch composition and on the relationships between reproductive values and optimal harvesting strategies.
2. Compilation and analysis of existing data on the fisheries of the Philippines.
3. Initiation of comparative studies of the multispecies fisheries of the Philippines, Thailand, Indonesia, and the Northwest Australian shelf.
4. Dissemination of results and methodologies under development to fisheries biologists in LDC's and institutes concerned with international development.

Description of Work Undertaken:

1. A method was developed for the stochastic modeling and analysis of observed changes in catch rates by similar species or species groups. Aggregated time series of catches from research vessels in the Gulf of Thailand and the Northwest Atlantic were analyzed comparatively as Markov chains based on transition matrices derived by quadratic programming. Projections of the matrices give indications of the stabilities and predicted compositions in the fisheries.

Studies were made into the relationships between reproductive value and optimal harvesting strategies in a variety of fish populations, using linear and geometric programming approaches. Optimal yields tend to reflect a species specific reproductive value distribution. The best yields can be obtained by strategies involving a partial harvesting of the age class with the smallest reproductive value to the population. Research into this and other stochastic models of fisheries is continuing with the work of Saul Saila and Karim Erzini of URI and Dr. Sonia Formacion in the Philippines.

2. The Philippines has had a long history of long- and short-term fishery surveys conducted by a variety of research teams and agencies. Prof. Geronimo Silvestre, Dr. Daniel Pauly and Victor Sambilay are engaged in assimilating all existing data on Philippine fisheries so that trends in time and location and the effects of fishery management schemes can be analysed. Several large data sets from the Bureau of Fisheries and Aquatic Resources and the Philippine Council for Agricultural Resources Research and Development have been analysed. Arrangements have been made to incorporate the data from the Philippine Fisheries Development

Authority over the next few months.

Extrapolations from over 1200 trawl hauls using the swept-area method indicate that bottom-fish stocks in the Philippines have declined in the 1980's to less than 30% of their 1947/48 biomass levels. It is estimated that an additional US\$60-85 million per year worth of fish could be obtained through proper management procedures, including a drastic reduction in fishing pressure in heavily fished areas. Similar results were obtained in a more detailed study of Manila Bay, wherein the current losses are estimated at US\$1.5-5 million per year.

Existing data from the UPVCF and other agencies are being analysed on a daily basis. Population parameters are being calculated for a variety of stocks using the ELEFAN programs. Reviews of fishery status in demersal, coral reef and pelagic fisheries are underway by the UPVCF team, Dr. Pauly and Dr. McManus. A program has been developed by the UPVCF team for the calculation of optimal mesh sizes in multispecies fisheries to use as an alternative to that available in the FSAS Package. Optimal mesh sizes have been calculated for a representative demersal fishery in the Philippines. Improved methods for optimizing mesh size are under development, and the effects of variations in assumptions on results from existing methods have been documented. Studies are being initiated into the relationships between recruitment maxima predicted with ELEFAN analysis and the timing of fecundity in selected species. This project will include both the UPVCF and UPMSI teams.

3. Trips to Thailand by Dr. Saila and Dr. Donald McCreight (URI-ICMRD), and to Indonesia by Dr. Saila and Mr. Brian Crawford led to the formulation of project arrangements with the Thailand Marine Fisheries Division and the Research Institute for Marine Fisheries of Indonesia. Microcomputer hardware has been shipped to each institution to help facilitate the analysis of their fisheries data and to enable these institutions to utilize the software being developed from this project. A trip through Australia by Dr. McManus led to arrangements for collaborative research on the fisheries of that country bordering on Southeast Asia. A pilot study of community structure in the Samar Sea fishery of the Philippines has been completed, and analyses are now underway of the community structures of the southern Indonesian shelf and northwest Australian shelf fisheries.

The initial pattern analyses being applied to these data sets include TWINSPAN divisive classification/tabular sorting, and detrended correspondence analysis. Working versions of programs for these analyses have been prepared for microcomputers by Mr. Philip Roa (UPMSI). Dr. McManus is continuing work on extending the capabilities of Ordered Similarity Matrix Analysis (OSMA). These programs and others will be incorporated into a user-friendly package for ecological analysis to be distributed in 1988. In the meantime, Mr. Roa is preparing 35,000 samples of Australian data and approximately 800 Indonesian trawl samples for preliminary screening by the programs. The Indonesian JETINDOFISH data were obtained via collaborative research agreements arranged by Dr. Pauly. Mr. Victor Sambilay (UPVCF) is preparing various Philippine trawl data sets for similar comparative analyses. The

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comparative community and catch composition analyses are oriented towards facilitating area and depth based analysis and management, and towards separating anecdote from trend in determining the effects of gear changes in multispecies fisheries.

4. The project has been represented in a broad range of international symposia in spite of budget limitations. External sources of funding were located, principally through the efforts of Dr. Pauly, to permit CRSP papers to be read at several regional conferences. Dr. McManus acted as a session chairman for fisheries at the WESTPAC Symposium on Marine Science in the Western Pacific in Townsville, Australia, in December, 1986. He presented a paper on "Multispecies fisheries in Southeast Asia: a strategy for collaborative empirical analysis", in which the activities of the CRSP in the region were outlined. Prof. Geronimo Silvestre (UPVCF) presented his and Dr. Pauly's results from studying the economic losses to the Philippines through poor fisheries management at the same conference. Dr. Gomez (UPMSI) was a keynote speaker on "Human Influences on the Marine Environment".

Prof. Silvestre presented CRSP papers at the 22nd Session of the Indo-Pacific Fisheries Commission in Darwin Australia, February 1987, at the BFAR-FAO National Workshop on Fisheries Policy and Planning in Baguio, March 1987, and at the FAO-DANIDA Workshop on Fish Stock Assessment in the tropics in Manila, January 1987. Titles are listed under technical contributions.

Dr. Conrad Recksiek and Dr. Saul Saila (URI) presented papers at the American Fisheries Society Meeting in Providence Rhode Island, October 1986, on aspects of CRSP research. Dr. Recksiek explained the FSAS Computer Package developed at URI for performing over 40 analyses useful in fisheries management. Dr. Saila presented the results of his stochastic model analyses of Southeast Asian and temperate fish community variability. Dr. Saila presented both topics to researchers at the Ocean Research Institute of the University of Tokyo, to UPMSI, UPVCF and BFAR in Manila, to the Research Institute of Marine Fisheries in Indonesia, and to the Department of Marine Fisheries in Thailand, all in a single trip in October, 1986. Dr. McManus presented a seminar to researchers from various Philippine research institutions on the community analysis of fisheries in July, 1986.

Technical Accomplishments:

1. A stochastic modeling approach to the analysis of time series of catch compositions has been developed and applied in a comparative analysis of tropical and temperate fisheries to reveal characteristic community behavior patterns useful in fisheries management.

2. A geometric and linear programming approach to the determination of optimal harvest strategies was developed and applied to elucidate the relationships between life history strategies and harvesting approaches in selected fish species of commercial value.

3. A program and improvements in methodology have been produced for determining the optimal net mesh size to use when harvesting a multispecies fishery, and applied to determine a suggested mesh size for a Philippine fishery.

4. A strategy for the intercomparison of the fishery community structure in time and space across Southeast Asia was developed, necessary programs have been developed for carrying out the analyses, a pilot study of Philippine trawl data has been completed, and comparative studies of Indonesian and northwest Australian trawl data are underway.

5. Reviews of Philippine fishery studies and analyses of existing data suggest that the country is losing from US\$60-85 million annually worth of potentially harvestable fish through mismanagement of its fish stocks, principally by failure to limit overfishing in heavily fished areas.

6. The following five papers have been submitted as CRSP working papers:

- (1) Saila, S.B. and K. Erzini. 1987. An empirical approach to multispecies stock assessment. Working Paper Series No. 1. Fisheries Stock Assessment Collaborative Research Support Program. 36 p.
- (2) Saila, S.B. and K. Erzini. 1987. Geometric Programming Applied to Some Optimal Harvesting Problems. Working Paper Series No. 2. Fisheries Stock Assessment Collaborative Research Support Program. 12 p.
- (3) Saila, S.B. and K. Erzini. 1987. A comparison of the relationship between optimal harvesting strategies and reproductive values in four marine species with different life history characteristics. Working Paper Series No. 3. Fisheries Stock Assessment Collaborative Research Support Program. 30 p.
- (4) Silvestre, G. and S. Ganaden. 1987. Status of Philippine demersal stocks: an overview. Paper presented at the BFAR-FAO National Workshop on Fisheries Policy and Planning, March 16-20, 1987, Baguio City, Philippines. 24 p.
- (5) Silvestre, G. and M.L. Soriano. Effect of incorporating sigmoid selection on optimum mesh size estimation for the Samar Sea Multispecies Trawl Fishery. 21 p.

Training:

1. The URI component design provides for a full-time on-site URI scientist to be assigned to the Philippines. This permits continual training of co-workers in a variety of subjects, including quantitative ecological and fishery methods, and

computer programming. UPVCF and BFAR researchers have participated in formal courses in Community Ecology Concepts, and Community and Population Methods taught by Dr. John McManus (URI) at the University of the Philippines as a part of the CRSP information dissemination program. The latter course will be co-taught with Dr. Pauly in coming months, and includes methods in classification, ordination, and applied population analysis for management. Dr. Pauly and Dr. McManus serve on the graduate committees of several researchers from UPVCF, UPMSI and BFAR.

2. Dr. Saul Saila conducted training in the use of the URI/CRSP Fisheries Statistics Applications Package (FSAS) in October 1986 to researchers from UPVCF, UPMSI, and the Bureau of Fisheries and Aquatic Resources (BFAR).

WORK PLAN 1987 - 1988

Project Name: EMPIRICAL ANALYSES AND MODELING

Host Country: Philippines

Host Country Lead Institution:

College of Fisheries, 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), and Marine Science Institute, University of the Philippines (UPMSI)

Host Country Principal Investigator: Dr. Sonia S. Formacion (UPVCF)

Host Country Associate Investigators:

ICLARM:

Dr. Daniel Pauly

Senior Scientist

UPVCF:

Prof. Geronimo T. Silvestre M.S.

Scientist

Prof. Ricardo R. Federizon, M.S.

Dept. Head

Mr. Victor C. Sambilay

Research Assistant

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: University of Rhode Island

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

Other Participating U.S. Institutions: None

United States Associate Investigators:

Dr. Conrad Recksiek Scientist

Dr. John W. McManus On-Site URI Scientist, Philippines

United States Research Assistants:

Mr. Karim Erzini M.S. Research Assistant II

Ms. Xiu Chen Research Assistant II

Research Locations:

University of the Philippines in the Visayas College of Fisheries
University of Rhode Island

Project Objective:

To use existing 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.

Specific Objectives for 1987-1988

1. To continue research into new applications of stochastic modeling directed towards improving the management of tropical multispecies fisheries.
2. To complete comparative analyses of the community structures of the JETINDOFISH survey data from the southern Indonesian shelf, the Taiwanese trawl data from the northwest Australian shelf, the CSIRO research trawl data from the same region, the Ragay Gulf survey data of the UPVCF in the Philippines, and selected data sets from Thailand.
3. To continue to compile and analyse existing fishery data from various agencies in the Philippines to detect fishery trends useful in the management of these and other tropical fisheries.
4. To produce a user-friendly package of programs for community structure analysis of fishery and ecological data on microcomputers.
5. To initiate studies into the relationships between reproductive cycles and recruitment patterns derived from length-frequency analyses of selected soft-bottom commercial fish species.
6. To train Philippine researchers in modern approaches to fisheries and ecological analysis methods, including methods developed within the CRSP, in the context of semesteral courses offered at the University of the Philippines.

Work Plan By Quarter:

July 1 - September 30, 1987

1. Investigate existing applications of stochastic modeling and related analytical approaches in other fields to determine which might be adaptable to fishery situations.
2. Complete community analyses of the Indonesian JETINDOFISH data on TWINSPAN and Decorana programs previously converted to use on microcomputers.
3. Assemble and analyse underutilized existing data from the Philippine Bureau of Fisheries and Aquatic Resources (BFAR), the Bureau of Agricultural Economics, the Bureau of Agricultural

Statistics, and the Philippine Fisheries Development Authority.

4. Continue work on the development of a flexible community analysis program based on the Ordered Similarity Matrix Analysis approach.

5. Analyze existing data on length-frequencies and maturity stages of 13 selected species for which a substantial data base exists in studies from the Ragay Gulf, Burias Pass, Ticao Pass, Samar Sea, and Carigara Bay of the Philippines.

6. Continue teaching a semester course at the University of the Philippines on applied community ecology and population biology approaches to fisheries and ecological management.

October 1 - December 31, 1987

1. Continue developing new modeling approaches for tropical fisheries management and producing appropriate microcomputer programs for dissemination to LDC fishery scientists.

2. Complete community analyses of Australian Taiwanese trawl and survey data subsets. Compare results with those of Indonesia and the Philippines.

3. Continue length-frequency, catch-effort, and community structure studies of existing Philippine data sets.

4. Make user-friendly modifications to all existing community analysis programs being used for the international comparative analyses of trawl data for dissemination to CRSP collaborating agencies.

5. Evaluate results of recruitment vs. reproduction studies based on existing data to determine the need for obtaining more field samples of these or other species. Begin field sampling as appropriate.

6. Begin teaching a semester course in Community Ecology Concepts with an emphasis on approaches to community level fisheries management.

7. Implement a one-week training program in fish stock assessment October 16 - 23, 1987 at the UPVCF campus in Miagao, Iloilo.

January 1 - March 31, 1988

1. Continue developing new modeling approaches to tropical fisheries management. Publish and disseminate applications programs as available.

2. Obtain additional multispecies fishery data sets from Thailand, Indonesia, and elsewhere to confirm trends and patterns identified in previous analyses of Southeast Asian data which have value for management.
3. Obtain other data sets in Philippine agency files. Begin comparing overlapping data sets to determine error factors involved in estimations for management related trends.
4. Add supplemental computer programs to the community analysis package and begin preparing it for general distribution.
5. Continue field sampling of selected species for recruitment vs. reproduction studies.
6. Continue course on Community Ecology Concepts relevant to fisheries management. Compose a manuscript on this subject based on a literature review and developments within the CRSP activities.

April 1 - June 30, 1988

1. Continue developing new stochastic modeling approaches, new programs, and preparing these for general distributions.
2. Assimilate all information obtained thus far from comparative analyses of Southeast Asian trawl data sets into a manuscript with management recommendations.
3. Assimilate all know information on the Philippine fisheries into a general review of the results obtained from the CRSP data analyses.
4. Finalize a community ecology data analysis package for general distribution, using the IBM microcomputer format. Prepare associated manuscripts and announcements.
5. Continue sampling for the recruitment vs. reproduction study. Evaluate preliminary results to produce guidelines for continuance into the second year of this sampling program.
6. Begin a new course in Applied Community Analysis and Population Biology at the University of the Philippines incorporating new methods as available from the CRSP. Incorporate training in the new community analysis package, and old and new versions of the URI-CRSP Fisheries Statistics Applications System (FSAS).

Summary of Expected Accomplishments by June 30, 1988

1. To have a tested set of user-friendly microcomputer programs

facilitating a variety of stochastic modeling analyses, for distribution to LDC fishery researchers.

2. To have prepared a manuscript summarizing trends and patterns of management significance identified in community structure analyses of existing trawl data sets from the Southeast Asian Region.

3. To have a series of papers and a review manuscript covering aspects of the fisheries of the Philippines brought to light in comparative analyses of all available data sets.

4. To have a user-friendly package of programs available to facilitate community-level analyses of fisheries and other ecosystems, for distribution to LDC fishery and environmental managers.

5. To have a preliminary analysis of data on recruitment vs. reproduction in selected soft-bottom fishes from both existing and field gathered data.

6. To have trained at least 30 Philippine researchers in fisheries and ecological analysis methods developed and adapted within the CRSP.

ANNUAL REPORT 1986 - 1987

Project Name: MULTISPECIES FIELD STUDIES

Host Country: Philippines

Host Country Lead Institution: Marine Science Institute,
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, University of the Philippines in the
Visayas (UPVCF)

Host Country Associate Investigators:

ICLARM:

Dr. Daniel Pauly Senior Scientist

UPMSI:

| | |
|------------------------------------|------------------------------|
| Mr. Wilfredo L. Campos, M.S. | Research Associate |
| Ms. Annabelle G.C. del Norte, M.S. | Senior Research Assistant |
| Mr. Naniel V. Aragones | Senior Research Assistant |
| Mr. Philip A. Roa | Senior Scientific Programmer |
| Mr. Ruben C. Garcia | Senior Scientific Engineer |
| Mr. Cleto L. Nanola | Research Assistant |
| Ms. Clarissa C. Arida | Research Assistant |
| Ms. Mary Janeth P. Poot | Research Assistant |
| Mr. Wilnorie P. Rasay | Research Assistant |
| Mr. Rodolfo Reyes, Jr. | Research Assistant |
| Mr. Miguel P. Miguel | Research Aide |
| Mr. Jesse Cabansag | Research Aide |

Also members of the U.S. AID/ASEAN Coastal Resources Management
Program (CRMP) working collaboratively with the CRSP.

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

United States Principal Investigator: Dr. Saul B. Saila

Other Participating U.S. Institutions: None

United States Associate Investigators:

Dr. John W. McManus (On-Site URI Scientist)
Dr. Conrad W. Reckseik (URI)
Mr. Kim Richardson (URI - voluntary Landsat research)

United States Research Assistants:

Mr. Alejandro Acosta (URI)
Mr. Ralph Turingan (URI/UPV)

Research Locations:

University of the Philippines
University of Rhode Island

Project Objective:

1. To produce at the end of the five-year CRSP substantial contributions to a book of methods for multispecies stock assessment, including a summary of existing methods for assessing and managing shallow water (principally coral reef) multispecies fisheries, in conjunction with methods tested and developed by our own research team.
2. To assess the impact of fishing pressure relative to other factors influencing the abundances and distributions of fish species across a heterogeneous coral reef system and the variations in community structure over a three-year period.
3. To obtain general information as to the relationship between the catch composition yielded by each of several important small-scale fishing gears and the composition of the fish community being exploited.
4. To assess the relationship between catch composition, standing stock, and fishery production in a variety of shallow water fish habitats.
5. To determine to what extent the catch composition and fishery production of a coastline can be predicted from habitat information obtained from satellite imagery, aerial photographs from low-cost aircraft, chart information, bathymetry, and environmental parameters obtained from site sampling.
6. To disseminate this information to countries involved in multispecies fisheries management, including the United States and developing countries.
7. To develop within the host country collaborating institution the capability to continue independently to investigate and to refine the assessment and management approaches which are being developed within the CRSP.

Specific Objectives for 1986-1987:

1. To provide for a preliminary classification of fish habitats in the Bolinao region to be used as a basis for sampling the fish communities and the small-scale fishery production and catch compositions associated with each.
2. To initiate research into ways to improve on this classification using improved satellite image processing and ground truthing methodologies, ultralight aerial surveys, and remote-controlled aircraft.

3. To organize and train a team of field researchers who will monitor composition and production variability in the habitats during project years three to five.

4. To establish contacts among the thousands of fishermen in the Bolinao region and to initiate exploratory sampling of selective gears to provide guidelines for the extensive monitoring to be conducted in following years.

Description of Work Undertaken:

1. A series of surveys and formal transects have been made in strategic sections of the more than 60 sq km portion of the reef system of Bolinao (>250 sq km total) constituting our primary study area. Several members of the U.S. AID/ASEAN Coastal Resources Management Program UPMSI team participated in this effort. This CRMP team will use the satellite maps we produce as a basis for their pilot management program for a larger area of which Bolinao is an economically important subregion. Other transects were conducted by the Seagrass and Coral research teams of UPMSI which will use the compiled results for their ongoing resource and ecology studies. Compilation of results is expected to be completed by the end of July, 1987.

2. A series of preliminary maps have been constructed which emphasize the bathymetry and bottom cover types of the region. Methods include image enhancement, and both supervised and unsupervised clustering studies. Principal work is ongoing at UPMSI on a Decision Images enhancement of an IBM PC-AT microcomputer with reel-to-reel tape download and high resolution photography capabilities sponsored under the CRSP. We are grateful to Mr. Kim Richardson of URI for conducting supplementary analyses in the U.S. in spite of a lack of compensation necessitated by budgetary limitations.

CRSP Senior Scientific Programmer Mr. Philip Roa received training in Landsat analysis in workshops sponsored by UNDP and the Australian ASEAN program, and in collaborative research with Dr. McManus. Mr. Roa and Dr. McManus are currently investigating methods by which the effects of bottom cover can be isolated from that of depth.

Mr. Ruben Garcia, CRSP Senior Scientific Engineer, is developing a system by which aerial surveys can be conducted by a remote-controlled aircraft. The major problem is to determine the exact location of the aircraft before useful photographs can be obtained. By incorporating a small television camera and transmitter in the aircraft, we hope to guide the plane along systematic transects between established ground position and scale markers to obtain stereo photographs. A suitable transmitter has been obtained and efforts are underway to boost its power. Mr. Garcia and Dr. McManus are concurrently engaged in developing ways of automating stereo image analysis and

incorporating it with methods of image enhancement and classification. Initial success has been had with a clear digitizing pad using resistance technology in conjunction with Jandel Scientific software. The technological expertise of Mr. Roa and Mr. Garcia has substantially enhanced the capabilities of UPMSI, and efforts are underway in the U.S., Australia, Canada, and England to find funding for establishing a Center of Excellence within UPMSI for the Remote Sensing of Coastal Resources - a spin-off of the CRSP.

The need to improve groundtruthing methods in shallow-water areas has led to trials of a variety of transect and location methods. We have currently settled on a methodology involving three-point triangulation with field compasses at points evaluated by a diver on a "manta" board towed from a boat. Tests with plastic sextants were equally satisfactory. Mr. Cleto Nanola is continuing efforts to improve on the design of a two-man towed underwater sled for deeper SCUBA surveys. Supplemental funding is being sought in various quarters to sponsor tests of a remotely operated underwater vehicle (ROV) for the classification of habitats from 100 to 900 feet deep, beyond the effective range of SCUBA divers.

Mr. Alan Cournoyer was engaged for five weeks to train Dr. McManus in the use of an ultralight aircraft equipped with floats. Mr. Cleto Naniola was trained as an ultralight mechanic. Initial surveys with the aircraft were extremely successful. The ultralight is capable of cruising at 30 mph, about one-half of the minimum speed of most aircraft. At such a slow speed, and with the unobstructed view provided by the Eipper Aircraft design, it was possible to count and evaluate the relative positions of large coral heads. Several large features which showed up in Landsat Analyses were completely indiscernable by SCUBA divers because of the scale of observation. A single survey on the ultralight revealed the precise nature of each of these features, which included remnant erosional features with characteristic vegetations, and gently graded sand deposits. The ultralight will be extremely useful for determining and mapping the distribution of fishing effort, a world-wide problem with few affordable solutions. Unfortunately, a defective bearing caused damage to the engine, and we are currently ordering a new one. The ultralight costs less than most cars, and uses standard gasoline at a rate of about 5 gallons for two to three hours flight time.

3. Mr. Wilfredo Campos is in charge of a field research team in Bolinao which has been conducting preliminary sampling of selected fishing gears including traps, spearfishing, and gill nets. Mr. Campos will use aspects of the project for his PhD dissertation for the University of Miami. The Bolinao Market includes any of more than 350 species, and each member of the field team is being trained in taxonomy. The major habitats of the area include seagrass, brown algae, lagoonal coral, lagoonal sand, fore-reef coral, soft sandy silt, non-reef coral patch, and giant sponge communities. An appropriate method for sampling each

of these habitats is being sought. Studies by Mr. Ralph Turingen (URI/UPV) in 1986 of underwater transects will be used as a basis for designing visual survey methods for certain of these habitats. Tests are now underway to develop an appropriate net enclosure method for sampling the massive seagrass beds of the reef flats.

4. Preliminary analyses of fishery data are underway, particularly those made by URI research assistant Alejandro Acosta (Venezuelan) in 1986 at Bolinao. These results will be combined with those of the team of Mr. Campos to provide a basis for the determination of appropriate sample sizes and frequencies during the extensive fishery sampling and monitoring program scheduled for 1987-1990. The thousands of fishermen of Bolinao share with fishermen the world over a general mistrust of fishery researchers. The CRSP field team has been gradually winning the confidence of individuals from each of the major fishing communities. In one community, a full time research aide chosen from among the fishermen keeps records of catch and effort data. We now have nine months of data on spearfishing, hook and line, and fish trap methods used in the area. We also have preliminary data on fish corrals and both surface and bottom gill nets.

Technical Accomplishments:

1. A preliminary mapping of the marine habitats of the Bolinao region has been completed. This mapping will serve as a basis for all future research in the area by projects including the U.S. AID/ASEAN Coastal Resources Management Program (CRMP - ASEAN), which will incorporate the information into a pilot management plan for the area.

2. Preliminary surveys with an ultralight aircraft equipped with floats confirm that this is an excellent means by which developing country fishery managers can monitor coastal fisheries, map shallow-water habitats, and determine the distribution of fishing effort.

3. Preliminary investigations reveal that it may be feasible to use a remote-control aircraft for the mapping and monitoring of coastal fishing grounds. The aircraft would be guided with the help of a television camera and transmitter. Work on this concept is continuing.

4. A protocol has been developed for broad area ground truthing of reef areas in collaboration with the U.S. AID/ASEAN CRMP team. The protocol involves the use of a standard sample form, a towed manta board with a diver, and compass or sextant angular measurements to precisely locate sample stations. A towed two-man underwater sled has been developed for SCUBA surveys to 60 ft depth. Refinements to these technologies will be forthcoming.

5. Four papers are in preparation for submission by August, 1987 on aspects of this work.

Training:

1. The URI/UP collaborations involve a full-time on-site URI scientist, Dr. John W. McManus, who provides continual co-worker training in topics such as field sampling, data analysis, SCUBA research methods, ecological theory, fisheries biology, coral reef science, darkroom and camera techniques, and computer programming.
2. Dr. McManus taught a formal full semester course at UPMSI on "Community Ecology Concepts". The course was preparatory for a course which he is now co-teaching with Dr. Daniel Pauly (ICLARM/CRSP) on "Community and Population Methods" which introduces quantitative methods useful in fisheries and ecological analysis of marine resources. Students include personnel from the University of the Philippines and the Bureau of Fisheries and Aquatic Resources. Topics in the latter course include classification, ordination, and length-frequency based population analysis. Emphasis is equally divided between simple methods for calculation by hand and more tedious methods involving microcomputers. Hands-on training is arranged in all cases.
3. Ms. Annabelle Del Norte successfully completed her Master's thesis on the population dynamics of a commercial scallop in the Philippines. She was assisted in her data analysis by Dr. Saul Saila during his trip to the Philippines in October, 1986. Several of her analyses were employed programs in the Fisheries Statistics Applications Package (FSAS) produced at URI for the CRSP. Her committee included CRSP researchers John McManus (URI), and co-advisors Daniel Pauly (ICLARM) and Edgardo Gomez (UPMSI). These three CRSP researchers are involved in advising several other Philippine students performing Master's research employing methodologies under development in the CRSP. Dr. Saila also assisted project leaders of several UPMSI projects with approaches to data analysis, including Ms. Annette Junio of the Lobster Project, and Ms. Marie Jo Trinidad (now Mrs. Roa) of the Giant Clam Aquaculture Project. Subsequently, Ms. Junio became a PhD student at URI.
4. Mr. Philip Roa conducted a "Workshop on Remote Sensing" which was jointly sponsored by the ASEAN-Australia Coastal Resources Project and the CRSP. Participants included researchers from UP, the Natural Resources Management Center, and the Bureau of Fisheries and Aquatic Resources (BFAR). Mr. Roa is the Senior Scientific Programmer for the UPMSI CRSP, and classes utilized the CRSP IBM PC-AT based image analysis system.
5. Mr. Cleto Nanola received special training from Mr. Alan Cournoyer in ultralight aircraft mechanics during a 5-week period in April and May, 1987.

WORK PLAN 1987 - 1988

Project Name: MULTISPECIES FIELD STUDIES

Host Country: Philippines

Host Country Lead Institution:

Marine Science Institute, 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, University of the Philippines in the Visayas (UPVCF)

Host Country Associate Investigators:

ICLARM:

Dr. Daniel Pauly

Senior Scientist

UPMSI:

Mr. Wilfredo L. Campos, M.S.

Research Associate

Ms. Annabelle G.C. del Norte, M.S.

Senior Research Assistant

Mr. Naniel V. Aragones

Senior Research Assistant

Mr. Philip A. Roa

Senior Scientific Programmer

Mr. Ruben C. Garcia

Senior Scientific Engineer

Mr. Cleto L. Nanola

Research Assistant

Ms. Clarissa C. Arida

Research Assistant

Ms. Mary Janeth P. Poot

Research Assistant

Mr. Wilnorie P. Rasay

Research Assistant

Mr. Rodolfo Reyes Jr.

Research Assistant

Mr. Miguel P. Miguel

Research Aide

Mr. Jesse Cabansag

Research Aide

Also members of the U.S. AID/ASEAN Coastal Resources Management Program (CRMP) working collaboratively with the CRSP.

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

United States Principal Investigator: Dr. Saul B. Saila

Other Participating U.S. Institutions: None

United States Associate Investigators:

Dr. John W. McManus (On-Site URI Scientist)

Dr. Conrad W. Reckseik (URI)

Mr. Kim Richardson (URI - voluntary Landsat research)

United States Research Assistants:

Mr. Alejandro Acosta (URI)

Mr. Ralph Turingan (URI/UPV)

Research Locations:

University of the Philippines

University of Rhode Island

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Project Objectives:

1. To produce at the end of the five-year CRSP one or more chapters in a book of methods for multispecies stock assessment, a summary of existing methods for assessing and managing shallow water (principally coral reef) multispecies fisheries, in conjunction with methods tested and developed by our own research team.
2. To assess the impact of fishing pressure relative to other factors influencing the abundances and distributions of fish species across a heterogeneous coral reef system and the variations in a community structure over a three-year period.
3. To obtain general information as to the relationship between the catch composition yielded by each of several important small-scale fishing gears and the composition of the fish community being exploited.
4. To assess the relationship between catch composition, standing stock, and fishery production in a variety of shallow water fish habitats.
5. To determine to what extent the catch composition and fishery production of a coastline can be predicted from habitat information obtained from satellite imagery, aerial photographs from low-cost aircraft, chart information, bathymetry, and environmental parameters obtained from site sampling.
6. To disseminate this information to countries involved in multispecies fisheries management, including the United States and developing countries.
7. To develop within the host country collaborating institution the capability to continue independently to investigate and to refine the assessment and management approaches which are developed within the CRSP.

Specific Objectives for 1987-1988:

1. To classify the major fish habitats in the Bolinao, Philippines study area using remote sensing and ground truth survey methods, to assess the areal extent of each habitat, and to determine the dominant biota associated with each.
2. To determine the commercially and nutritionally important fishes associated with each habitat, their relative abundances, and their variability over the year.
3. To identify the major small-scale fishery gear associated with each habitat, and to assess the catch per unit effort and catch compositions obtained by gear and habitat type.

4. To determine the levels of exploitation of representative fish species in each habitat to determine the degree of over- (or under-) fishing by length-frequency analysis.

5. To initiate regular sampling of the fishing activities and fish compositions by habitat to be continued until project completion for the evaluation of interannual variability and the extrapolation of results to remote-sensing based broad area fishery potential yield estimates.

6. To develop and evaluate field and analytical methods which are useful for the management of shallow-water small-scale fisheries, including low cost methods for habitat mapping and fishing effort determination by aerial surveys.

7. To determine the relationships between length-frequency based recruitment estimates and reproductive stage in selected coral reef fish.

Work Plan by Quarter (1987 - 1988)

July 1 - September 30, 1987

1. Continue refining habitat discrimination in Bolinao satellite image analysis, particularly with respect to the isolation of the effects of depth from those of bottom cover.

2. Continue developing the ultralight aircraft as a low-cost tool for marine habitat mapping, ground truthing, and the determination of small-scale fishing effort relative to available fish habitats.

3. Develop and test a low-cost television transmitter suitable for guiding a remote controlled aircraft along a preset aerial photography transect relative to position and scale markers placed along a route. Construct a remote control trainer aircraft for training in landing and take-off procedures.

4. Expand ongoing fishery monitoring to include a representative sampling of the fisheries of the Bolinao area. Both length-frequency and catch composition data will be obtained. Initiate in-situ sampling of fish in each major habitat type.

5. Initiate studies of the reproductive patterns of selected coral reef fishes relative to recruitment period predictions available from length-frequency data analysed on the ELEFAN programs.

October 1 - December 31, 1987

1. Develop software to facilitate specifically the computer analyses which have been most effective in discriminating fish habitat types in satellite imagery. Develop software for the analysis of aerial photographs of shallow water habitats, particularly with respect to distinguishing, enhancing, and quantifying features likely to be important in determining fish distributions
2. Conduct regular sampling of fishing effort using aerial surveys and sea-level boat counts.
3. Build a remote controlled aircraft capable of carrying the TV camera, transmitter, and still camera.
4. Continue sampling of fish compositions in selected habitat types, and the associated fisheries.
5. Continue length-frequency and reproductive index studies of selected coral reef fish species.

January 1 - March 30, 1988

1. Continue image analysis research and extend into studies of the feasibility of computerised stereo analysis of underwater features for height and improved size measurements.
2. Continue fishing effort surveys.
3. Develop a protocol for use of the remote-controlled aircraft for aerial photography surveys.
4. Continue sampling of fish compositions in selected habitat types, and the associated fisheries.
5. Continue length-frequency and reproductive index studies of selected coral reef fish species.

April 1 - June 30, 1988

1. Begin developing a package of programs for image analysis of underwater marine habitats to supplement commercially available microcomputer image analysis systems.
2. Continue fishing effort surveys.
3. Continue refining the methodology for remote-controlled aerial surveys of fish habitats.

4. Continue sampling fish compositions and fishery productions by habitat and gear. Prepare initial reports for presentation at the 6th International Coral Reef Congress scheduled for Australia in August, 1988.

5. Continue length-frequency and reproductive index studies of selected coral reef species. Begin preliminary data analyses to determine whether or not procedural changes are desirable prior to continuation to achieve a two-year data set.

Summary of Expected Accomplishments by June 30, 1988

1. To have a preliminary version of a package of computer programs designed to facilitate image analysis of satellite and stereo aerial photographs to facilitate the classification of fish habitats in shallow waters.

2. To have modified an ultralight aircraft developed a protocol for systematic surveys of fishing effort in shallow water areas, and to have used this system to obtain a general assessment of fishing effort by gear in each fish habitat in the Bolinao area.

3. To have a working model of a low-cost remote-controlled aircraft with a TV camera and transmitter, and a still camera system for the mapping of fish habitats in shallow waters.

4. To have completed a short-term assessment of the distribution of fish species in habitats of the Bolinao region, and of the harvestable production and catch composition by species and size for each major small-scale gear used in the habitats. This assessment will be summarized in manuscript form for presentation at the 6th International Coral Reef Congress in Australia in August, 1988.

5. To have obtained the first of two-year's of data necessary for investigating the relationships between recruitment predictions based on length-frequency analysis and reproductive cycles in selected coral reef fish species.

International Travel:

| Investigator | Tentative Dates | Location |
|--------------|----------------------|-------------|
| S. B. Saila | Oct 11 - Nov 3, 1987 | Philippines |

Purpose of Travel:

1. Evaluate Field Studies sub-project.
2. Assist project personnel.
3. Provide information exchange with colleagues at University of the Philippines.

4. Conduct workshops or training sessions on new aspects of research conducted at URI on fishing stock assessment methodologies.

| Investigator ----- | Tentative Dates ----- | Location ----- |
|-----------------------|--------------------------|-------------------|
| S. B. Saila | Sept 13 - 17, 1987 | Charlotte, NC |

Purpose of Travel:

Attend American Fisheries Society meeting. Present paper on the Gulf of Thailand fishery and possibly attend technical committee meeting.