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AGENCY FOR INTERNATIONAL DEVELOPMENT

PROJECT PAPER FACESHEET

TO BE COMPLETED BY ORIGINATING OFFICE

1. TRANSACTION CODE ("X" appropriate box)
☐ Original ☒ Change
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PP

DOCUMENT CODE 3 81

2. COUNTRY/ENTITY
TA Bureau RDA-27 A

3. DOCUMENT REVISION NUMBER
2

4. PROJECT NUMBER
931-0526

5. BUREAU
a. Symbol: TAB
b. Code: 08

6. ESTIMATED FY OF PROJECT COMPLETION
FY 80

7. PROJECT TITLE - SHORT (stay within brackets)
[Artificial Propagation of Milkfish]

8. ESTIMATED FY OF AUTHORIZATION/OBLIGATION
a. INITIAL mo. 0 yr. 75 b. FINAL FY 77

9. ESTIMATED TOTAL COST ($000 or equivalent, $1 =)

a. FUNDING SOURCE	FIRST YEAR FY 75 b. FX	c. L/C	d. Total	ALL YEARS e. FX	f. L/C	g. Total
AID APPROPRIATED TOTAL						
(Grant)	(250)	( )	( )	(1,440)	( )	( )
(Loan)	( )	( )	( )	( )	( )	( )
Other U.S. 1.						
Other U.S. 2.						
HOST GOVERNMENT						
OTHER DONOR(S)						
TOTALS	250			1,440		

10. ESTIMATED COSTS/AID APPROPRIATED FUNDS ($000)

a. Appropriation (Alpha Code)	b. Primary Purpose Code	c. Primary Tech. Code	FY Prior d. Grant	e. Loan	FY 77 f. Grant	g. Loan	FY h. Grant	i. Loan	ALL YEARS j. Grant	k. Loan
FN	121 I	954	528		912				1,440	
TOTALS			528		912				1,440	
11. ESTIMATED EXPENDITURES										

12. PROJECT PURPOSE(S) (stay within brackets) ☐ Check if different from PID/PRP

[To develop techniques to breed milkfish in captivity and raise the fry for release to commercial growers in brackish water areas.]

13. WERE CHANGES MADE IN BLOCKS 12, 13, 14, or 15 OF THE PID FACESHEET? IF YES, ATTACH CHANGED PID FACESHEET.

☐ Yes ☐ No

14. ORIGINATING OFFICE CLEARANCE

Signature: Leon T. Hesser

Title: Leon Hesser
Director TA/AGR

Date Signed: ~~mo. 05 day 13 yr. 77~~
04 - 11 - 77

15. Date Received in AID/W, or For AID/W Documents, Date of Distribution
mo. day yr.

AID 1330-4 (7-75)

R E S E A R C H P R O J E C T P A P E R

April 11, 1977

A. PROJECT SUMMARY

1. Basic Identification and Fiscal Data

Project Title: RESEARCH AND IMPLEMENTATION OF MILKFISH PROPAGATION

New or Extension: Extension

Contractor and Address: Oceanic Institute
Waimanalo, Hawaii 96795

Principal Investigator: Colin E. Nash, Ph.D.

Duration: Currently Authorized: January 13, 1975 - January 12, 1978
Extension: January 13, 1978 - January 12, 1980.

Total Estimated Cost: $1,440,409
Cumulative Obligation Through Current Year: $528,369
Current Year: $248,532
FY 1 (4) $463,097
FY 2 (5) $448,943

A.I.D. Project Manager and Sponsoring Office: TA/AGR(Fisheries)
P.M. Roedel

2. Abstract

Fish are traditionally the major source of animal protein for the peoples of Southeast Asia and other LDC's. Fish farmers rely on the natural annual production of juveniles which each year decreases. Artificial breeding of certain brackishwater fish, particularly milkfish and mullet, and propagation of fry in hatcheries are vital for the future supplies of seedstock for the farmers.

Support for fisheries projects in the LDC's by the international development agencies has recently been renewed with the emphasis on a strong technical base implementing "packaged technology".

This project concerns the development of breeding techniques for the milkfish. production of fry. design of hatcheries and hatchery technology, and production in the field. Technical barriers are being positively attacked by concentrating on key research areas; for example, reproductive physiology, pathology, behavior, and nutrition. Technical development is being conducted in Hawaii, with field application intended first for the Philippines.

This project paper is based on a proposal developed by the Oceanic Institute, reviewed and modified by TAB and jointly developed to its present form.

B. EXPANDED NARRATIVE STATEMENTS

1. General Background and Rationale

a. Background Information

Fisheries are one of the few food-producing industries whose growth rate has kept ahead of the rate of population increase since World War II. In order to maintain present per capita consumption, however, fish production will have to reach 107 million tons annually by 1985. If consumption increases are to be sustained without irreparably depleting stocks and endangering prized species, much greater reliance must be placed upon controlled fish production (aquaculture) as an ever-increasing complement to wild fish capture.

Fish supply about 10 percent of the animal protein and three percent of the total protein in human diets worldwide. However, while in "high-calorie countries" it constitutes 6.7 percent of animal protein supplies, in "low-calorie countries" (i.e., the LDC's) it supplies 21 percent. In parts of Southeast Asia, fish constitute a major source of animal protein in the diets of many people--50 percent or more in most countries of the area--whereas in other parts of the world, such as the Balkans, Central America, the Near East, and landlocked countries such as Bolivia, Paraguay, Nepal, Afganistan and most of the Sahelian countries, fish often represent as little as one percent of all animal protein consumed. In many countries, aquaculture has until recently been all but unknown, but in none are there insuperable, long-term barriers to its development.

Total world fish production in 1974 was 69.8 million metric tons (mmt), an increase of over 350 percent since 1948. Inland waters supplied 9.5 mmt, or nearly 14 percent of the world harvest. About 63.7 percent of total production was used directly for human food, and 36.3 percent was converted into fishmeal, oil or for uses such as fish flour, margarine, cooking fats, industrial uses, and livestock and poultry feed.

The world's largest fish producers in 1974 were: (1) Japan 10.773 mmt, (2) Russia 9.235 mmt, (3) China (mainland) 6.880 mmt, (4) Peru 4.149 mmt, (5) USA 2.743 mmt, and (6) Norway 2.644 mmt. Seven developing countries are among the top 14 nations; they are: (1) India 2.255 mmt, (2) Korea (north and south) 2.240 mmt, (3) Thailand 1.626 mmt, (4) Indonesia 1.341 mmt, (5) Philippines 1.291 mmt, (6) Chile 1.126 mmt, and (7) Vietnam (north and south) 1.080 mmt.

Fish production is the cheapest and nutritionally one of the highest quality sources of animal protein. The protein content of fish is comparable to that of beef, pork, and lamb, and it is an excellent source of calcium. But most importantly, fish production has an unmatchable feed-conversion ratio. In steers,

1,000 grams of feed produce a weight gain of 163 grams; the rates of gain with chicken flesh are substantially better. But with tilapia, catfish and probably many unexplored types of fish, the weight gain approaches 1.000 grams - - i.e., a 1:1 ratio of flesh to feed.

Long-range demand outlook for fish is difficult to predict. Present consumption patterns are highly country and culture specific with an important factor being historic availability of supplies. Experience is too limited for conclusions on the degree of acceptability of fish in previously non-fish-eating societies but does suggest affirmative responses. The demand outlook is encouraging. Income elasticities of demand for livestock products in LDC's are high. With increases in the price of conventional livestock products, high-quality protein sources such as fish become more attractive - - particularly among low-income consumers. Furthermore per capita fish supplies from conventional capture sources may be expected to decrease and their relative production costs to increase.

Finally, at the opposite extreme from most forms of livestock production, fish-farming systems can be highly supportive of ecological values, via three relationships:

1. Increasingly, fish production systems are being built on waste materials as primary feed sources, ranging from the normal organic residues in contaminated streams to animal (including fish) excrements, and other organic byproducts. Conversely such wastes from other animals are a principal source of environmental contamination.

2. Pond fish production is a concomitant of good surface water management designed for erosion control and other conservation purposes.

3. By increasing animal protein production on a highly land-intensive basis, aquaculture can remove pressure of overgrazing by land animals, a most direct source of ecological destruction in most LDC's.

b. Project Extension

The program objective is to breed the milkfish, Chanos chanos, in captivity and to raise the fry from the egg, undertaking any research and development which may be necessary to attain that goal. During the 2-year life of this program progress has been made in a number of important areas. This progress in the critical areas of capturing adults, maturing, adults, handling live fish, and inducing spawning has brought the state of the art to a point where achievement of the program goal is a realistic probability. Progress to date is outlined in the following paragraphs.

Procedures for capturing and handling the fragile wild breeding fish have been improved. Evidence suggests the need to minimize handling, to use fish with oocytes of 0.7 mm diameter or above, and to inject once immediately upon capture. Experience suggests low-level injections are perferable, possibly followed by artificial stripping; however, control of stress is essential.

Work on health care and husbandry continues to be productive. The handling techniques developed to reduce stress have been beneficial. In addition to previous information on the stress of the adult fish during capture, autopsies have revealed incidences of blood clots. Wild fish have also shown evidence of gastritis, particularly when taken from the heavily polluted coastal areas.

Significant experience has been gained in procedures for holding experimental populations for maturation and spawning experiments. The resident population of fish on site numbers 50 adult fish, 65 subadult fish, and about 100 0-group juveniles. Over 89 adult fish were caught during the second year, but losses were sustained. One entire tank of 12 fish was lost by mechanical accident following storm damage; several adult fish were poached; and others died during experimental treatment.

Captive adult fish have been conditioned for twelve months in manipulated environmental conditions (18L/6D) at 25% C, but failed to show any oocyte development. The diet of the captive stock has been changed for one with a higher protein composition in an effort to improve this performance.

In summer of the second year of the project, seven mature fish were captured and deemed ready for spawning inducement. Following the results of the first year with doses of salmon gonadotropin SG-G100 at levels similar to those used for the grey mullet, Mugil cephalus, six of the fish were injected with a low priming dose. One was deliberately not injected. Only one of the injected fish hypophysated completely and released eggs. One fish receiving several small injections died. The eggs of the rest of the fish went atretic. These preliminary trials have provided a basis for expanded experimentation when greater numbers of experimental animals become available.

Eye lens protein analyses continue to give evidence of racial differences in milkfish from around the Pacific Islands and the work has been reinforced with isozyme identification from various tissues. In addition over 250 adult fish have now been examined for statistical morphology to provide a basis for identification of races.

The electronic tag for use in tracking adult fish has been developed and tested, is now being miniaturized and a number are being developed for testing in the next breeding season.

The project has benefited from international cooperation in many elements of milkfish knowledge. An extensive bibliography on the milkfish is being assembled: morphometric data are being pooled: and there are beneficial exchanges of data on physiology, reproduction, and general handling.

A total of five publications relevant to the project have been prepared and three published. The other two are in press.

Progress to date has been satisfactory, and the prospects for solving the problem during the next 2 years are encouraging. The Oceanic Institute through this research has not only made significant progress on this particularly difficult and complex problem, but has assumed a prominent leadership role in the field and is now in position to make a breakthrough of major importance. If AID support is not continued the momentum of this activity will be lost as well as much of the technical expertise of this team pertaining specifically to milkfish.

The substantial increase in the budget over last year is attributable to a substantial increase in the personnel required to focus necessary attention on this research, the travel and personnel requirements related to additional field work in the Philippines, and new holding facilities to increase available numbers of experimental adult fish. Although important progress has been made with about 39 man months of effort, the completion of the research will require an increased level of scientific input (about 156 man months) because of technical and logistical difficulty of the research.

2. Research Purpose and Expected Products

a. Purpose

The purpose of this project is to learn how to increase the potential for effective controlled production of young milkfish upon which mature fish production by small farmers must be based.

b. Objectives and Expected Products

The overall objective is to learn how to supply an adequate and predictable quantity of juvenile fish to the fish farmers. Specific objectives are:

(1) To induce spawning of milkfish in captivity economically and do so over long periods.

(2) To discover specific pathological effects of stress and handling and to prevent or overcome these effects.

(3) To learn how to increase egg production and the larvae survival rate.

(4) To learn how to increase hardiness of larvae and juveniles.

(5) To develop handling techniques for juveniles that will assure low mortality in the farmers' pens.

Present fish-farming practice is largely based on collection of wild juveniles from natural sources, a costly, unpredictable, and ultimately destructive approach. Collection of milkfish juveniles by such countries as the Philippines, Indonesia, and Taiwan is enormous, estimated at 160 million per year for Taiwan alone. It is estimated that the annual production of 2,000 metric tons of mature grey mullet in Taiwan involves an annual collection of 10,000,000 juveniles from coastal waters. Japan has set an annual catch limit of 31 million juvenile yellowfish; a similar limit on young eel catch has caused Japanese eel farmers to scour the world for seedstock. Crude calculation suggests that the modest goal of doubling farm fish production, to some 15 million tons per year, might require capture of some 100 billion juveniles per year, under the optimistic assumption of a one-third survival rate to maturity. Natural populations unquestionably cannot sustain juvenile catches of this magnitude.

Although an interrelated set of factors are involved, the technical constraints to managed juvenile fish production fall into two categories: brackishwater parent fish which reproduce only in the sea, and excessive mortality of very young fish larvae. The first problem must be solved if brood fish are to reproduce under man-controlled conditions, and to find the solution to the second problem--or indeed to any kind of production of seedstock fish in captivity. Since such research is somewhat species specific, it will be necessary to investigate most parameters for the milkfish even though much of this is known for the mullet.

Research, largely by the principals of this project, primarily with mullet species, has gone a long way toward establishing feasibility of solving the first type of problem. In this project what has been learned will be applied to the milkfish. They have been able to induce spawning over much longer than normal periods by manipulating such external environmental parameters as water quality, diet, hygiene, temperature, salinity and light. Salinity alone appears to be the principal factor causing fish to go to sea for breeding purposes. Regularly induced spawning has been achieved by use of salmon hormones. The investigators have found considerable promise from use of human hormones, and the very much cheaper hormones from several other mammals. However, a number of environmental variables appear strongly to influence physiological changes in the pituitary gland and to stimulate gonads to time-controllable maturity. This study would clarify those variables in quantitative relationship to their effects on reproduction. Once these relationships can be sufficiently understood and controlled, continuous fish larvae production systems can be established. With other support research will be consistent on the mullet to complete the understanding of how to husband the fish to market and in broods.

Similarly, the principals in the project and others have made considerable strides toward understanding the biological mechanisms, and their relationships to environmental factors, which result in the extremely high mortality ratios of fertilized eggs and fish larvae. Relationships to larvae survival of a large number of variables--especially temperature, salinity, pH, oxygen, light, and food supply--have been observed and catalogued. The principals in the project have observed a key variable to be the osmo-regulatory system of the larvae, by which body fluid balances are maintained. In fact, it would appear that several of the other noted variables are associated with survival not so much directly as via their effect on body fluid supplies. Clearly quantity and type of food intake and salinity of the environmental water have direct bearing on body fluids during the first critical days when the larvae are unscaled and most mortality is effected. Simply stated, it is their hypothesis that it is primarily through finding means of supplying "drinking water" of the right types and quantities, through the right means and at the critical times that the excessive mortality can be reduced.

To the extent possible during fish breeding, a selection will be made of brood fish of propensity toward higher larvae survival rates and other good breeding qualities.

If the two sets of problems outlined above can be solved, controlled production of juvenile seedstock fish can be made a relatively modest cost component of the entire aquacultural enterprise. The numbers of larvae produced per fish are so enormous that the numbers of brood fish required for continuous production would be relatively small. Also, rearing of larvae to the size now normally captured as fish stock would require relatively modest-scale facilities in relationship to the ultimate mature fish production enterprise.

The study will determine factors and procedures necessary to reduce mortality and improve performance of the juveniles through delivery to fish farmers and subsequent production activities.

3. Relevance and Significance of Proposed Work to A.I.D.

a. Significance

The high priority given by the Agency to improve nutrition, particularly of low-income groups, needs no reiteration. Development of highly efficient aquacultural systems very directly and importantly serves that objective. Aquaculture of this type in Southeast Asia and in the Philippines is normally highly labor intensive and thus provides a realistic opportunity for increasing protein availability to rural and urban poor of the region while at the same time increasing income to the small producers. Land used for fish culture can be space essentially unused for food production---marshes, land with saltladen soils, brackish and saltwater streams, estuaries and sea shelves. Many of the suitable sites are public lands or waters available to the rural poor who own no land. The most rapid recent expansion of milkfish farming has been labor intensive pen culture in natural waters utilizing bamboo cages, and requiring little capital. Fish production is well suited for small pond and small land holdings as well, and with high labor inputs yields as high as 24,000 lbs. of fish per acre have been achieved.

In addition to the general benefits of fulfilling a major aquaculture void, a successful project will first contribute significantly to local and then national domestic need for animal protein which cannot be met by land animal production. In the long term such a project would contribute to maintaining low and stable prices of fry or juveniles, and subsequently harvested fish. The planning and development of hatchery and nursery centers are the national priority of many countries which are dependent on aquatic animal protein to meet minimal population requirements, and which are facing annual shortages because of natural and environmental influences.

The Agency has recognized, through its Fisheries Division in the Technical Assistance Bureau (Agriculture), and in its Overseas Missions, the importance of integrating modern technical research and development in aquaculture with the traditional practices of subsistence fisheries in the LDC's. The opportunities for increased gain are substantial, but the technology has to be "packaged" before application in the field.

Best Available Document

b. Side Effects

Environmental side effects are predominantly beneficial. There is the minimum tradeoff with land animal production as aquaculture mostly occupies non-agricultural land, but does compete for fertilizer and, in some cases, raw materials for feed. Aquaculture is labor intensive in certain seasons, but is similar to agriculture for the rest of the year. Aquaculture complements the utilization of agricultural waste, a problem presently affecting modern intensive aquaculture, but not rural agriculture of the LDC's where the two have been integrated for centuries.

Any aquaculture projects closely complement the other concerns of the Agency as they are directly concerned with food and energy requirements, and the status of the poor in the LDC's. Primarily aquaculture is concerned with the production of directly utilizable aquatic animal protein in the immediate vicinity of a needy village community, and by methods which have been traditional to the community for many decades. There is the added benefit of labor and income both to the individual and to the community.

4. Relation to Existing Knowledge

The countries of Indonesia, the Philippines, and Taiwan are the three main centers of milkfish culture. The traditional practices in Indonesia (about 350 kg/ha per annum) and the Philippines (600 kg/ha) are less productive than the new techniques for management currently being developed in Taiwan (over 2,000 kg/ha). However, for all three nations the main constraint is the nonavailability of the young fry, and this is very evident in Taiwan which for many years imported fry from the other two countries. In the Philippines, the annual deficiency of fry is estimated to be over half a billion, and in Taiwan the need is of lesser magnitude but still numbering in the millions.

The current interest in milkfish has therefore added to the very scant background knowledge of the species. Most of the literature contains references to farming practice and fertilizer application, and general biology and natural history. Only in the last few years has specific information been added due to some independent studies on breeding and holding adult stock in the Philippines, Taiwan, and Hawaii. Currently, egg and larval surveys are being conducted in Thailand and South India, and there is a UNDP-supported project involving milkfish in Indonesia.

Without making specific references, information is now being accumulated rapidly in the following areas. Note that reference to Hawaii mostly indicates Agency-sponsored work.

a. Behavior and Bio-ecology in Nature

Taxonomic data is being accumulated from a number of sources which indicate racial differences. This is being reinforced by electrophoresis of eye lens proteins and isozymes. Migratory pathways of the adults are being followed by telemetry, together with oceanographic conditions and preferences of the fish for spawning. Age and growth data are being collected universally in addition to feeding requirements.

b. Egg and Larval Surveys

Plankton surveys from milkfish regions are being reviewed for eggs and larvae of milkfish. Predominantly these took place in Southeast Asia, but new surveys are being planned. The need is to define spawning grounds and to verify or deny unsupported observations.

c. Maturation and Reproduction

Data on reproductive physiology of the fish are all recent. Work is predominantly being conducted in Hawaii, Taiwan, and the Philippines. Details are being provided on gonad development for both males and females. Preliminary induced spawning is being attempted at all three places with hormones.

d. Egg Incubation and Larval Rearing

Only very old information is available on egg incubation and early larval rearing. New data await the success of induced spawning. Rearing of fry after the yolk-sac stages is well established and traditional but can be improved by better handling and distribution techniques.

e. Predators, Pathology, and Physiology of Stress

Nothing existed on milkfish pathology or physiology of stress in the literature until recently. Present work is being conducted in Hawaii and the Philippines. Information of a general nature was available on parasites.

f. Hatchery Technology

The technology for hatchery production of brackishwater fish species of interest to LDC's is being developed in Hawaii, Taiwan, and Israel.

5. Relation to Other Related Projects

The project directly complements other Agency activities in fish culture integrating the emphasis on brackishwater fish with that of the freshwater fish

projects undertaken by the International Center for Allied Aquacultures at Auburn University, Alabama. With the support of the Auburn Center, the Agency has concentrated strongly on improving the freshwater fisheries of Central and South America, and in Africa. Support to the Agency by the University of Rhode Island for coastal zone fisheries and production economics add to the Agency's increasing emphasis on aquaculture development.

These three institutions maintain close contact on fisheries topics, particularly in working on areas of key constraints.

The International Center of Auburn through its involvement with the Agency-backed University of the Philippines Inland Fisheries Project, is involved in pond management for improving milkfish production, and is undertaking studies on fish migration.

Through its support of the Oceanic Institute in Hawaii, the Agency is indirectly assisting the joint cooperative program developed by the International Development Research Center and the Southeast Asian Fisheries Development Center in the Philippines. Contributors to the program are individuals from projects supported by the Taiwan Fisheries Research Institute, the University of the Philippines, the Philippine Council for Agriculture and Resources Research, the Philippine Bureau of Fisheries and Aquatic Resources, the Hawaii Institute of Marine Biology, the Central Fisheries Research Institutes of India, the Shrimp Culture Research Centre of Indonesia, Thailand Department of Fisheries, and the Ichthyological Society of Japan. Many of these projects are backed by funds from international development agencies.

Finally, and most important, the Agency interest in aquaculture closely parallels the objectives of the newly established International Center for Living Aquatic Resources Management. The new organization has a strong interest in the production of aquatic animal protein through the propagation and farming of the brackishwater fishes important to the LDC's. Many of the brackishwater fish species have similar breeding problems. The culture of milkfish in Hawaii and elsewhere will be of direct importance to the entire brackishwater fish and farming movement. The core of technical personnel supported by the Agency in Hawaii can be the nucleus of a technical group applying research and technology to a much wider range of brackishwater species and coastal aquaculture production problems working in association with the broader objectives of ICLARM.

6. Research Project Design and Methods

a. Design Procedure and Tasks

The research project design and methods of approach for most of the contract have been specifically identified in the first contract (AID/TA-C-1189). As has been demonstrated in both the annual reports and in scientific publications resulting from the initial phase of this research correct experimental procedures have been stressed and experimental designs facilitating statistical analysis of results are used routinely. In instances where only a few experimental animals have been available only preliminary trials have been possible. These trials have lead to the establishment of appropriate ranges of parameters to be examined in later properly designed experimehts.

The research tasks to be addressed under this contract are as follows:

(1) Establish broodstock in captivity.

(a) Collection of increased numbers of mature fish in season (at sea).

(b) Collection and growing-on greater numbers of immature fish (from brackishwater ponds).

(c) Collection of migratory fish (from known runs).

(d) Development of broodstock husbandry.

(e) Holding, handling and sampling large fish.

(f) Identification of broodstock individuality.

(g) Year-round breeding through environmental control.

(2) Establish conditions for spawning.

(a) Determination of natural spawning conditions (through location of spawning sites).

(b) Simulation of spawning conditions in laboratory (by environmental control)

(c) Attempt spawning without hormone treatment (by behavioral responses).

(3) Induce spawning by hormone injection was to:

(a) Define the optimum induced spawning procedure (for salmon gonadotropin, specifying correct time for treatment, dosage, dose rate, response. etc.).

(b) Determine cost effectiveness of readily available hormones.

Experiments will include:

i. Determine natural reproductive physiology (for both sexes) from immaturity.

ii. Determine responses to hormone treatment.

iii. Test reactions to salmon pituitary gonadotropin.

iv. Test reactions to other cheaper hormones.

(4) Improve survival of larvae in laboratory.

(a) Nursery I (Day 0 - Day 21*) development Definition of Nursery I rearing procedure with recommended facilities, food and food density, rearing density water quality and external environmental conditions etc.

(b) Production high survival (%) from available eggs.

(5) Increase hardiness of larvae to juvenile stage.

(a) Nursery II (Day 21 - Day 50*) development Definition of Nursery II rearing procedure with recommended facilities, food and food density, rearing density, water quality and environmental conditions.

Juveniles larger and healthier than those caught and distributed by the existing farming operators and expected products.

(b) Economics of operations--low cost of juveniles.

* An estimated stage differentiation.

(6) Improve handling and husbandry of juveniles.

(a) Improve collection of juveniles from Nursery II facilities.

(b) Develop safe transportation methods.

i. Develop safe procedures for mass collection and transportation of nursery stock.

ii. Recommend optimum economic transfer method for fry distribution.

The new contract proposes to extend the project with the following specific tasks in years FY 04 and FY 05.

(7) Conduct practical pathological treatment to eliminate handling stress and mortalities and reduce diseases of captive stocks.

(a) Routine examination or autopsy of all fish for background pathology.

(b) Conduct diagnostic tests using modern histological and biochemical clinical methods.

(c) Pursue related research toward practical application for the hatchery and the farmer.

(8) Commence tracking and tagging operations in the field.

(a) Examine existing plankton collections in Hawaii and conduct systematic plankton survey.

(b) Capture, tag, and track adult fish and synchronize plankton tows.

(c) Conduct large tagging trials in the Philippines.

(9) Conduct experimentation on breeding in the field.

(a) Assemble annually a team to work in the field responding to individual seasonal availability in the Pacific Islands and Southeast Asia.

(b) Design field units for a mobile task force investigating breeding locations.

(10) Establish a cryogenic unit.

(a) Collect and preserve sperm.

(b) Test periodically for viability.

(11) Begin hatchery development.

(a) Site selection survey.

(b) Engineering drawing and design.

(c) Construction planning.

b. Tasks, Targets, and Milestones

See Figure 1.

c. Resources Required

The staff resources required are those which would constitute a multidisciplinary team of scientists, technologists, engineers, and practical culturists. Briefly, the elements are:

i. Reproductive physiology-requiring a Ph.D. team leader supported by three research assistants concentrating on physiology, histology, biochemistry, cryogenics, and hormone studies.

ii. Fish culture - requiring a Ph.D. team leader with a research assistant responsible for research projects in larval bioenergetics, larval nutrition, environmental regulations, and rearing facilities; together with a research associate responsible for production and husbandry, supported by three technicians and/or fishermen.

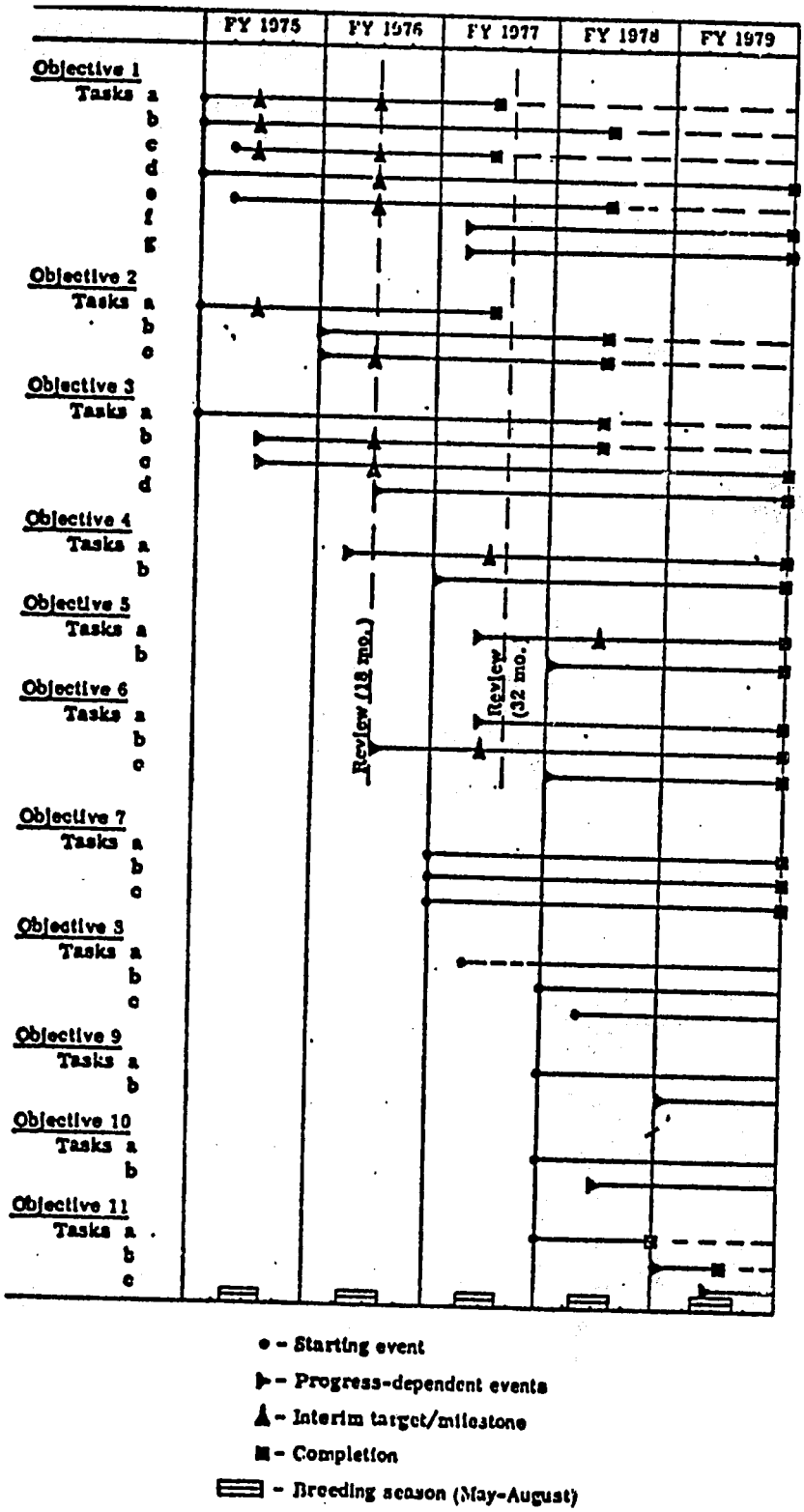

Figure 1. Project time chart.

iii. Pathology — requiring a Ph.D. team leader and a research assistant responsible for the health and care of the fish and research aspects related to the project.

iv. Engineering — requiring a certified engineer team leader supported by a junior engineer for equipment development, hatchery technology, and implementing hatchery development.

v. Coordination and direction — requiring a Ph.D. project leader to coordinate the teams to be directly involved in at least one aspect of the research, and for overall responsibility for field application.

Overseas cooperation would be necessary by at least one technical aquaculture group. Liaison between the group(s) would be made through the Agency centers and some of their established technical support. For example, in the Philippines, the work could be linked through the UP.IFP Project funded by the Agency and involving Auburn University aquaculture staff as technical advisers.

The cost of continuing the project which was established first in 1975 (FY 01) into 1978 and 1979 (FY 04 and 05), including the addition of five new elements to the original six elements, is $912,040.00.

7. Contribution to Institution Building

In most developing countries, existing aquaculture centers are extremely small with limited facilities for research or pilot-scale operations. Few have interdisciplinary teams of workers or the equipment for advanced research. Consequently, few are able to undertake the long-term research and development programs which keep a team together. Even in countries like the United States, where funding is much easier comparatively, it is recognized that excessive diffusion of research funds negates the quality and intention of the work.

The high-priority research problems in aquaculture in most regions of the world have been formulated many times by expert groups. Within the limits of the available funding resources, a few existing institutions in the developed world are attempting to undertake work on some of the problems. Recognizing that none of the existing institutions have the capability to carry out research on all or even a number of the problems, there is a need to establish a few centers of scientific, and technical expertise with a critical mass of staff and facilities. These centers will concentrate their efforts on major problems of general regional and

inter-regional importance, implementing the results in cooperation with institutions in the LDC's through demonstration and training; that is, by developing the packaged technology in technically advanced countries and applying it directly in the field.

The increased support of this project by the Agency will help create a technical group capable of backstopping a number of seed production programs. It will increase the overall competence and efficiency of the personnel, and assure more effective utilization of equipment, facilities, and instrumentation. As a result, it will provide the Agency with another center of competence in aquaculture and fisheries, together with the International Center for Allied Aquaculture at Auburn University and the University of Rhode Island, capable of applying present and future Agency projects in the LDC's.

8. Plans for Utilization

The principal utilization potential lies in a country-by-country effort to select key opportunities for aquacultural development and tying them appropriately for technical support to these institutional expertise centers, once the aspects limiting the husbandry of the fish are learned. TAB is investing a major effort in support of this effort, particularly toward effecting the necessary integration of effort and experience among the research centers and between them as a group and the aquacultural programs of individual LDC's.

The LDC's interest in aquaculture is growing rapidly. One aggressive country effort is underway in the Philippines under the general technical assistance tutelage of Auburn University. If economic or marketing problems become central. Oceanic will solicit Rhode Island's cooperation.

Brazil is developing, also with assistance from Auburn a research and development center which Brazilians hope can be a center of support for aquaculture in abutting countries if not, indeed, for the oontinent. Colombia, Vietnam, Laos, and others have active growing programs.

The Rockefeller Foundation has established an international center to concentrate on problems in aquaculture and artisanal fisheries, and the International Development Research Center of Canada is supporting pilot-level production and training aspects of fish farming in the Philippines. These are all complementary projects to the present efforts by the Agency.

4. Research Competence and Resources

The staff and research approach to aquaculture by the Oceanic Institute are both interdisciplinary. The program proposed by the Institute will fulfill the basic research and development priorities for all aspects of juvenile milkfish production and distribution. The present work is fundamental to the effectiveness of Auburn and Rhode Island in saltwater and brackishwater production systems.

The Oceanic Institute supported a five-year study on the artificial propagation of the grey mullet, Mugil cephalus, supplying one-third matching funds to annual grants from the Office of Sea Grant (U.S. Department of Commerce, NOAA). The support was terminated on July 31, 1975. The overall cost of the program has been $906,900. The Office of Sea Grant considered that the Oceanic team achieved its goal of developing induced spawning techniques and improving larval survival to a stage where the methods could be transferred and utilized for other more commercial species. Work on this species is being continued on funds provided by the International Center for Living Aquatic Resources Management to implement mullet hatchery technology in the LDC's.

The aquaculture team at the Institute is recognized internationally as a leading authority on induced spawning and artificial propagation of brackishwater species, particularly the mullet. Letters from people in both developed and developing nations come continually to the Institute asking for training and instruction in the methodology.

Other recognized experts in the field are the staff of the Tungkang Fisheries Research Station in Taiwan, with whom the Institute staff has worked closely over the years. The two organizations have produced the majority of technical reports and procedural manuals on the artificial propagation of a brackishwater fish.

Few other aquaculture organizations could take on the artificial propagation program for milkfish without major investment and relocation of key and experienced personnel.

Dr. H. Burr Steinbach, until recently Dean of the Graduate School of Woods Hole Oceanographic Institution, serves as President of the Oceanic Institute. Dr. Colin E. Nash, Director of Research, and Dr. Ching-ming Kuo, head of the Aquaculture Division, under whom the research project will be carried out, have extensive research experience in the problems addressed by this project. They will be supported by other senior researchers including Albert C. Smith, Ph.D., M.D., and Guy N. Rothwell, Jr., B.S., C.E.

The Oceanic Institute's physical facilities are modest but adequate, consisting of a cluster of wooden framed buildings of various sizes adjacent to the sea in Waimanalo Hawaii. Its 3,600-square-foot principal laboratory houses aquaria, larval, chemistry, microbiology, histology, microscopy, and controlled water-temperature laboratories. Other buildings contain an electronics lab, photoperiod lab, office space, library, and training facilities.

The Institute obtained in 1976 an appropriation from the State of Hawaii for $300,000 to complete a fish hatchery for marine and brackishwater propagation. Plans are being completed and construction will start in 1977. This will be a key focal point for fish culture work in the Pacific and has direct relevance to the aquaculture needs of LDC's everywhere.

10. Overall Cost Estimates (combined Hawaii and field projects)

See following tables.

FISCA 078

	Salaries & Overhead	Capitol Items	Supplies	Travel Local & US	Travel Overseas	Publications	Consultants	TOTAL
1. Broodstock	58,113	16.750	7,000	2,000				83,863
2. Spawn. Conditions	10,397		500					10,897
3. Induced Spawning	98,625	9,450	3,600	800		500		112,975
4. Larval Survival	30,178		1,600					31,778
5. Larval Rearing	30,178		1,500					31,678
6. Husbandry	23,043		3,000					26,043
7. Pathology	58,281	4,900	3,500	800		1,000		68,481
8. Tracking	37,327		8,500		4,800	500	2,500	53,627
9. Field Breeding	10,291		500		3,300		1,500	15,591
10. Cryogenics	10,301	1,700	1,700					13,701
11. Engineering	10,063		1,100		3,300			14,463
	376,797	32,800	32,500	3,600	11,400	2,000	4,000	463,097

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FISCAL 1979

	Salaries & Overhead	Capitol Items	Supplies	Travel Local & US	Travel Overseas	Publications	Consultants	TOTAL
1. Broodstock	41,507	6,000	6,300	2,300		500		56,607
2. Spawn Conditions	5,499							5,499
3. Induced Spawning	95,692	1,500	3,000	1,600		500		102,292
4. Larval Survival	45,888		1,000					46,888
5. Larval Rearing	40,362		500					40,862
6. Husbandry	33,266		2,000					35,266
7. Pathology	58,286	500	2,000	800		1,000		62,586
8. Tracking	39,828		1,000	800	3,500	500	2,500	46,128
9. Field Breeding	13,236		1,000		3,500		1,500	19,236
10. Cryogenics	10,301		1,800					12,101
11. Engineering	12,078		3,200		3,500	500		19,278
	395,943	8,000	22,000	5,500	10,500	3,000	4,000	448,943

11. Work Plan and Contract Budget

Item 1 - Establish Broodstock in Captivity

a. Collection of mature fish in season (at sea)

We have so far collected by various means a total of 120 adult milkfish, of which 50 survive. Adult milkfish will continue to be collected from coastal bays and harbors in Hawaii using well-developed capture and transport methods. Capture at sea, while not now possible with present gear or staff, will be pursued in cooperation with NMFS and other agencies which have greater resources (e.g., large ships).

Continued efforts to improve handling methods of adult fish will be made. Specific work will be directed toward improving survival of the fish during transport by using anesthesia, temperature, and salinity. A further reduction in stress levels would be expected to increase survival of wild adults and juveniles above the present 50% level. A doubling of the number of adult fish from the present 50 is a primary goal of the capture program.

b. Collection and growing-on of immature fish (from brackishwater ponds)

We have collected (with no significant losses) 100 first-year-class juveniles, plus an additional 100 subadults. Immature fish will continue to be taken whenever encountered. Methods to ensure high survival of adults and juveniles will be improved further. Collection of these fish will be primarily from fishponds. Juveniles and fry will be stocked in ponds at O.I. for growing out to ensure a satisfactory supply of research and broodstock animals for the next program years. Present stocks of juvenile and subadult milkfish will be doubled pending increased pond capacity.

c. Collection of migratory fish (from known runs)

Liaison with the fishing community in Hawaii has been established and O.I. will continue to exploit information regarding spawning and migratory patterns of the milkfish. Collection of fish from migratory pathways in Hawaii will be expected when and if such runs have been identified.

d. Development of broodstock husbandry

Diet requirements will be defined through laboratory and growout experiments. Cooperation with other laboratories such as HIMB which currently have necessary facilities for laboratory analysis will occur. A satisfactory prepared feed for milkfish is expected. Growout trials in ponds will be conducted at O.I. and, as opportunities arise, in association with various pond owners throughout the State. Disease and parasite control will be an important aspect of the husbandry work. Prophylactic methods have been developed and will be further

defined. This portion of the work is closely linked to the pathology program and will be emphasized. A manual will be written, with a preliminary draft available for review on 1 March 1978.

e. Holding, handling and sampling large fish

Further development of techniques and methods to handle adult milkfish so as to reduce stress and eliminate injury and mortality will be made. Adult fish (>3 kg) are present handled by hand using a restraining box developed during 1976. This device restricts movement and facilitates weighing, tagging, gonad sampling, and hormone injection without anesthetization. Continued improvements will be expected.

f. Identification of broodstock individuality

Two years' experience with physical segregation, fin clipping, and plastic identification tags has shown that while fin clipping has short-term utility, a combination of segregation and tagging is necessary in the long term. Work with plastic tags will continue, leading to recommendations for tag type and method of application.

g. Year-round breeding through environmental control

Regimes for the extension of the reproductive cycle throughout the year by environmental control will continue to be developed. Definition of environmental parameters required for spawning will enable us to more critically control the maturation of the fish out of season. Behavior of broodstock animals will continue to be studied in the laboratory under photoperiod and temperature control.

Item 2 - Establish Conditions for Spawning

a. Determination of natural spawning conditions (through location of spawning sites)

An electronic fishtag has been developed, and data on inshore currents in Hawaii have been compiled. Subject to the success of the tagging trials scheduled for summer 1977, and/or to obtaining notice of observations of a milkfish spawning event, a small-scale survey of the physical, chemical, and biological properties of the spawning location will be made by O.I. personnel. The results will be used directly in adjusting the appropriate parameters of the various induced spawning experiments.

b. Simulation of spawning conditions in laboratory (by environmental control)

Experiments on induced gonadal development by manipulation of environmental conditions (photoperiod of 18L/6D, water temperature of 26° C) were conducted from January 1976 to December 1976. Two sets of salinity (32 °/oo and 10-12 °/oo) were examined. Inadequacy of nutritional supply to these experiments was identified as a serious problem. It is planned to emphasize nutritional and physical conditions in future experiments. The conditions for gonadal maturation will be refined as the attempts continue. The overall results will be reported at the end of 1979. If environmentally induced maturation proves possible, the best conditions for gonadal development will be established.

c. Attempt spawning without hormone treatment (by behavioral responses)

Observations on the possibility of spontaneous spawning of milkfish in confinement have been made in 1975 and 1976. No positive indication was obtained. The attempts will be continued by modification of physical conditions whenever mature females are available. The priority of breeder usage will be given to the hormonal induced spawning in order to achieve artificial propagation of milkfish fry as soon as possible. Once the possibility of spontaneous spawning in captivity has been observed, the results will be reported.

Item 3 - Induce Spawning by Hormone Injection

a. Define the optimum induced spawning procedure (for salmon gonadotropin, specifying correct time for treatment, dosage, dose rate, response, etc.)

The responsiveness of mature females to salmon pituitary gonadotropin has been examined since 1975. Various injection schedules and dosages were tested. The response of treated females were followed individually. Asynchronism of egg hydration was observed and premature spawnings were repeatedly obtained. It is anticipated that human chorionic gonadotropin will be more effective to induce spawning, if fully ripened eggs can be assured. The technique of artificial fertilization will be examined. To test this possibility, a group of three O.I. staff is planning to join the SEAFDEC/IRDC team at Pandau, Philippines, in April 1977. All the results will be reported and a procedural manual of induced breeding of milkfish will be published for technology transfer use.

b. Determine cost effectiveness of readily available hormones

As a standard induced spawning technique is established, search for alternative hormones and/or drugs will continue. Feasibility of any available hormones will be examined on the basis of effectiveness and cost.

Research on the mullet is continuing. The results are readily applicable to the milkfish.

Item 4 - Improve Survival of Larvae in Laboratory

a. Nursery I (Day 0 - Day 21*) development
Definition of Nursery I rearing procedure with recommended facilities, food and food density, rearing density, water quality, and external environmental conditions, etc.

Nursery methods will be developed for Nursery I using, as a starting point, the methods proven successful in rearing grey mullet larvae. Similar food items and densities will be varied to accommodate milkfish requirements in a multivariable investigation of water quality and nutritional parameters.

If this investigation is successful, experiments to test artificial foods for larval rearing will be conducted and food requirements will be defined. Cooperation with the NMFS and other workers in nutrition is anticipated to provide alternative feeds at less cost than is now possible with live foods.

b. Production high survival (%) from available eggs

The procedures developed for Nursery I will be implemented to demonstrate a technical ability to successfully raise milkfish larvae with high survival.

Survival rates of mullet using both extensive and intensive rearing methods range from 2.5% to 20% by day 21. These methods will be applied to milkfish larval-rearing efforts, with the goal of similar survival rates.

Item 5 - Increased Hardiness of Larvae to Juvenile Stage

a. Nursery II (Day 21 - Day 50*) development
Definition of Nursery II rearing procedure with recommended facilities, food and food density, rearing density, water quality and environmental conditions

As for Nursery I, nursery methods will be developed to be utilized in rearing Nursery II milkfish to juvenile stage. These methods will expand upon

*An estimated stage differentiation.

current literature and observations on the rearing of milkfish larvae at the Oceanic Institute and elsewhere.

Evidence suggests that milkfish larvae differentiate at the third week after which they are able to feed on algal foods. As with Stage I larvae, work will be directed toward defining the best food species, densities, fry density, and water quality requirements. The goal for this work will be juveniles which are larger and healthier than wild stock and of a consistent size for stocking.

b. Economics of operations--low cost of juveniles

When rearing procedures have been outlined sufficiently, a cost evaluation will be made to explain and improve upon cost functions in rearing milkfish.

Item 6 - Improve Handling and Husbandry of Juveniles

a. Improve collection of juveniles from Nursery II facilities

Improvement of juvenile collection from Nursery II facilities will be based upon consolidation techniques now being evaluated for mullet larvae. These will include physical crowding mechanisms, use of phototaxis on both the juveniles and food organisms, and directional currents and salinity gradients.

b. Develop safe transportation methods

Current handling and collecting techniques in Taiwan, Indonesia, and the Philippines will be reviewed. Methods employing least cost and ensuring greatest survival will be examined and compared with known tolerances and requirements of the fry. Further definition of life support requirements will be made. Equipment and procedures developed or adapted will be reported on.

Item 7 - Conduct Practical Pathological Treatment ($ 68,481 & 62,586)

a. Routine examination or autopsy of all fish for background pathology.

All milkfish, whether ocean or pond captive or fish maintained on site, will be routinely autopsied. In addition to standard autopsy procedures with body organs, particular attention will be paid to new pathogens. Records of such will continue to be filed with the Smithsonian Institution (as presented in 1976). Information of a general pathology nature will be published, possibly in the form of information leaflets. End results (though continual) will be an extensive description of naturally occuring pathogens which effect milkfish of all ages and origins.

b. Conduct tests using modern clinical methods.

New methods for detecting pathogens will be developed using relevant medical techniques. Continued attention will be paid to the pathogens known or thought to be relevant to the condition of nervous stress, as reported in 1976. Treatments will be applied to both newly caught and resident fish, and also tested during specific experiments designed to encourage stress among resident stocks. The results will be published as developed. End results (though continual) will be substantial pathological data on the stress factors of milkfish and other brackishwater fish, and a practical improvement in the handling capabilities of live adult milkfish for captivity and breeding. A target milestone by the end of the project would be a 50% survival factor during induced breeding handling.

c. Pursue all related research toward practical application for the hatchery and the farmer.

Undertake basic research where it will be relevant to the safer handling and maintenance of milkfish. Cooperative work will be maintained with the pathology laboratory of St. Francis Hospital, and the Hawaii College of Tropical Agriculture. Material for research has and will continue to be derived from both captive and wildstock of all age groups. End results (though continual) will be substantial pathological research data reported as it develops. Results of a practical nature will be interpreted and printed as information leaflets.

Item 8 - Commence Tracking and Tagging Operations in the Field. ($ 53,627 & 48,128)

a. Examine existing plankton collections in Hawaii and undertake new tows.

Extensive plankton collections exist at the Hawaii Institute of Marine Biology, the NMFS Honolulu Laboratory, and the University of Hawaii Department of Marine Biology.

These collections will be examined to determine if they have been recorded sufficiently site and time specific to give clues to milkfish spawning grounds in Hawaii. If this looks promising, an attempt will be made to identify milkfish eggs and larvae in selected samples, and to relate the data developed to geography, season, and ocean currents. The results of this work will be reported in a paper on or about January 1978. During the summer of 1977, tows will be made near Kaneohe Bay to look for milkfish eggs and larvae from this year's season. Results will be reported on or about January 1978, along with data above.

b. Capture, Tag, and Track Adult Fish and Synchronize Plankton Tows.

Development of the electronic tag circuitry is complete, and it is planned that 50 will be made up by summer 1977. Ten of these will be expended during the summer spawning period during trials in Kaneohe Bay to develop techniques for attachment and tracking. The goal is to achieve successful tracking of at least one school of milkfish including tagged individual(s), to identify the environmental parameters of spawning locations. Proof of accomplishment will be our ability to maintain contact with the tag(s) for a period of several hours, and stated parameters at spawning locations.

If the tracking trials succeed in following a seaward-migrating school, transects will also be made across the prevailing currents with plankton nets in an attempt to intercept fertilized milkfish eggs to learn more of egg incubation and coastal movement of larvae.

c. Conduct Large Trials on Location in the Philippines.

The accomplishment of this item will depend very largely upon arrangements with and cooperation by existing organizations in the Philippines. No detailed plans have yet been formulated for this item. We expect that a memorandum outlining a planned field operation will have been written, circulated among the interested organizations, and approved by March 1978, leading to field operations beginning in that year.

Item 9 - <u>Conduct Experimentation on Breeding in the Field.</u> ($ 15,591 & 19,236)

a. Assemble Annually a Team to Work on Location in the Field, Responding to Individual Seasonal Demands in the Pacific Islands and Southeast Asia.

In April 1977 three members of the Institute team are being sent at the expense of the project to work with the SEAFDEC/IRDC team at Pandan, Philippines. In

March 1977 a staff member of the Hawaii Institute of Marine Biology was commissioned to visit Palau in the Trust Territory to make preliminary observations on reported lunar spawnings of milkfish. If these missions are successful, each year at the appropriate time, staff members will be sent to these and other locations to collect mature fish on the threshhold of spawning, and subject them to many 'spot-check' injections, using gonadotropins, HCG, and prostaglandins, etc. The results will be data which will set the ranges for controlled experimentation on captive fish. Observations on spawning will also direct construction of future facilities for captive fish (that is, large units for schooling behavior). The program will also provide strong linkages with other units in the field (SEAFDEC and MMRC) and other international programs (IDRC).

b. Design Field Units for a Mobile Task Force Investigating Breeding Locations.

If reports of accessible spawning schools in the Pacific Islands are confirmed, the objective will be to collect and transport fertile eggs and emergent fry in large quantities back either to Hawaii, Palau or the Philippines. A small portable field unit and personnel will be prepared to undertake such a mission(s). Success will be accepted if live eggs or larvae are transported to a major fish culture base. The end result (though continual) will be material to advance other program sub-projects (#4). Another end-result might be a major source of large numbers of active fry for such countries as the Philippines or Taiwan.

Item 10 - Establish a Cryogenic Unit ($ 13,701 & 19,278)

a. Collection and Preservation of Sperm.

Although experiences with other fish indicate that running males can be found at most times of a natural breeding season, the numbers (50) of males involved might not be adequate to cover all eventualities. Cryogenic methods for storing fish sperm have improved sufficiently to be practiced by the project without extensive research into techniques. A small cryogenic unit will be established to collect and preserve sperm from male milkfish. Sperm viability will be recorded by standard observations and tests on live fish if possible. End results will be directions for the collection and storage of sperm for milkfish, technical publications, and a stock pile of sperm.

b. Periodic Testing for Viability

As an investment for a long term sperm bank, the stored sperm will be spot-checked and logged for viability using standard observations and spot checks on live females. Trials on shipment of sperm will be conducted in assocation with

SEAFDEC in the Philippines. The end results will be recommendations for sperm banks (should the practice prove feasible), and their use with genetic programs at hatcheries. The data will be published.

Item 11 - Hatchery Development ($ 14,463 & 19,278)

a. Site Selection Survey

At this time it is not possible to state with an assurance, where or when a milkfish hatchery will be constructed or by whom. The responsibility of the engineering group is therefore to gather engineering information from what ever source, and to assemble a design memorandum containing appropriate site selection criteria, hatchery schematics including space requirements, tankage volumes, water supply and management schematics, and as much detail as possible on such aspects of brackish/saltwater fish hatchery design as are not site-specific. At present, we envision the first "edition" of this memorandum as complete at the end of June, 1978, and available for review and responses by other workers in the field at that time. A second edition would be published in June, 1979.

b. Engineering Drawing and Design

This is properly accomplished by professionals in the country of interest, if such exist, aided by consultation from our engineering group. Because of the nebulous nature of the eventual hatchery locations, size, owner, etc., we have provided only modest allowances of time (2 man months/year) for this category. The bulk of the actual consultation costs should be defrayed from the appropriation for hatchery design and construction, which is outside the scope of the present contract.

c. Construction Planning

Working with the International Center for Living Aquatic Resources Management (ICLARM), the Institute is preparing a Hatchery Design Guide for the breeding and propagation of grey mullet and (potentially) other brackishwater fish. The Institute will be using this guide to implement construction of a hatchery in a developing country as part of ICLARM's program in aquaculture. The project proposes to update this Design Guide using the most recent techniques (if available) for the milkfish. A Guide for milkfish propagation might therefore be available by January 1980.

12. Management Considerations

Oceanic Institute shall maintain appropriate contacts with AID on both technical and other contractual matters affecting the carrying out of this project. Questions involving technical matters, funding and managerial decisions will be referred to the Fisheries Division in the Bureau for Technical Assistance (TA/AGR/F). Other routine matters will be handled directly with the Office of Contract Management (SER/CM).

Periodic project reviews and evaluations will be scheduled at mutually agreeable times with the concurrence of the TA/AGR/F Staff.

Oceanic Institute will continue to provide annual reports to AID and to provide occasional scientific and technical reports to interested scientists and institutions.

13. Internal and External Reviews

Reviews have been held in May 1966 and March 1977. Copies of reports resulting from these reviews are attached. Reviewers were generally complimentary and agreed with the importance of this research. Oceanic Institute has been responsive to the criticisms of the first review team and the proposal for continuation reflects responses to the second review. Specifically, new holding facilities are being constructed to increase the numbers of experimental adult animals available, major emphasis is being placed on development of hormone spawning techniques, and research activities will be conducted in the Philippines with races of fish most valuable to fish farmers under local environmental conditions. This step will significantly increase the availability of experimental animals since spawning times in Hawaii and the Philippines are different.

14. Proposing Office General Approval

The project has a very high rating from the Sponsoring Office with respect to the importance of the research to the rural poor in LDC's, the quality of the research conducted so far under the contract, the significance of the research findings. and the probability of additional contributions of major consequence.

The Sponsoring Office expects a rapid acceleration of the research with the fourfold increase in personnel. The promising nature of results obtained thus far has encouraged the assignment of additional manpower to the project, and this office supports the need for such an increase.

The highest priority should be placed upon perfecting techniques for hormonal inducement of spawning and the aquisition of sufficient adult fish to complete this phase of the research. Most other activities are supportive of this role and are, therefore, also important. Efforts to track adults to their spawning grounds using radio tags do not have the high priority assigned to the hormone spawning work but are, nevertheless, an important part of the research on spawning inducement through environmental control.

15. Minority Personnel and Women

The complement of staff involved in the project, either full or part-time is twelve. Of these, two are female Oriental technicians who are responsible for laboratory work.

The male staff includes one Japanese, one Chinese, one Hawaiian, one Jew, and six Caucasians. The project also involves local fishermen principally Orientals and Hawaiians hired according to their ability to deliver live adult fish.

Of the total Institute staff, some of whom provide administrative and clerical services associated with the grant as overhead, eleven of the thirty are female.

16. Environmental Statement

The research being conducted has no adverse environmental effects. With the fish farming likely to result from this research the environmental side effects are predominantly beneficial. There is the minimum tradeoff with land animal production as aquaculture mostly occupies nonagricultural land, but does compete for fertilizer and in some cases, raw materials for feed. Aquaculture is labor intensive in certain seasons, but is similar to agriculture for the rest of the year. Aquaculture complements the utilization of agricultural waste, a problem presently affecting modern intensive agriculture but not rural agriculture of the LDC's where the two have been integrated for centuries.

AID-1020-20 (1-72)

PROJECT DESIGN SUMMARY
LOGICAL FRAMEWORK

Life of Project:
From FY 1975 to FY 1980
Total U.S. Funding $1,440,409
Date Prepared: April 8, 1977

Project Title & Number: Research and Implementation of Milkfish Propagation

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Program or Sector Goal: The broader objective to which this project contributes: To promote fish farming thereby increasing availability of food and opportunities for employment for the rural poor.	Measures of Goal Achievement: 1. Increase of production of low-priced fish in LDC's. 2. Increased consumption of fish by the rural poor. 3. Increased employment of poor in fish farming activities.	1. Fishery statistics. 2. Economic studies of fish farming and product distribution. 3. Observation of use of new technology in LDC's.	Assumptions for achieving goal targets: 1. Land and labor resources for increased saltwater fish farming are available. 2. Fingerling supplies from wild stocks are inadequate and limit production. 3. Hatchery procedures will be used when practical technology is available. 4. Appropriate extension work will make technology available.
Project Purpose: To develop dependable methods for maturing and spawning milkfish and for rearing fry to a size suitable for stocking.	Conditions that will indicate purpose has been achieved: End of project status. 1. Description of methods of handling adults. 2. Demonstration of methods for holding and maturing adult fish in captivity. 3. Description of practical techniques for inducing spawning on demand. 4. Description of methods for rearing fry.	1. Data collected during research and demonstration activities. 2. Acceptability of results for publication in scientific journals. 3. Project reviews.	Assumptions for achieving purpose: That research approach is valid. That method similar to those used with other fish (e.g. mullet can be developed within given time frame.
Outputs: Publications describing methodology and techniques for holding maturing, spawning milkfish and for rearing fry.	Magnitude of Outputs: Minimum of 5 scientific and/or technical reports with at least 500 copies of each report being made available through publication in scientific journals and widespread distribution of reprints in appropriate LDC's	1. Observed publication of report. 2. Discussions and feedback with the scientific community.	Assumptions for achieving outputs: 1. Research results will be published and distributed. 2. Appropriate extension mechanisms are operating.
Inputs: Scientific manpower Supplies Equipment Travel funds	Implementation Target (Type and Quantity) 156 man months per year as budgeted	Contractors Annual Report Project management records Audit reports	Assumptions for providing inputs: Proposal is funded as requested.

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Vice-President and Director of Research
The Oceanic Institute

Academic

Leeds University, Yorkshire, B.Sc., 1959.
Leeds University, Yorkshire, Ph.D., 1962.

Experience

Vice-President, The Oceanic Institute, 1973 - present.
Director of Research, Oceanic Institute, 1972 - present.
Co-Director, Aquaculture Division, Oceanic Institute, 1971 - 1973.
Assistant Principal Officer, Fish Farming, for White Fish Authority, 1970.
Research Officer and Project Head for aquaculture in discharges from electricity generating plants, for White Fish Authority, 1966 - 1970.
Research Officer and Deputy, Plaice propagation hatchery development, White Fish Authority, 1963 - 1966.
Research Fellow, International Wool Secretariat, London, 1962 - 1963.

Affiliations

American Fisheries Society
Challenger Society
Smithsonian Institution
World Mariculture Society

National and State Services

Consultant, U.S. AID (RED).
Delegate, South Pacific Islands Fisheries Development Association, 1971 - 1972.
Delegate, South Pacific Commission, 1971 - 1972.
National Oceanographic and Atmospheric Administration (NOAA), Aquaculture Survey Steering Committee Member, 1973.
Governor's Advisory Panel for Marine Resource Development, Aquaculture Sub-Committee Member, 1972 - 1974.
Consultant, Aquaculture, Office of Sea Grant, 1973-present.

Editorial Board

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April, 1976

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Colin E. Nash, Ph.D.

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Nash, C.E. 1973. Automated mass production of Artemia salina for hatcheries. Aquaculture 2:289-298.

Kuo, C-M., Z.H. Shehadeh and C.E. Nash. 1974. A procedural guide to induce spawning in grey mullet (Mugil cephalus L.) Aquaculture 3:1-14.

Nash, C.E., C-M. Kuo and S.C. McConnell. 1974. Operational procedures for rearing larvae of the grey mullet (Mugil cephalus L.) Aquaculture 3:15-24.

Kuo, C-M., C.E. Nash and Z.H. Shehadeh. 1974. The effects of temperature and photoperiod on ovarian development in captive grey mullet (Mugil cephalus L.) Aquaculture 3:25-43.

Nash, C.E. 1974. Residual chlorine retention and power plant fish farms. Progr. Fish-Cult. 36:92-95.

Nash, C.E. and J.R. Sylvester. 1974. Thermal tolerance of eggs and larvae of Hawaiian striped mullet (Mugil cephalus L.). Trans. Am. Fish Soc. (in press).

Sylvester, J.R., C.E. Nash and C.R. Emberson. 1974. Preliminary study of temperature tolerance in juvenile Hawaiian mullet (Mugil cephalus) Progr. Fish-Cult. 36:99-100.

Nash, C.E. and C-M. Kuo. 1974. Hypotheses for problems impeding the mass propagation of grey mullet and other finfish. Paper presented at IBP/PM International Symposium on the Grey Mullets and their Culture, Haifa, Israel, June 1974. Also, Aquaculture 5:119-133, 1975.

Kuo, C-M. and C.E. Nash. 1974. Recent progress on the control of ovarian development and induced spawning of the grey mullet (Mugil cephalus L.) Paper presented at IBP/PM Int'l Symposium on Grey Mullets and their Culture, Haifa, Israel, June 1974. Also, Aquaculture 5:19-29, 1975.

July 1975

Nash, C.E. 1974. Potential for the development of aquaculture in the Indo-Pacific region. 16th Session of Indo-Pacific Fisheries Council, Jakarta, Indonesia, October-November.

Lee, J.H., C.E. Nash, and J.R. Sylvester. 1975. Effects of mirex and methoxychlor on striped mullet, Mugil cephalus L. EPA Grant No. R 802348. Report No. EPA-660/3-75-015.

Sylvester, J.R., C.E. Nash, and C.R. Emberson. 1975. Salinity and oxygen tolerances of eggs and larvae of Hawaiian striped mullet, Mugil cephalus L. J. Fish Biol. 7:621-629.

Sylvester, J.R., C.E. Nash. 1975. Thermal tolerance of eggs and larvae of Hawaiian striped mullet, Mugil cephalus L. Trans. Am. Fish. Soc., Vol. 104, No. 1:144-147.

Nash, C.E., T. Joyner, and R.D. Mayo. 1976. Seeding the Southern Ocean with salmon - an ocean range management program. Report to ICLARM.

June 1976

Colin E. Nash, Ph.D.

Restricted Papers for the White Fish Authority

** Senior Scientist and Author; * Senior Scientist and Joint Author
+ Joint Author

** Plaice rearing at Hunterston and Carmarthen Bay electrical generating stations, 1966.
** Dover sole rearing at Hunterston nuclear generating station, 1966-1968.
** Plaice rearing at Hunterston, 1968.
** Plaice rearing at Hunterston, 1969.
** Turbot fattening at Hunterston, 1969.
** The influence of water temperature on the growth of the plaice and Dover sole at Port Erin, Isle of Man, 1965.
* Survival of young Dover sole fed with liver supplement, Hunterston, 1970.
* Chlorination and its detection for a power station fish farm.
* Residual chlorine retention in relation to flow rate in a fish tank.
* The development of tank rearing facilities for marine flatfish.
* Design of ancillary services at a power station fish farm.
* The potential of the ormer (abalone) in marine fish farming, Hunterston, 1968.
* The measurement of water flow into a fish tank, Hunterston, 1969.
* The production of Artemia salina nauplii, Hunterston, 1968.
* An instrument for the measurement of dissolved oxygen in a marin fish farm, Hunterston, 1968.
* Production technique and costing for plaice at a power station fish farm, Hunterston, 1970.
* A synopsis of the marine fish cultivation programme, 1964-70.
+ Hydrography and management of the Ardtoe inter-tidal pool, May 1968-April 1970.
+ Plaice rearing in a sheet polyethylene floating tank, Ardtoe 1967.
+ Plaice rearing in a prototype floating cage for sheltered water, Ardtoe 1967.
+ Plaice rearing in a netting enclosure and floating cage, Ardtoe 1968.
+ Hatching of plaice at Ardtoe, 1969.
+ Plaice rearing in a prototype floating sea-cage, Ardtoe 1969.
+ An incidence of pop-eye disease at Ardtoe, 1968.
+ Design, construction and operation of a netting enclosure.
+ Design, construction and operation of small floating cages.
+ Design, construction and operation of large floating cages.

April, 1974

CHING-MING KUO, Ph. D.
Head, Aquaculture Division
The Oceanic Institute

Academic

National Taiwan University, Taipei, B.S., 1958.
Scripps Institution of Oceanography, University of California, San Diego, Ph.D., 1970.

Positions and Experience

Head, Aquaculture Division, Oceanic Institute, 1972 - present.
Research Associate, Aquaculture Division, Oceanic Institute, 1970 - 1972.
Post-graduate Research Biologist, Scripps Institution of Oceanography, 1970.
Research Assistant, Scripps Institution of Oceanography, 1964 - 1970.
Teaching Assistant, Department of Zoology, National Taiwan University, 1960 - 1964.
Research Biologist, Institute of Fishery Biology, National Taiwan University, 1960.

Publications

Kuo, C-M. 1965. The physiology of some teleost fishes, part I. Study on the sexual maturity of Silver Carp, Hypophthalmichthys molitrix C. & V. Rept. Inst. Fish. Biol., 2(1):46-52.

Kuo, C-M. 1964. Morphology of Yellowfin Tuna. China Fish., No. 138, pp 2-7 (in Chinese).

Kuo, C-M. 1964. Behavior of Yellowfin Tuna. China Fish, No. 139, pp 2-7 (in Chinese).

Shehadeh, Z.H., C-M. Kuo, and K.K. Milisen. 1973. Induced spawning of grey mullet (Mugil cephalus L.) with fractionated salmon pituitary extract. J. Fish Biol. 5:471-478.

Shehadeh, Z.H., C-M. Kuo, and K.K. Milisen. 1973. Validation of an in vivo method for monitoring ovarian development in the grey mullet (Mugil cephalus L.) J. Fish Biol. 5:489-496.

October 1976

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(Publications - continued)

Kuo, C-M., Z. H. Shehadeh and K. K. Millsen. 1973. A preliminary report on the development, growth and survival of laboratory reared larvae of the grey mullet (Mugil cephalus L.) J. Fish Biol. 5:459-470.

Shehadeh, Z. H., C-M. Kuo and C. E. Nash. 1973. Establishing brood stock of grey mullet (Mugil cephalus L.) in small ponds. Aquaculture 2:379-384.

Kuo, C-M., Z. H. Shehadeh, and C. E. Nash. 1973. Induced spawning of captive grey mullet (Mugil cephalus L.) females by injection of human chorionic gonadotropin. Aquaculture 1:429-432.

Kuo, C-M., C. E. Nash and Z. H. Shehadeh. 1974. The effects of temperature and photoperiod on ovarian development in captive grey mullet (Mugil cephalus L.). Aquaculture 3:25-43.

Kuo, C-M., C. E. Nash and Z. H. Shehadeh. 1974. A procedural guide to induce spawning in grey mullet (Mugil cephalus L.) Aquaculture 3:1-14.

Nash, C. E., C-M. Kuo and S. C. McConnell. 1974. Operational procedures for rearing larvae of the grey mullet (Mugil cephalus L.). Aquaculture 3:15-24.

Nash, C.E. and C-M. Kuo. 1974. Hypotheses for problems impeding the mass propagation of grey mullet and other finfish. Paper presented at IBP/PM International Symposium on the Grey Mullets and their Culture, Haifa, Israel, June 1974. Also in Aquaculture 5:119-133, 1975.

Kuo, C-M. and C.E. Nash. 1974. Recent progress on the control of ovarian development and induced spawning of the grey mullet (Mugil cephalus L.). Paper presented at IBP/PM International Symposium on the Grey Mullets and their Culture, Haifa, Israel, June 1974. Also in Aquaculture 5:19-29, 1975.

October 1976

GUY N. ROTHWELL, Jr.
Senior Engineer
Oceanic Institute

Professional/Academic

Registered civil and structural engineer, Hawaii 1961.
Loyola University, Los Angeles, B.A. Philosophy, 1950.
UCLA, completed undergraduate engineering curriculum, 1959.
University of Hawaii, completed courses in ocean engineering.

Positions and Experience

Senior Engineer, Oceanic Institute, 1970 - present.
Project Manager (planning, conceptual design, EIS and construction contract drawings) for ocean related projects including light draft harbors and a fish hatchery.
Principal investigator of Open Ocean Fish Enclosure Study.
Task Force member of ICLARM Southern Ocean Salmon Project.
Chief Engineer of MOSES, Floating City Development Studies, Offshore Coal-fired Electrical Power Generation, OTEC Platform Study; responsible for conceptual and preliminary engineering design, coordination with consultants and technical supervision of engineering staff.

President and Chief Engineer, Pacific Submersibles, Inc., 1967 - 1970.
A Hawaiian Company which operated the research submersible NAIA. Projects included marine biology research, bottom surveys, development and testing of undersea products, oil field and pipeline surveys, and militairy ordnance recovery in Hawaii, the Gulf of Mexico and the Gulf of Suez. Developed several electro-mechanical work systems for the submersible, including remote manipulators, a large object recovery device, and an oil field work jig for servicing undersea well heads. The latter system has been awarded American and foreign patents.

Partner, Guy Rothwell & Associates, 1963 - 1967. Engineering Consultants; heavy engineering structures including waterfront structures, undersea pipelines and cables; a nuclear reactor refueling facility; and several underground facilities resistant to nuclear weapons.

Chief Engineer, Rothwell, Lester & Phillips, Architects and Engineers, 1961 - 1963. Structural design of large buildings, waterfront structures, and harbors; operated a hydraulic model laboratory for the State of Hawaii in connection with harbor design projects.

Structural Engineer, Paderewski, Mitchell & Dean, San Diego, Cal., 1959 - 1961. Broad range of engineering structures: hospitals, schools, hotels, apartment buildings, industrial structures.

Structural Designer, Daniel, Mann, Johnson & Mendenhall, Los Angeles, Cal., 1956 - 1959. Missile launching facilities, large commercial, aseismic design of high-rise buildings.

U.S. Air Force, 1951 - 1956. Discharged in 1953 as staff sergeant to receive commission as 2d Lt. USAF. Separated in 1956 as 1st Lt.

Patents

On remotely controlled Underwater Work Systems Apparatus & Methods:

American	- 366615
British	- 1282858
Venezuelan	- not available
New Zealand	- 159564
Pending:	Canada and Japan.

Special Qualifications or Experience

Qualified SCUBA diver
Qualified submersible pilot

Instrument Design and Construction (unpublished)

MARS, multi-channel Beta particle counter for in-situ determination of sinking rate of ^{14}C-labeled phytoplankton. 1976, Oceanic Institute.

Inertial motion sensing package for model tests in connection with OTEC platform study. Vertical gyro reference, triaxial accelerometer, pressure proof case, weight 11 lb. Remote digitizing and logging equipment can receive data by wire or FM telemetry. 1976, Oceanic Institute.

Lightweight, field programmable equipment for operating and logging data from a multi-sensor oceanographic probe. Provides high quality data, has operated from a small outboard craft in surf. 1975, Oceanic Institute.

Direct digitizing data logging system, 24 channel, wind, velocity, and structures response. 1970, Oceanic Institute.

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Surface-following wave measuring buoy. 1972,Oceanic Institute.

Flicker/fusion apparatus for clinical research and diagnosis of brain damage. 1971, Oceanic Institute.

Vibration sensing, recording, and spectral analysis apparatus for investigation of building motions. 1965, Guy Rothwell & Associates.

Multi-channel wave measurement and recording system for small amplitude waves. 1964. Guy Rothwell & Associates.

Publications

Principal author or co-author, over a period of twenty years, of a large number of major and minor pieces of engineering documentation, such as proposals, conceptual designs, preliminary engineering reports, research reports, environmental impact statements, construction contract drawings and specifications, etc. Clients have included the U.S. Air Force, U.S. Navy, Army Engineer Corps, Federal Aviation Agency, U.S. Department of Commerce, State of California, State of Hawaii, and many private clients.

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ALBERT CARL SMITH, Ph.D., M.D.
Marine Pathologist

EDUCATION

University of California, Los Angeles, B.A. Zoology
University of Southern California Medical School, 3 years
University of Hawaii Graduate School, Zoology, 1 year
Santa Monica City College, University of California Los Angeles extension, and Kerckhoff (California Institute of Technology) Marine Laboratory--summer sessions
University of California, Irvine, Graduate School in Biology, Fall, 1965-1966, Ph.D. in Biological Science
University of Hawaii, John A. Burns School of Medicine, 1973-1975, M.D.
Saint Francis Hospital - University of Hawaii, John A. Burns School of Medicine, July 1975 - June 1976, Pathology Research Fellowship

EXPERIENCE

Resident, Department of Pathology, Saint Francis Hospital - John A. Burns School of Medicine, University of Hawaii, Honolulu, 1976-present.
Pathology Research Fellow, Department of Pathology, John A. Burns School of Medicine, University of Hawaii, Honolulu, 1975-1976.
Chief Consultant, Hawaii BioMarine, Honolulu, Hawaii, 1973-present.
Associate Professor of Biology, Division of Natural Science, University of Hawaii, Hilo, 1969-1973.
California Department of Fish and Game, Long Beach, research on molecular genetics of fishes, 1971, 1970, 1965-1966, 1963, 1962, 1961.
Program Director in Pathology, Aquatic Sciences, Inc., Boca Raton, Florida, 1969.
Research Associate and Instructor, Department of Population and Environmental Biology, University of California, Irvine, 1966-1967.
Research Assistant to Dr. Grover C. Stephens, Chairman, Department of Organismic Biology, University of California, Irvine, 1966.
Lab Technician (II) to Dr. R. L. Taylor, Assistant Research Pathologist, University of California, Irvine, 1964-1965.
Studied electrophoresis of blood and urine for Cancer Research Institute, Orange County General Hospital, 1964.
Tested actions of new drugs on lab animals of Allergan, pharmaceutical firm, 1963.
Assistant to Senior Scientists, Eniwetok Marine Biological Lab, University of Hawaii, 1959.
Teaching Assistant in Zoology, University of Hawaii, 1958-1959.

June 1976

1. Smith, A.C. & van Weel, P.B., 1960. On the Protease and Amylase Production in the Mid-Gut Gland of Young and Mature African Snails Experientia, 16:60-62.

2. Smith, A.C., 1962. The Electrophoretic Characteristics of Albacore, Bluefin Tuna, and Kelp Bass Eye Lens Proteins. Calif. Fish Game, 48:199-201.

3. Smith, A.C., 1963. Variant Hemoglobin and Electrophoretic Whole Blood Studies in Two Tunas and Three Other Fish Species. Calif. Fish Game, 49:44-49.

4. Smith, A.C., 1965. Intraspecific Eye Lens Protein Differences in the Yellowfin Tuna, Thunnus albacares. Calif. Fish Game, 51:163-167.

5. Smith, A.C., 1966. Electrophoretic Studies of Soluble Protein from Lens-Nuclei of Bluefin Tuna, Thunnus thynnus, from California and Australia. Amer. Zool., 6:577.

6. Smith, A.C., 1966. Electrophoretic Studies of Eye Lens Protein from Marine Fishes, Doctoral Dissertation, Dept. of Organismic Biology, University of California at Irvine; Dissertation Abstracts, 28, 1968.

7. Taylor, R.L. & Smith, A.C., 1966. Polypoid and Papillary Lesions in the Foot of the Gaper Clam, Tresus nuttalli. J. Invert. Path., 8: 264-266.

8. Smith, A.C., 1967. Serological Studies of Kelp Bass, Paralabrax clathratus. Calif. Fish Game, 53:197-202.

9. Smith, A.C. & Goldstein, R.A., 1967. Variation in Protein Composition of the Eye Lens Nucleus in Ocean Whitefish, Caulolatilus princeps. Comp. Biochem. Physiol., 23:533-539.

0. Smith, A.C. & Taylor, R.L., 1968. Tumefactions (Tumor-Like Lesions) on the Foot of the Moon Snail, Polinices lewisii. J. Invert. Path., 10:263-268.

1. Smith, A.C., 1968. Effects of Sodium Chloride Concentration on Solubility and Electrophoretic Characteristics of Protein from the Eye Lens Nucleus in a Yellowfin Tuna (Thunnus albacares) and in a Desert Wood Rat (Neotoma lepida). Comp. Biochem. Physiol., 27:543-549.

2. Smith, A.C. & Taylor, R.L., 1968. Digestive Gland and Integument Lesions Associated with Malnutrition in a Ghost Shrimp, Calianassa affinis. J. Invert. Path., 12:1-6.

3. Smith, A.C., 1969. Protein Variation in the Eye Lens Nucleus of the Mackeral Scad (Decapterus pinnulatus). Comp. Biochem. Physiol., 28: 1161-1168.

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4. Smith, A.C., 1969. Effects of Urea on Solubility and Electrophoretic Characteristics of Protein from the Eye Lens Nucleus in Bigeye and Skipjack Tunas, and in Menpachi. Comp. Biochem. Physiol., 29:251-258.

15. Smith, A.C., 1969. An Electrophoretic Study of Protein Extracted in Distilled Water and in Saline Solution from the Eye Lens Nucleus of the Squid, Nototodarus hawaiiensis. Comp. Biochem. Physiol., 30: 551-559.

16. Smith, A.C. & Little, H.F., Liver Lesions Produced by Hydatid-Like Cysts in an Elasmobranch, the Electric Ray (Torpedo californica).

A. Full-length version: 1969. Mar. Biol., 3:136-142.
B. Short version: 1969. Nat. Cancer Inst. Monogr., 31:251-254.

17. Peterson, G.L. & Smith, A.C., 1969. Intraspecific Variation in the Soluble Nuclear Eye Lens Proteins of the Sandbar Shark, Carcharhinus milberti (Müller and Henle). Comp. Biochem. Physiol., 31:679-684.

18. Smith, A.C., 1969. Pathology in the Aquatic Environment. Mar. Tech. Soc. J., 3:65-66.

19. Smith, A.C., 1970. Electrophoretic, Solubility, and Thermostability Differences in Proteins of Eye Lens Nuclei From Two Closely Related Fish Species, the Yellowfin Tuna and the Bigeye Tuna. Comp. Biochem. Physiol., 33:1-14.

20. Smith, A.C., 1970. Permeability of the Eye Lens Capsule of the Bigeye Tuna to Nuclear Eye Lens Proteins. Comp. Biochem. Physiol., 34:101-108.

21. VanArman, J. & Smith, A.C., 1970. The Pathobiology of an Epibranchial Bopyrid Isopod in a Shrimp, Hippolysmata wurdemanni. J. Invert. Path. 15:133-135.

22. Smith, A.C. & Goldstein, R.A., 1971. Natural Agglutinins Against Sea Urchin Sperm in Hemolymph of the Crab, Cardisoma guanhumi. Mar. Biol., 8:6.

23. Smith, A.C., 1971. Protein Differences in the Eye Lens Cortex and Nucleus of Individual Channel Rockfish, Sebastolobus alascanus. Calif. Fish Game, 57:177-181.

24. Smith, A.C., 1971. The Soluble Proteins in Eye Lens Nuclei of Albacore, Bluefin Tuna and Bonito. Comp. Biochem. Physiol., 39: 719-724.

25. Smith, A.C., 1971. Genetic and Evolutionary Analysis of Protein Variation in Eye Lens Nuclei of Rainbow Trout (Salmo gairdnerii). Intern. J. Biochem., 2:384-388.

4 8

26. Smith, A.C., 1971. Absorption of Water and Nuclear Lens Protein by Nuclear Lens Tissue. Pac. Sci., 25:566-568.

27. Smith, A.C., 1972. Lens Iso-Percipitin in Yellowfin Tuna (Thunn albacares). Comp. Biochem. Physiol., 42:497-499.

28. Smith, A.C. & Taylor, R.L., 1972. Preliminary Results of Marine Pathology Study off the Florida Coast. Mar. Tech. Soc. J., 6:51-52

29. Smith, A.C., 1972. Reacting Components in Mixtures of Nuclear Lens Extracts from Yellowfin Tuna (Thunnus albacares). Program, 52nd Annual Meeting, Amer. Soc. of Ichthyologists and Herpetologists, Boston, Mass., June 18-23, 1972.

30. Smith, A.C. & Clemens, H.B., 1973. A Population Study by Proteins from the Nucleus of Bluefin Tuna Eye Lens. Trans. Amer. Fish. Soc., 102:578-583.

31 Smith, A.C., Taylor, R.L., Chun-Akana, H., & Ramos, F., 1973. Intestinal Tumor in the Sea Cucumber, Holothuria leucospilata. J. Invert. Path., 22:305-307.

32. Smith, A. C., 1975. Search Among Marine Invertebrates for Eosinophils Useful in Medical Research. Abstracts of Papers, VIIIth Annual Meeting, Soc. for Invertebrate Pathology, Corvallis, Oregon August 18-22.

33. Ramos, F. & Smith, A. C., 1975. Protein Differences in the L Nucleus from the Desert Woodrat (Neotoma lepida). Psychologi Reports, 37:219-222.

34. Smith, A. C. & Taylor, R. L., 1975. Immunoglobulins or Similar Substances in Invertebrate Body Fluids: A Preliminary Study. Aquaculture, 6:295-299.

35. Smith, A. C., in press. Catalase in Fish Red Blood Cells. Comp. Biochem. Physiol.

36. Smith, A. C., in press. Reactions of Fish Red Blood Cells with Mucus and Sera from Other Fish(es). Calif. Fish Game.

37. Smith, A. C. & Hartley, F. K., in press. Keloid in the Gray Reef Shark, Carcharhinus amblyrhynchos. Pac. Sci.

38. Smith, A. C. & Ramos, F., in press. Occult Hemoglobin in Fish Skin Mucus as a Possible Indicator of Early Stress. J. Fish Biol.

39. Taylor, R. L. & Smith, A. C., in press. Proposal for a Center for Marine Pathology. Arch. Path.

40. Smith, A. C., ~~submitted m.s.~~ in press. Immunologic Reactions of the Sea Cucumber, Holothuria cinerascens, to Serum from the Milkfish, Chanos chanos.

41. Smith, A.C., submitted m.s. Formation of Specific Binding Activity in Fish Lens Protein.

42. Smith, A.C., submitted m.s. Hypersensitivity and Desensitization in the Sea Cucumber, Holothuria cinerascens.

43. Smith, A.C., submitted m.s. Hepatoma in Tilapia, Tilapia mosambica.

44. Smith, A.C. & Smith, D.J., in press. Diseases of Man and Marine Animals. Sea Grant Newsletter, University of Hawaii.

45. Smith, A.C. & Smith, D.J., in press. Man's Evolutionary Roots in the Sea. Sea Grant Newsletter, University of Hawaii.

H. BURR STEINBACH, Ph. D.
President
The Oceanic Institute

Academic

University of Michigan, B.A., 1928.
Brown University, M.A., 1930.
University of Pennsylvania, Ph.D., 1933.

Experience

President, The Oceanic Foundation, 1974 - present.
Dean of Graduate Studies, Woods Hole Oceanographic Institution, 1968 - 1974.
Professor and Chairman, Department of Zoology, University of Chicago, 1957-1968; Professor of Zoology, University of Chicago, 1968-1971.
Consultant, Institute for Defense Analysis
Consultant, Presidne'ts Science Advisory Committee
Visiting Professor, National Taiwan University, 1966.
Visiting Professor, University of Hawaii, 1964.
National Science Foundation Divisional Committee Chairman, 1954-1959.
Guggenheim Fellow, 1955-1956.
Assistant Director, National Science Foundation, 1954-1954.
Professor, University of Minnesota, 1947-1957.
Associate Professor, 1942-1946; Professor, 1946-1957, Washington University.
Assistant Professor, Columbia University, 1938-1942.
Assistant Professor, University of Minnesota, 1936-1938.
Instructor, University of Minnesota, 1935-1936.
National Research Council Fellow, University of Chicago, 1933-1934.
Instructor, Zoology, University of Pennsylvania, 1930-1933.
Assistant, Physiology and Biochemistry, Brown University, 1928-1930.

Member of the Corporation, Marine Biological Laboratory, Director and President, 1966-1970.
Member of the Corporation, Woods Hole Oceanographic Institution.
Member of the Executive Committe and Trustee, Chicago Zoological Society, 1966-1968.
Biophysical Society, Charter Council Member
American Society of Zoologists, President, 1959-1959.

April, 1974

(Experience - continued)

Physiological Society.
Society for General Physiologists, President, 1956-1957.
Member, Founding Committee AIBS (Executive Secretary).
AIBS Curriculum Study, 1958-1963.
Chairman, Division of Biology and Agriculture, N. R. C., 1958-1963.
Member, Physiological Study Section, NIH, 1958-1959.
Member, Heart Council, NIH, 1959-1963.
Member, Science Information Council, NSF, 1966-1968.
Member, Sino-American Committee on Scientific Cooperation (NAS-NRC)
Chairman, Pacific Science Board, NRC, 1967-1970.
Member Advisory Committee, Sea Grant, NSF, 1968.
Editorial Board, Physiological Zoology
Managing Editor, Biological Bulletin, 1942-1950.

H. Burr Steinbach, Ph. D.

Publications

1931. with I. R. Taylor. Respiratory metabolism during pupal development of Galleria mellonella (bee moth). Physiol. Zool. 4:604.

1933. The electrical potential difference across living frog skin. J. C. C. P. 3(1), April.

1933. Injury potentials in scallop muscles. J. C. C. P., 3(2), June.

1935. Diffusion potentials in colloidal systems. J. C. C. P., 7(2), Dec.

1935. Diffusion potentials in scallop muscles. J. C. C. P. 7(2), Dec.

1937. Potassium and chloride in Thyone muscle. J. C. C. P. 9 (3), April.

1937. Potassium in frog skin. J. C. C. P., 10(1), June.

1940. with the assistance of Jack Auringer. Electrolytes in Thyone muscles. J. C. C. P. 15(1), Feb.

1940. Sodium and potassium in frog muscle. J. Biol. Chem. 133(3), May.

1940. Chemical and concentration potentials in the giant fibers of squid nerves. J. C. C. P., 15(3), June.

1940. The distribution of electrolytes in Phascolosoma muscle. Biol. Bull. 78(3), June.

1940. Electrolyte balance of animal cells. Cold Spring Harbor Symposium.

1941. The role of the injured surface in the production of the injury potential of frog muscle. Physiol. Zool., 14(1), Jan.

1941. Chloride in the giant axons of the squid. J. C. C. P. 17(1), Feb.

1942. with M. L. Gabriel. Zoology in 1941. Chem. Eng. News 20:Feb 26.

1942. with D. Nachmansohn. On the localization of enzymes in nerve fibers. Science 95: Jan. 16.

April, 1974

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(Publications - continued)

1943. with A. Glenn Richards and Thomas F. Anderson. Electron microscope studies of squid giant nerve axoplasm. J.C. C. P. 21(2), April.

1943. with D. Nachmansohn, A. L. Machado and Sol Spiegelman. Localization of enzymes in nerves. II. Respiratory enzymes. J. Neurophysiol. 6

1943. with Sol Spiegelman. The sodium and potassium balance in squid nerve axoplasm. J. C. C. P. 22(2), October.

1943. with Sol Spiegelman and N. Kawata. Rectification and injury potential in squid axons. Federation Proc., 3(1), March.

1944. with N. Kawata. The recovery of the cut surface of the scallop muscle. Federation Proc., 3(1), March.

1944. with S. Spiegelman and N. Kawata. The effects of potassium and calcium on the electrical properties of squid axons. J. C. C. P. 24(2), Oct.

1944. Osmotic behavior of frog sartorius muscles. J. C. C. P. 24(3)

1945. Adenylphrophosphate in chick embryos. J. C. C. P. 25(2), April.

1945. with S. Spiegelman. Substrate-enzyme orientation during embryonic development. Biol. Bull. 88(3), June.

1945. with Florence Moog. Localization of adenylpyrophosphatase in cytoplasmic granules. J. C. C. P. 26(175)

1945. The intracellular cations in muscle. Trans. N. Y. Acad. Sci.

1946. Localization of acid and alkaline phosphomonoesterases in cytoplasmic granules. J. C. C. P. 28(2), Oct.

1947. Intracellular inorganic ions and muscle action. Ann. N. Y. Acad. Sci. XLVII:849, May 30.

1949. Temperature coefficients of muscle apyrase systems. J. C. C. P. 33(1).

April, 1974

H. Burr Steinbach, Ph. D.

(Publications - continued)

1949. Calcium and apyrase system of muscle. Arch. Biochem. 22(2), June.

1950. Animal electricity. Sci. Amer. Feb.

1950. Ion binding in muscle homogenates. Am. J. Physiol. 163(2), Nov.

1951. Permeability. Ann. Rev. Physiol. 13

1951. Sodium extrusion from isolated frog muscle. Am. J. Physiol. 167(1), Oct.

1952. The sodium and potassium balance of muscle and nerve. Modern Trends in Physiology and Biochemistry.

1952. On the sodium and potassium balance of isolated frog muscles. Nat. Acad. Sci. 38(5), May.

1954. The regulation of sodium and potassium in muscle fibers. Symp. of Soc. Exp. Biol., 8.

1956. The extraction of ions from muscle by water and sugar solutions with a study of the degree of exchange with tracers of the sodium and potassium in the extracts. with E.J. Harris. J. Physiol., 133(2).

1960. The chemistry of the alkali metals. In: Comparative Biochemistry. Vol. IV.

1961. Ionic gradients in some invertebrate spermatozoa. With Philip Dunham. Biol. Bull., 120(3):411.

1961. Na extrusion by the sartorius of R. pipiens. J. Gen. Physiol. 44(6):1131.

1962. Ionic balance of sperm cells. In: Spermatozoan Motility (with P. Dunham).

1962. Ionic and water balance of planarians. Biol. Bull. 122:310.

1962. The prevalence of K. Persp. in Biol. & Med. July.

1962. The chemistry of the alkali metals. Comp. Biochem. Vol. 4.

H. Burr Steinbach, Ph.D.

(Publications - continued)

1963. Sodium, Potassium and Chloride in selected hydroids. Biol. Bull. 124:322.

1964. The Quest for Certainty: Science Citation Index. Science, July issue.

1966. The sodium and potassium exchange between intact frogs and their environment. J. Gen Physiol. 6:1111.

1966. The effects of glycerol and other organic solutes on the motility and respiration of some invertebrate spermatozoa. Biol. Bull. 131:166.

1967. Movement of Na and K across and within frog skin. Am. J. Physiol. 212:371.

1967. On the ability of isolated frog skin toe manufacture Ringer's fluid. J. Gen Physiol.

April, 1974

REVIEW OF THE RESEARCH PROGRAM RESEARCH IN ARTIFICIAL PROPAGATION OF MILKFISH CONDUCTED BY THE OCEANIC FOUNDATION FOR AID

BACKGROUND

This review was held at the Oceanic Institute, Waimanalo, Hawaii on May 6 and 7, 1976, in accordance with the terms of the contract between AID and the Oceanic Foundation (now Oceanic Institute) entered into on January 13, 1975.

This contract, AID-TA-0-1189, is in the amount of $498,532 for the 3-year period ending January 12, 1978. Of this sum, $250,000 was alloted initially. The balance, $248,532, was to be provided if funds were available and "contingent upon ... favorable AID review and evaluation of the results of the program after 18 months." The review was actually held after 16 months to avoid a session during the spawning season.

The original research proposal, which was submitted to the AID Research Advisory Committee on 16 October 1974, covered a 5-year study at a total cost of $870,000. Whether the contract will be extended for two additional years will be determined by a second review which, under the terms of the contract, is to be held after 32 months.

The review team consisted of:

Philip M. Roedel, Fisheries Advisor, AID, Washington, D. C.,
H. R. Schmittou, Fisheries Advisor, USAID Mission, Manila, Philippines,
James A. Storer, Office of Marine Resources, NOAA, Rockville, Md.

The principal Oceanic Institute staff participants in the review were:

H. Burr Steinback, President
Colin J. Nash, Director of Research
Ching-Ming Kuo, Head, Aquaculture Division
Guy N. Rothwell, Jr., Senior Engineer
Albert C. Smith, Marine Pathologist

SUMMARY FINDINGS

The team agreed that the work being done is in accordance with the terms of the contract, that it is generally on schedule, and that the timetable for the next year remains valid. The project projections for the proposed years 4 and 5 will require careful scrutiny at the second (final) review of the existing contract. The project staff, while small in numbers, is obviously extremely competent professionally. There are some questions with respect to certain aspects of the work which are addressed in the report. The program as a whole, however, is sound and fully deserving of continued AID support. The team endorsed Oceanic's request for additional funds ($30-35,000) for pathology work and recommended that the program be funded for its third year at no less than the level indicated in the contract.

PURPOSE OF THE RESEARCH

The program objective set by AID for the contractor was to breed the milkfish, Chanos chanos, in captivity and to raise the fry from the egg, undertaking any research and development which might be necessary to attain that goal.

Specific objectives are:

a. To induce spawning of milkfish in captivity economically and over long periods.

b. To increase the survival rate of eggs and larvae.

c. To increase the hardiness of juveniles.

d. To develop handling techniques for juveniles that will assure the lowest possible mortality.

The original proposal from Oceanic Foundation proposed research, design, and construction of low-cost pens and enclosures for aquacultural production of brackish-water fish. The revised research project excludes any work on pens and enclosures for commercial production.

PROJECT PLAN

The review team agreed that the Institute is carrying out the research program in a very satisfactory fashion. The original plan was well conceived, the staff has been able to adhere to it, and Oceanic expects to be able to achieve its objectives within the allocated time. This is not due simply to an automatic adherence to the original plan but rather to the staff having periodically examined the plan to determine its continuing validity and productivity, as well as their progress under its terms.

STAFF

The team was impressed with the attitude, enthusiasm and general approach of the staff. It is a talented group of professionals who seem to work very well together, stimulate one another, have respect for each other's special area of competence, thereby achieving a good degree of interaction and esprit de corps. The leadership provided by Colin Nash appears to be most effective,

The breadth of approach is exemplified by the role of Dr. Smith who took his doctorate in biology but more recently obtained his MD. With that unique training he can bring to his fish pathology work the training and interest of a physician. He is, for instance, pursuing a number of

by-products of his pathology research that may have significant medical application. Such a result that would, of course, increase the pay-off of the project. This broad capacity of the staff is to be highly valued and bodes well for the continued health of the Institute and for its potential not only in aquaculture but as well in other activities.

The staff tends to be academically and intellectually oriented, yet it maintains a strong practical orientation manifested in such ways as in efforts to reduce the cost of feed.

The team had, however, some concern that the staff might be overly academically oriented, with not enough contact with practical fishermen or practicing aquaculturists. In that sense there was a feeling that the staff feels itself to be something of an "intellectual elite" and that it wishes to keep it that way.

RELATIONSHIPS WITH OTHER ORGANIZATIONS

The staff was well aware of the activities of the other institutions working in the fisheries field with AID support -- Auburn University and the University of Rhode Island. They were quite open to the possibilities of closer cooperation with either or both, at the same time pointing out quite correctly that such cooperation could more easily be effected with the University of Hawaii.

However, they appear to be quite selective in their relations with other professionals at that University. While the staff seems to have associated regularly with some groups, they have almost no contact with others, particularly social scientists, including economists. They should exert a greater effort in this direction.

FUNDING

The Institute is operating on a very tight budget, but should be able to carry out the work as scheduled in the contract. It is essential that the full $249,000 budgeted for the third year be obligated in FY 1977, and equally essential that certain studies of stress be funded immediately. Cost is estimated at $30-35,000. (Note: The budget was augmented by $30,000 on June 22, 1976).

As we have noted, the project proposal presented to the AID Research Advisory Committee called for a 5-year study at a cost of $870,000. The contract finally let covered the first three years only for which approximately $500,000 was budgeted. Requirements beyond the third year are to be considered by the review to be made "after 32 months". If the project is to continue, this review will in fact have to be made after about 28 months (e.g. in May 1977) to permit the Agency sufficient time to process extension documents, this assuming the board so recommends.

Oceanic noted in the executive summary of its annual report for 1975 that the essentially similar 5-year program for gray mullet cost $1-3/4 million including capital construction. It believes that the milkfish work will require funding support of the same order of magnitude -- perhaps $1 million exclusive of construction.

SPECIFIC ~~COMMENTS~~ Objectives

Sexual Maturity and GSI

The following is based on a comment from one of the board members: So little is known about the biology of milkfish that it is not valid to make concrete comparisons between two apparent subpopulations. There are some important apparent differences in spawning biology between milkfish in Hawaii and in Southeast Asia such as:

1. Reported minimum sizes of sexually mature fish in SEA are almost 5 kg while Hawaii fish are 2.5 to 3 kg.

2. SEA fish apparently spawn over a long season with only a relatively few females gravid at any given time while Hawaii fish apparently all develop and spawn within a short season during July and early August.

3. Reported minimum spawning temperatures for SEA fish have been 28°C while waters around Hawaii do not exceed 26°C.

Another apparent difference of possible significance is in gonad weight relative to total body weight — GSI. The most developed Philippine fish studied had GSI values of 5 to 7 for males and 8 to 12 for females, while GSI's for both sexes in Hawaii were only approximately 3.3 during peak development (based on available data).

The Board suggests that the Staff should consider what the apparent differences mean and what importance they may have.

Supplemental Feed

Oceanic is using feeds to supplement natural growth of vegetation in the tanks and pools. An example of the supplemental feed reported consists of:

Wheat middlings	55.0%
Cottonseed meal	14.0
Soybean meal	14.0
Tuna meal	14.0
Propylene glycol	1.4
Visorbin	1.4
Vitamin pre-mix	0.2

A Board member points out that total protein in this feed could not be more than 20% and animal protein not more than about 9%; carbohydrates are high and fats, vitamins and minerals are low. Supplemental feeds for fish should be high in protein (30% or more) and low in carbohydrates. The feed may not be nutritionally adequate for developing breeders especially since there appeared to be very little natural foods available in Oceanic tanks and ponds. The fish may not be able to get enough nutrients, especially protein to develop sex products and especially viable products.

The team suggests that Oceanic begin using some of the proven nutritionally complete trout diets. Since little is known about milkfish nutrition, it would appear Oceanic could collaborate profitably with a fish nutritionist.

Electronic Tagging

Oceanic intends to locate milkfish spawning grounds by tracking from a boat a released gravid female equipped with an electronic tag. The odds for success of this method seem extremely small. For example, the spawning grounds may be as much as 300 km from the Hawaii beaches where the larvae and postlarvae are collected.

Other troublesome factors include:

1. The problem of selecting and preparing the specimen for tagging.

2. The possibility if not probability that handling stress will cause altered behavior to a point where these tagged fish will not move immediately to the grounds for spawning, will spawn outside of the normal spawning grounds, will lose their eggs to atresia or premature release.

It seems to the team that in addition to electronic tagging, upcurrent sampling of larvae and eggs be used to locate spawning grounds. Theoretically, larvae development would become less developed as sampling progressed upcurrent away from shore.

Some advantages of these methods are that:

a. There is a greater chance index for success than with the electronic tagging method;

b. It would be less expensive than electronic tagging;

c. It will provide valuable information on development of wild eggs and larvae for use in artificial spawning studies; and

d. It will provide information on the environment in which eggs and larvae exist between spawning grounds and shore, as well as just the spawning grounds.

One team member has suggested to Oceanic that they consider mass tagging as a possible preliminary to electronic tagging. This could provide valuable information on distribution, range, migration habits and subpopulations. Releases of mass-tagged milkfish should be considered in a broad geographic area including Indonesia, Philippines, and Taiwan as well as Hawaii and possibly other Pacific Islands. The tagging program requires especially careful consideration before final plans are made for the 1977 spawning season.

Milkfish Pathology Project

It became apparent in 1975 that naturally-occurring organic disease and stress induced by confinement could seriously affect the outcome of the entire program. Consequently, in October 1975, Oceanic made a formal application to AID for supplementary funding so that it could itensify the work being carried out by Dr. Smith. This includes studies of basic pathology and studies of diseases that manifest themselves under condition of contamination. In the latter case, Oceanic hopes to develop a fundamental understanding of the stress state and how to cope with it. Preliminary work is promising.

The team fully endorsed this project and believed it should be adequately funded. As noted under "Funding", the budget was augmented by $30,000 in June, 1976.

FUTURE WORK

The study as authorized will provide answers to only part of the questions no matter how successful the scientific work may be. Oceanic can with its present staff and facility develop the laboratory techniques needed for artificial propagation. However, with its present physical facilities, Oceanic cannot carry out pilot production operations designed to field-test the techniques that are needed as an intermediate step leading to the design and operation of large-scale production hatcheries. There is a real question as to whether, even if the facilities in Hawaii were expanded, the work should be done there. The team feels, as does the staff, that this should be carried out in South East Asia where production operations will ultimately take place.

This question requires full consideration at the second review team which will determine where and in what form the project will continue.

Informal Minutes of the Research & Development Committee Meeting

May 24, 1977

Project: Research and Implementation of Milkfish Propagation, Oceanic Institute, TA/AGR.

Dr. Hesser opened the discussion of the proposal by explaining historical developments that lead to AID funding this particular project. His office has been surprised and happy with the quality of researchers at the Oceanic Institute. He went on to explain that Milkfish are a very important food commodity in South East Asia. They are captured as fry in the ocean and sold to individuals who rear them to maturity in basically small holding ponds. The supply of these juvenile fish is much less than the demand and the objective of this project is to find a way to provide more young fish by artificially breeding Milkfish in captivity. The Oceanic Institute is very close to achieving some breakthroughs in this breeding activity.

The Asia Bureau generally supports the proposal and sees a useful role for the Oceanic Institute in this area of research. The project paper, however, does not indicate what Oceanic Institutes role will be in the future considering Hawaii is on the fringes of Milkfish dispersion patterns. The question concerning the specific transferability of research findings from Hawaii to other areas of S.E. Asia was raised. Obviously some technology is transferable, but how much?

The present proposal does not address institutions in the Philippines doing essentually the same thing with a Grant from Canada. Maybe IILARM or the Philippines should be the center of future Milkfish research. It was noted that very little of the present budget is earmarked for Philippine institutions.

The Bureau feels that future Milkfish research should be centered in Asia somewhere. The question as to how Hawaii would wind down its research activities needs to be addressed.

The project paper assumes that the experience gained by Oceanic Institute with mullet is transferable to Milkfish. What similarities and differences between these fish types might effect future breakthroughs? Also raised as a question is the mention of milkfish culture in Laos and VietNam, the Bureau would like more information about this.

The Bureau is willing to support the project if the Oceanic Institute understands that AID is making no long term commitments to them and that future work should be transferred to Asia.

Additional comments by the Asia Bureau included the low amount of money allocated for publications, and the applicability of 20 acre fish farms in meeting the mandate of providing for the small farmer.

The representatives of the other Regional Bureaus thought they generally supported the proposal and basically felt that their questions had been addressed by the Asia Bureau. An additional area of concern was the significant jump in the budget for the next two years, and the cost-benefit of such a budget increase.

TA/AGR response

Dr. Hesser indicated that the budget was purposely held down during the initial phase of the project because of organizational difficulties with Oceanic Institute at the time, but their progress on this work in the last two years has been excellent. The competence to do this focused basic research did not exist in the LDC's when this project was originally funded. All indications presently point to a successful technology transfer from OI to the LDC's.

Dr. Roedel indicated that more money is needed as the OI is moving more operations into the Asian area and will become even more involved with Asian institutions in the next couple of years. He does not see the need for a project extension beyond 5 years.

Dr. Neal suggested that after 5 years, one should see hatcheries and pilot projects to actually rear juvenile fish. Some problems of handling the fish, stress, and pathology may be transferable when they are worked out. The Canadian grant to CIEFDECK for milkfish was given without informing AID. Dr. Neal noted that the Office of Agriculture had just received a letter from OI that they had been successful with hormonal induced spawning.

Dr. Jones suggested that the researchers at OI have published several papers, and the budget for publications is adequate since there are many outlets for publishing research materials that have minimal costs.

FINAL VOTE

- Unanimous approval

ATTACHMENT 3

ADDENDUM TO PROJECT PAPER OF 4/11/77 WITH CHANGES RECOMMENDED BY RAC

I. Detailed Plan of Work August 15, 1977

The broad objectives of this project are to:

A. Induce spawning of milkfish in captivity.
B. Discover pathological effects of handling and holding stresses and prevent these effects.
C. Increase egg production and larval survival rates.
D. Increase hardiness of larvae and juveniles.
E. Develop handling procedures for juveniles that will assure low mortality in farmers' pens.

In order to accomplish these objectives the activities described briefly below and in detail on pages 24 - 32 of the attached proposal will be completed.

(1) Establish broodstock in captivity.

(a) Collection of increased numbers of mature fish in season (at sea).

(b) Collection and growing-on of greater numbers of immature fish (from brackishwater ponds).

(c) Collection of migratory fish (from known runs).

(d) Development of broodstock husbandry.

(e) Holding, handling and sampling large fish.

(f) Identification of broodstock individuality.

(g) Year-round breeding through environmental control.

(2) Establish conditions of spawning.

(a) Simulation of spawning conditions in laboratory (by environmental control).

(b) Attempt spawning without hormone treatment (by behavioral responses).

(3) Induce spawning by hormone injection.

(a) Define the optimum induced spawning procedure (for salmon gonadotropin, specifying correct time for treatment, dosage, dose rate, response, etc.).

(b) Determine cost effectiveness of readily available hormones.

Experiments will include:

i. Determine natural reproductive physiology (for both sexes) for immaturity.

ii. Determine responses to hormone treatment.

iii. Test reactions to salmon pituitary gonadotropin.

iv. Test reactions to other cheaper hormones.

(4) Improve survival of larvae in laboratory.

(a) Definition of Nursery I (Day 0 - Day 21) rearing procedure with recommended facilities, food and food density, rearing density, water quality and external environmental conditions, etc.

(b) Improve survival from available eggs.

(5) Increase hardiness of larvae to juvenile stage.

(a) Definition of Nursery II (Day 21 - Day 50) rearing procedure with recommended facilities, food and food density, rearing density, water quality and environmental conditions. Produce juveniles which are larger and healthier than those caught and distributed by the existing farming operators and expected products.

(b) Economics of operations--low cost of juveniles.

(6) Improve handling and husbandry of juveniles (second year only).

(a) Improve collection of juveniles from Nursery II facilities.

(b) Develop safe transportation methods.

i. Develop safe procedures for mass collection and transportation of nursery stock.

ii. Recommend optimum economic transfer method for fry distribution.

(7) Conduct practical pathological treatment to eliminate handling stress and mortalities and reduce diseases of captive stocks.

(a) Routine examination or autopsy of all fish for background pathology.

(b) Conduct diagnostic tests using modern histological and biochemical clinical methods

(c) Pursue related research toward practical application for the hatchery and the farmer.

(8) Conduct experimentation on breeding in the field.

(a) Assemble annually a team to work in the field responding to individual seasonal availability in Southeast Asia.

II. Staff

The program will utilize 124 man months of personal services per year distributed among 13 people working in the following capacities.

1	Project Coordinator
3	Senior Staff Scientists
3	Research Assistants
6	Technicians
13	

III. Reporting

1. One hundred copies of each annual progress report will be submitted to AID/W by January 30.

2. Within six months after expiration of this grant a termination report will be prepared and submitted to the Grant Project Officer.

3. Twenty-five copies of an annual administrative report will be submitted describing briefly the status of work in progress, changes in personnel, other management information deemed necessary, and financing with detailed information as to how the project funds were expended.

4. Papers prepared for submission to journals or periodicals or to be published in any manner reporting on this project will be submitted to AID/W prior to publishing. All published papers, articles and books resulting from this research must give appropriate credit to A.I.D.

5. Reports of progress and data sheets will be sent by Contractors to cooperating institutions.

6. A fiscal report will be prepared as of December 31, showing actual expenditures for the Fiscal Year to

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date and anticipated expenditures for the balance of the year and sent to AID/W (6 copies).

7. One copy of all trip reports involving international travel in support of this project should be provided to TA/AGR Project Manager upon completion of travel.

8. It is understood by the parties that the Contractor may, within the amount specified as Total Estimated Cost, incur expense in variation of individual items in pursuit of the Task Order objectives.

IV. Period

The effective date of this contract is January 13, 1978. The estimated completion date is January 12, 1980.

V. Project Direction

Performance shall be subject to the technical directions of the Fisheries Division, Office of Agriculture of the Bureau for Technical Assistance of the Agency for International Development. As used herein, "Technical Directions" are directions to the contractor which fill in details, suggest possible lines of inquiry, or otherwise complete the general scope of work. "Technical Directions" must be within the terms of this Task Order and shall not change or modify them in any way.

VI. Estimated Cost

The estimated cost for performance under this Task Order is $738,000.00 which amount is obligated hereunder.

The estimated cost is budgeted as follows:

Salaries, Wages and Overhead	$630,800
Capital Equipment	47,100
Supplies	40,900
Travel	10,700
Publications	5,500
Consultants	3,000
TOTAL ESTIMATED COST	$738,000

A more detailed budget is attached. Estimated expenditures have been adjusted to reflect modifications in the project design suggested by RAC.

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F I S C A L 1 9 7 8

	Salaries & Overhead	Capitol Items	Supplies	Travel Local & US	Travel Overseas	Publications	Consultants	TOTAL
1. Broodstock	78,113	28,750	9,000	2,000				117,863
2. Spawn Conditions	7,397		500					7,897
3. Induced Spawning	126,662	9,450	5,600	800		1,500		144,012
4. Larval Survival	20,178		1,600					21,778
5. Larval Rearing	20,178		1,500					21,678
6. Pathology	43,281	4,900	2,500	800		1,000		52,481
7. Field Breeding	5,291		300		2,000		1,500	9,091
	301,100	43,100	21,000	3,600	2,000	2,500	1,500	374,800

F I S C A L 1 9 7 9

	Salaries & Overhead	Capitol Items	Supplies	Travel Local & US	Travel Overseas	Publications	Consultants	TOTAL
1. Broodstock	48,000	1,000	5,000					54,000
2. Spawn Conditions	7,000		500					7,500
3. Induced Spawning	87,000	2,000	2,600	800		2,000		94,400
4. Larval Survival	50,000		2,600					52,600
5. Larval Rearing	50,000		2,400					52,400
6. Husbandry	30,000		3,000					33,000
7. Pathology	45,500	1,000	3,200	800		1,000		51,500
8. Field Breeding	12,200		600		3,500		1,500	17,800
	329,700	4,000	19,900	1,600	3,500	3,000	1,500	363,200

Research on Artificial Propagation of Milkfish (Extension) - Oceanic Institute, Waimailo, Hawaii. Duration of extension, 2 years; additional cost $912,040. *Ehrenreich, Ludington, Moss, Wishik.

Recommendation: That the project extension be approved at a reduced annual rate of funding with the following provisions:

1. The major effort be given to resolving the key spawning problems.

2. Additional effort be given to fish-rearing units and nutrition work.

3. Racial, radio tracking, and field breeding studies (except the field work in the Philippines), development of a cryogenic unit and hatchery be suspended at least for the present

4. The project be reviewed for adequate progress and brought back to RAC within a year.

Note: Unlike mullet, with which the contractor (Oceanic Institute) had earlier been successful in similar research, there are difficult problems related to spawning milkfish that are not easily resolved. The Oceanic Institute did most of the basic research work that lead to a partial success by SEAFDECK, an LDC institution, in getting milkfish to spawn and RAC encouraged continued co-operation and exchange of information of this type. RAC felt that the possibility of shifting subsequent research activities to Southeast Asia should be explored.

* RAC review Subcommittee; chairman underscored

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7/11/77

ENVIRONMENTAL THRESHOLD DECISION

TO: AA/TA, Mr. Curtis Farrar

THRU: TA/PPU, Ken Malbow Mary Meigraho

FROM: TA/AGR, Leon F. Hesser

SUBJECT: Environmental Threshold Decision

Project Title: Research and Implementation of Milkfish Propagation
Project #: ~~931.0526~~
Project Manager: Richard Neal
REFERENCE: Initial Environmental Examination (IEE) contained in _____ dated July 7, 1977

On the basis of the Initial Environmental/Examination (IEE) referenced above and attached to this memorandum I recommend that you make the following decision.

X 1. The proposed agency action is not a major Federal action which will have a significant effect on the human environment.

____ 2. The proposed agency action is a major Federal action which will have a significant effect on the human environment, and:

____ a. An Environmental Assessment is required: or

____ b. An Environmental Impact Statement is required.

The cost of and schedule for this requirement is fully described in the referenced document.

____ 3. Our environmental examination is not complete. We will submit the analysis no later than _____ with our recommendation for an environmental threshold decision.

Approved: M Belch for Chairman

Disapproved: _____

Date: JUL 13 1977

Best Available Document

713-16

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IMPACT IDENTIFICATION AND EVALUATION FORM

Impact Areas and Sub-areas 1/	Impact Identification and Evaluation 2/
A. LAND USE	
1. Changing the character of the land through:	
a. Increasing the population	N
b. Extracting natural resources	N
c. Land clearing	N
d. Changing soil character	N
2. Altering natural defenses	N
3. Foreclosing important uses	N
4. Jeopardizing man or his works	N
5. Other factors	
_____	_____
_____	_____
B. WATER QUALITY	
1. Physical state of water	N
2. Chemical and biological states	L
3. Ecological balance	N
4. Other factors	
_____	_____
_____	_____

1/ See Explanatory Notes for this form.

2/ Use the following symbols:
N - No environmental impact
L - Little environmental impact
M - Moderate environmental impact
H - High environmental impact
U - Unknown environmental impact

August 1976

C. ATMOSPHERIC

1. Air additives ---------- N
2. Air pollution ---------- N
3. Noise pollution ---------- N
4. Other factors

_____ _____

_____ _____

D. NATURAL RESOURCES

1. Diversion, altered use of water ---------- N
2. Irreversible, inefficient commitments ---------- N
3. Other factors

_____ _____

_____ _____

E. CULTURAL

1. Altering physical symbols ---------- N
2. Dilution of cultural traditions ---------- N
3. Other factors

_____ _____

_____ _____

F. SOCIOECONOMIC

1. Changes in economic/employment patterns ---------- N
2. Changes in population ---------- N
3. Changes in cultural patterns ---------- N
4. Other factors

_____ _____

_____ _____

PPC IJD1

AGENCY FOR INTERNATIONAL DEVELOPMENT
PROJECT AUTHORIZATION AND REQUEST FOR ALLOTMENT OF FUNDS PART I

1. TRANSACTION CODE: A (A ADD, C CHANGE, D DELETE)

PAF

2. DOCUMENT CODE: 5

3. COUNTRY ENTITY: TA/AGR RDA-27 A

4. DOCUMENT REVISION NUMBER:

5. PROJECT NUMBER (7 digits): 931-0526

6. BUREAU/OFFICE: A. SYMBOL: TAB; B. CODE: 08

7. PROJECT TITLE (Maximum 40 characters): Artificial Propagation of Milkfish

8. PROJECT APPROVAL DECISION — ACTION TAKEN: A APPROVED, D DISAPPROVED, DE DEAUTHORIZED

9. EST. PERIOD OF IMPLEMENTATION: Extension — YRS. 02 QTRS 0

10. APPROVED BUDGET AID APPROPRIATED FUNDS ($000)

A. APPROPRIATION	B. PRIMARY PURPOSE CODE	PRIMARY TECH. CODE C GRANT	PRIMARY TECH. CODE D LOAN	E. 1ST FY 78 F GRANT	E. 1ST FY 78 G LOAN	H. 2ND FY ___ I GRANT	H. 2ND FY ___ J LOAN	K. 3RD FY ___ L GRANT	K. 3RD FY ___ M. LOAN
(1) FN	121 I	954		738					
(2)									
(3)									
(4)									
TOTALS									

A. APPROPRIATION	N. 4TH FY ___ O GRANT	N. 4TH FY ___ P LOAN	Q. 5TH FY ___ R GRANT	Q. 5TH FY ___ S. LOAN	LIFE OF PROJECT T GRANT	LIFE OF PROJECT U. LOAN
(1)					1268	
(2)						
(3)						
(4)						
TOTALS						

11. PROJECT FUNDING AUTHORIZED (ENTER APPROPRIATE CODE(S)) 1 - LIFE OF PROJECT, 2 - INCREMENTAL, LIFE OF PROJECT

A. GRANT	B. LOAN
1	

C. PROJECT FUNDING AUTHORIZED THRU FY 80

12. INITIAL PROJECT FUNDING ALLOTMENT REQUESTED ($000)

A. APPROPRIATION	B. ALLOTMENT REQUEST NO. ___ C. GRANT	D. LOAN
(1)		
(2)		
(3)		
(4)		
TOTALS		

13. FUNDS RESERVED FOR ALLOTMENT

TYPED NAME (Chief, SER/FM/FSD)

SIGNATURE

DATE

14. SOURCE/ORIGIN OF GOODS AND SERVICES: 000 941 LOCAL OTHER ___

15. FOR AMENDMENTS, NATURE OF CHANGE PROPOSED

After being reviewed, this ongoing project is to be extended for an additional two years.

FOR PPC/PIAS USE ONLY	16. AUTHORIZING OFFICE SYMBOL	17. ACTION DATE MM DD YY	18. ACTION REFERENCE (Optional)	ACTION REFERENCE DATE MM DD YY

AID 1330-6 (7-76)

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PROJECT AUTHORIZATION AND REQUEST FOR ALLOTMENT OF FUNDS

PART II

ENTITY : TA/Bureau

PROJECT : Artificial Propagation of Milkfish

PROJECT NUMBER : 931-0526

I hereby authorize grant funds of $738,000 for a two-year extension of the research project with the Oceanic Institute until January 12, 1980. The scope of work described in the contractor's proposal and as modified as a result of RAC recommendations includes the development of methods for maturing and spawning milkfish in captivity, for recognition and treatment of diseases, and for rearing larvae and juveniles in a dependable and efficient fashion.

This authorization also directs that an evaluation of project progress be completed no later than September 30, 1978 and that a recommendation be sought from RAC to continue the project beyond January 12, 1979 or to terminate the contract after the first anniversary date of this extension.

Curtis Farrar
Assistant Administrator for
Technical Assistance

Aug 22, 1977
Date

Attachments:
1. Memorandum from Dr. Hesser to AA/TA
2. Project Paper 4/11/77
3. 8/15/77 Addendum to Project Paper
4. RAC Recommendations

Clearance:

TA/AGR/F, DMJones 1/31/77
TA/AGR, DClark
TA/RES, MRechcigl
TA/PPU, KMilow

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7/11/77

ENVIRONMENTAL THRESHOLD DECISION

TO: AA/TA, Mr. Curtis Farrar

THRU: TA/PPU, Ken Milow

FROM: TA/AGR, Leon F Hesser

SUBJECT: Environmental Threshold Decision

Project Title: Research and Implementation of Milkfish Propagation
Project #: 931-0526
Project Manager: Richard Neal
REFERENCE: Initial Environmental Examination (IEE) contained in _____ dated July 7, 1977

On the basis of the Initial Environmental/Examination (IEE) referenced above and attached to this memorandum I recommend that you make the following decision.

x 1. The proposed agency action is not a major Federal action which will have a significant effect on the human environment.

_____ 2. The proposed agency action is a major Federal action which will have a significant effect on the human environment, and:

_____ a. An Environmental Assessment is required; or

_____ b. An Environmental Impact Statement is required.

The cost of and schedule for this requirement is fully described in the referenced document.

_____ 3. Our environmental examination is not complete. We will submit the analysis no later than _____ with our recommendation for an environmental threshold decision.

Approved: M Belch for C Farrar

Disapproved: _____

Date: JUL 13 1977

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IMPACT IDENTIFICATION AND EVALUATION FORM

Impact Areas and Sub-areas 1/	Impact Identification and Evaluation 2/
A. LAND USE	
1. Changing the character of the land through:	
a. Increasing the population	N
b. Extracting natural resources	N
c. Land clearing	N
d. Changing soil character	N
2. Altering natural defenses	N
3. Foreclosing important uses	N
4. Jeopardizing man or his works	N
5. Other factors	
_____	_____
_____	_____
B. WATER QUALITY	
1. Physical state of water	N
2. Chemical and biological states	L
3. Ecological balance	N
4. Other factors	
_____	_____
_____	_____

1/ See Explanatory Notes for this form.

2/ Use the following symbols:
N - No environmental impact
L - Little environmental impact
M - Moderate environmental impact
H - High environmental impact
U - Unknown environmental impact

August 1976

C. ATMOSPHERIC

1. Air additives ---------- N _____
2. Air pollution ---------- N _____
3. Noise pollution ---------- N _____
4. Other factors

_____ _____

_____ _____

D. NATURAL RESOURCES

1. Diversion, altered use of water ---------- N _____
2. Irreversible, inefficient commitments ---------- N _____
3. Other factors

_____ _____

_____ _____

E. CULTURAL

1. Altering physical symbols ---------- N _____
2. Dilution of cultural traditions ---------- N _____
3. Other factors

_____ _____

_____ _____

F. SOCIOECONOMIC

1. Changes in economic/employment patterns ---------- N _____
2. Changes in population ---------- N _____
3. Changes in cultural patterns ---------- N _____
4. Other factors

_____ _____

_____ _____