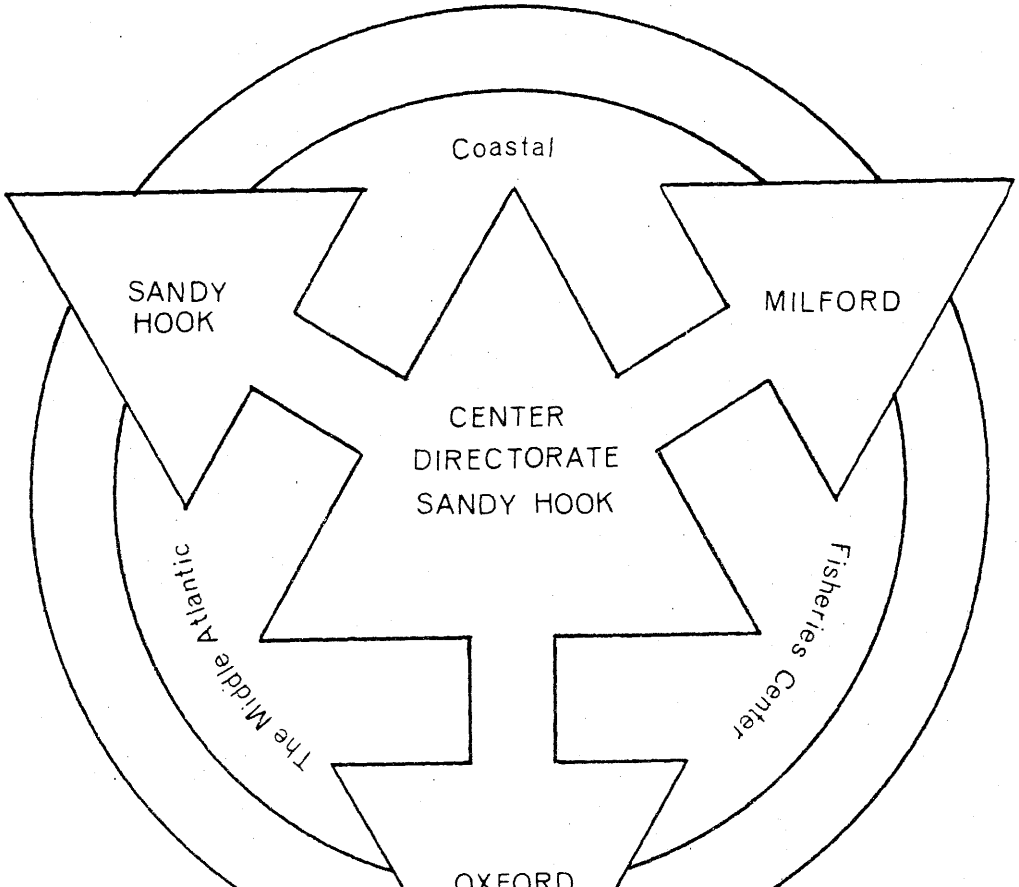
A PROPOSAL FOR REESTABLISHMENT OF AQUACULTURE RESEARCH IN THE MIDDLE ATLANTIC COASTAL FISHERIES CENTER

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Region

MIDDLE ATLANTIC COASTAL FISHERIES CENTER



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FOREWORD

This document contains a plan to reestablish molluscan aquaculture research and development as part of the activities of the Middle Atlantic Coastal Fisheries Center. It attempts to respond to a stated industry need by initial reprogramming of existing funds in the second half of FY 1975 (January to June, 1975) with the hope for additional funds in FY 1976 and the expectation of additional funds by FY 1977.

Section I of this document is a summary of the proposal: Section II is a narrative description of the research required, Section III contains summaries of ongoing molluscan aquaculture research, and commercial molluscan aquaculture operations in the United States, and Section IV contains detailed planning documents for each of the proposed research areas, for FY 1975, 1976, and 1977.

This proposal supersedes earlier drafts (MACFC Informal Reports No. 27 and 34) on the same subject.

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SUMMARY OF

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A. BACKGROUND INFORMATION RELEVANT TO THE PROPOSED AQUACULTURE R&D AS A MAJOR PROGRAM AREA OF THE MIDDLE ATLANTIC COASTAL FISHERIES CENTER

Two facilities of the Middle Atlantic Coastal Fisheries Center, Milford and Oxford, have a long history of involvement in molluscan aquaculture. Much of the basic biological information now used by oyster hatcheries on Long Island and elsewhere was developed at Milford over a period of three decades. The new physical plant at Milford was designed as an experimental molluscan hatchery. Raft and pond culture methods for oysters were explored at Oxford, and major oyster disease research has been centered there.

Research at Milford was reoriented in 1970 toward studies of the effects of marine contaminants on marine organisms. This contaminant-oriented research has been productive and is expected to continue, since problems concerned with effects of ocean pollution of resource species and on aquaculture are increasing. Much of the expertise in aquaculture research which existed at Milford and Oxford still exists, since many pollution related problems are close to those in aquaculture, and since disease problems in aquaculture are similar in many ways to those in natural populations. It should be noted too that some of the stocks of oysters isolated several years ago for genetic selection studies have been maintained and are still available.

Several recent events have been suggested that greater attention should be focused by NMFS on molluscan aquaculture. A nation-wide aquaculture survey by the Mardela Corporation (1972) identified disease, genetics, and nutrition as significant needs in molluscan and other aquaculture. Then in 1973 the Shellfish Institute of North America passed a resolution encouraging the reestablishment of molluscan aquaculture at the Milford facility. A representative group from that Institute met in October 1973 and identified disease control as an immediate need, and genetic and nutrition studies as long-term needs. These events combine to indicate that this may be propitious time to reestablish aquaculture as a major program area of the Middle Atlantic Coastal Fisheries Center. The following sections outline how this might be accomplished within realistic funding and staffing limitations.

B. RESPONSE IN FY 1975

As a response to stated industry needs for the second half of FY 1975 (Jan. 1, 1975 to July 1, 1975) we propose to reprogram on-going effort into four aquaculture areas: genetics, disease control, spawning and rearing, and nutrition. This initial reprogramming in FY 1975 would be done with the expectation that the reprogrammed amount would continue in FY 1976 and would be augmented in FY 1977 with increased funds and new positions.

It should be noted that the ongoing and planned contaminant research of the Center is important, and that the reprogramming efforts indicated in this and the following sections represent the extent to which the contaminant-related work can be reduced. It should also be noted that this reprogramming proposal assumes no further reductions in base funding of the Center. If further reductions occur (below the FY 1975 level), then reprogrammed funds must also be reduced.

One new geneticist position is essential to carry out the reprogrammed research in selective breeding outlined in our detailed plans for FY 1975, 1976 and 1977.

We have submitted Task Development Plans for FY 1977 to NMFS showing reprogramming in the second half of FY 1975 into Molluscan Aquaculture. The amount of reprogrammed money will be annualized in FY 1976. The amount of reprogramming would be $125K for the second half of FY 1975, annualized in FY 1976 to $250K.

For the second half of FY 1975 reprogrammed funds for Aquaculture are:

$29.4K from "Contaminant Effects on Algae" (MAC013) to "Nutrition of Shellfish" (MAC057).

$23.1K from "Mutagenesis" (MAC014) to "Genetics of Shellfish" (MAC056).

$20.4K from "Rearing of Indicator Organisms" (MAC012) to "Control of Disease" (MAC058).

$52.1K from "Rearing of Indicator Organisms" (MAC012) to "Spawning and Rearing of Shellfish" (MAC059).

For FY 1976 this extent of reprogramming would continue, but for the full fiscal year, so the amount would be $250K.

Since total FY 1975 funds for Experimental Biology at Milford were $431.6K, this proposal represents a reprogramming effort of almost two thirds of available funds (exclusive of support, and assuming no further changes in funding in FY'75). Remaining contaminant-related studies would be: Physiological Effects of Contaminants, $154.8K and Mutagenesis, $14.7K.

C. RESPONSE IN FY 1976, WITH REPROGRAMMED CENTER FUNDS

The proportion of reprogrammed Center funds indicated for FY 1975 would be continued in FY 1976. Total reprogrammed funds for FY 1976 would be $250K.

Additionally in FY 1977, $185K is requested as part of the proposed Aquaculture funding increase to augment the reprogrammed amount of $250K in the following areas:

	FY'76 reprogrammed	FY'77 reprogrammed	FY'77 increase	Total FY'77
MAC-057 (Nutrition)	58.8	58.8	40.0	98.8
MAC-056 (Genetics)	46.2	46.2	42.0	88.2
MAC-058 (Disease)	40.8	40.8	83.0	123.8
MAC-059 (Rearing)	104.2	104.2	20.0	124.2
	250.0	250.0	185.0	435.0

New positions would be expected with the new funds in FY 1977.

Emphasis will initially be placed on molluscan genetics, disease control, and nutrition, and much of the program will provide for more effective utilization of the physical plants at Milford, and at Oxford as well. It should be emphasized, however, that there are other aspects of aquaculture that are included in the long-range plans of the Center. These include, but are not limited to grow-out systems for mollusks in natural waters, genetics of aquaculture animals other than mollusks (crustaceans and fishes), diseases of aquaculture animals other than mollusks.

D. GUIDELINES FOR PROGRAM REORIENTATION RESULTING FROM PROPOSED REPROGRAMMING FOR AQUACULTURE

1. We do not plan to reduce contaminant related research at Milford beyond the actions outlined in previous sections. Thus a significant research effort will continue on experimental studies of contaminant effects on resource species and some work will continue on mutagenesis.

2. Aquaculture genetics will emphasize selective breeding of oysters; Aquaculture nutrition will concentrate on definition of algal nutrients for mollusks. The algology group will continue its service function of providing food for contaminants studies as well as to aquaculture studies.

3. Spawning and rearing for aquaculture will emphasize clams and scallops with some attention to surf clams for contaminant studies; oyster spawning and holding will continue as a service function to contaminants and aquaculture.

4. Initial disease efforts in FY'75 will concentrate on establishment of a Reference Center and Registry of Marine Disease, preparation of a Manual on Diagnosis and Control of Marine Aquaculture Disease, continuation of disease diagnostic services to U. S. aquaculture, establishment of a larval disease control group at Milford, and studies of water quality effects on marine animal health. Disease control efforts in FY'76 will continue to concentrate on larval disease control and improved preventive, diagnostic and trouble-shooting services.

5. Disease research of the Center will continue to be supervised by the Director, Pathobiology Investigations, regardless of where it is conducted. Larval disease studies will logically be conducted at Milford, by a group based there. Other aquaculture disease control efforts will remain at Oxford.

6. Aquaculture funds will be assigned to the Director, Aquaculture Investigations, once that group is established. He will, in the case of larval disease studies, outline problems and indicate needs in discussion with Director, Pathobiology Investigations, and will reassign reasonable portions of new aquaculture funds to him for disease studies.

SECTION II

MOLLUSCAN AQUACULTURE -- PRESENT AND LONG-TERM RESEARCH REQUIREMENTS

A. BACKGROUND INFORMATION

Mollusks, especially oysters, clams, and scallops, have been valued as a source of food for centuries. Today, although market trends for the various species of mollusks reflect gradual changes in consumer preferences and life styles, certain varieties are more popular than ever. In many cases, natural production is able to meet market demand. In other instances, because of shortage of seed stock, increasing pollution in estuarine areas, and demands for gourmet foods, shortages are evident. Because of this, increasing attention has been given to the potential of aquaculture to meet specific production/market needs, particularly in the U. S. market place. An outstanding example has been the significant advances in producing oyster seed stock for commercial use.

Beyond these more commonly recognized areas where aquaculture can meet specific current needs within the industry lies a long-range potential. The relatively simple food demands and physiology of these animals, compared with carnivores, together with their relatively rapid growth and hardy nature, provide intrinsic value as a high-volume source of valuable protein and minerals. Not only do they provide good opportunities to augment existing natural production for the high-value gourmet market (such as half-shell style oysters), but ultimate mass production of secondary protein sources, such as through mussel production, is possible. The opportunities for multi-species (polyculture), involving selected varieties of mollusks, also has considerable potential.

In order to provide the necessary technical expertise and, ultimately, the enabling technology to encourage sound industry investments in these areas, it is essential to provide a solid background of related research, even at a modest level. This would insure orderly growth and development within the private sector. Such has been provided in the past through long-term, highly successful basic mollusk investigations, particularly at the Milford and Oxford Laboratories. At present, however, NMFS in-house mollusk investigations for aquaculture systems do not exist, having been phased out in 1970. There is considerable need for reestablishment of such an in-house program on mollusk aquaculture research to insure that today's critical needs are being met, while providing the necessary long-term potential for new systems development.

Although research in oyster and hard clam (Mercenaria) culture (by public and private interests) has culminated in a method of general biological success for rearing the oyster and clam through all of its life stages on a commercial scale under controlled conditions, it has yet to be demonstrated that this method, at its present stage of development, has widespread economic feasibility. Special scientific skills are now needed to answer the difficult questions concerning genetics, nutritional biochemistry and pathology. NMFS has the background and the specialists

to answer many of these questions. Only this approach, coupled eventually with a sound engineering base, can ensure a new surge of progress in molluscan aquaculture and eventually a culture systems that will be competitive in the food industry.

The bay scallop has always enjoyed high consumer acceptance and the scallop industry would be much larger than it is if the natural supply of this bivalve were greater and its annual abundance more predictable. Modest attempts to rear the early stages of the bay scallop on more than an experimental scale have been encouraging. Much of the present methodology developed for oyster hatcheries is applicable with little modification to the large-scale rearing of scallop larvae. Moreover, it appears that present hatchery techniques for the care and rearing of so-called "cultchless" oyster seed can be used to grow post-set scallops during their stay in the hatchery.

In the long-term, we should also be looking at other candidate mollusk species including several species of clams as well as calico and sea scallops that have (1) potential for multiple species approaches, and (2) that have potential for supplying economically valuable sources of protein and minerals. In this regard, we should place emphasis on mass culture (high density) systems, taking advantage wherever we can of complementary natural conditions (i.e., oceanographic features,

weather, land-water configurations, etc.), and existing byproducts of man's efforts (i.e., thermal effluents, natural byproducts of forest industries, etc.).

B. SHORT-RANGE PROBLEMS

(1) Oysters and hard clams -- Although the basic problems of year-round breeding stock, controlled spawning, larval rearing, food supply and care of post-metamorphosis stages have been solved pragmatically, the resulting culture system is inefficient and costly. The main reason for this is that the dynamics of survival and growth of the oyster and hard clam, particularly their early developmental stages, are still not well understood. In short, oyster and hard clam aquaculture has reached the stage where progress through pragmatic solution to problems by general practitioners is no longer acceptable.

The following basic questions must be answered. What are the nutritional requirements of different stages of development and how can foods based on this knowledge be prepared? What is the immunological response of the developing animal in the presence of disease and how can epizootic mortalities be eliminated in the hatchery environment? What is the genetic potential of the oyster and hard clam for producing strains especially suited to the hatchery environment? Without the answers to these questions and many others, culture methodology will remain relatively crude, uninformed, inefficient and expensive.

(2) Bay scallops - A major problem in early attempts to develop scallop aquaculture on a commercial scale will be the rearing of post-hatchery scallops (10-15 mm) in large numbers. Because the scallop is motile in its juvenile stages, it cannot be farmed in the same manner as can oysters. Juvenile animals may be reared in outdoor tanks in sufficient numbers to be commercially feasible. Final growth to market size (75-100 mm) will probably have to be accomplished in controlled, natural environments where the scallops can have sufficient room and food for optimum growth, but where their movements can be confined and their enemies controlled.

The development of efficient methods for "growing out" hatchery-reared scallop seed will not automatically insure commercially successful aquaculture. This accomplishment alone would bring scallop culture only to the level of development of present-day oyster culture. The same need to understand the dynamics of survival and growth of scallop early life stages and to use this knowledge to improve the methodology of scallop culture exists as it does for the oyster.

C. LONG-RANGE PROBLEMS

(1) Oysters and hard clams - Long-range genetic problems are so intimately related to short-range ones that it is almost impossible to make a distinction. In the absence of further basic genetic information and with no genetic counseling, private selective breeding programs in industry will be mostly wasteful hit-and-miss efforts with a success rate lower than that if results of experimental breeding and advice were available through NMFS to hatchery operators. As such hatchery-bred lines develop predictable inbreeding problems, deteriorate genetically and are discovered to have too narrow a genetic base, they will be discarded again in favor of wild stocks. In doing this, considerable private activity and funds will be expended, but no real breeding progress will be made. If there is to be an "improvement" of oyster stocks, a major genetic program will have to be formulated and implemented.

Related to genetics, and closely allied to improvement of oyster stocks, is pathology. Although effort has been expended in the study of diseases of adults, little has been done to solve these problems except to weakly steer the natural selection process. There has been little consideration given to or work done to control epizootics of the various life stages of oysters under aquaculture conditions. Fundamental research must be conducted on the etiology of specific diseases and their cure.

Nutritional problems are both short- and long-range. One of the most pressing problems, however, is the development of "artificial" foods. Although the culture of algae for larval food is fairly dependable, the development of foods which can be stored and used as needed will be required to establish a viable aquaculture system for bivalves. An understanding of the nutritional requirements of all stages of development may help to minimize the incidence of disease, as well as promote faster growth and fatter animals.

Alternative rearing media to natural seawater, such as artificial seawater and seawater from wells, must be developed for those life stages which are most sensitive to poor water quality. Effective use must also be made of water-quality improvement techniques, such as UV irradiation, ion exchange, ozonization and filtration.

Hatchery engineering is a critical key to reducing the unit cost of the final product. A great deal of engineering effort will have to be expended during the development of a hatchery to design an efficient system. Although general designs of a system with a proven output can be defined, differences in locality and the organism involved will necessitate optimization for a particular problem area. Engineering input, that is, improvement of present designs, must be accomplished with the assistance of a competent biologist.

Along with optimization studies on a given hatchery, the economic aspects should be defined. Studies should be based not on the present static concepts utilized by the industry, but on the normal analysis performed in other industries (feasibility, marketing studies, etc.). Shellfisheries business practices, marketing, and supply methods must be modernized in order to assure a viable industry.

(2) Bay scallops - Long-range problems reported for genetics, disease, nutrition, culture systems and engineering and economic analyses of oysters are also of concern with scallops. Hatchery engineering, may, however, be a minor problem if the techniques and systems developed for oyster hatcheries are applicable to scallop culture. Because the life histories of the oyster- and the scallop are so similar, especially in their early stages, the expertise that NMFS scientists can bring to the further development of oyster culture can also be applied to the solution of problems inherent in scallop culture.

(3) Other species/varieties of mollusks - Screening and systems development of those species suited for multispecies or mass culture for economic protein sources will be revealed by subsequent studies.

D. RESEARCH EMPHASIS

1. Objectives -- FY 1975 and 1976 (with reprogrammed funds)

a. Nutrition - Determine the nutritional requirements for various life stages of the oyster and to develop techniques for harvesting, storing, and preserving large quantities of phytoplankton which will be necessary for a viable aquaculture operation.

b. Culture systems - Development of laboratory techniques for raising the various life stages of the oyster under controlled conditions in the laboratory. Although continuous, year-round culture systems exist for the oyster, there are certain aspects of their early life history, such as mortality, nutrition, and genetics, which are not fully understood.

c. Genetics - Specific areas of genetic information will be obtained that will make possible the development of oyster stocks with characteristics superior to the normal for wild stocks.

d. Disease - Development and implementation of an inspection system for routine diagnosis and identification of infectious agents, as well as the development and implementation of a program for disease prevention, treatment and control. Emphasis to be on hatchery-level mortalities.

2. Proposed Program: FY 1975-1976

a. The present time schedule calls for reestablishment, through reprogrammed funds, of aquaculture research on mollusks, particularly oysters and bay scallops, in FY 1975 for the 1/2-year starting January 1, 1975.

b. The program would include integrated studies of genetics, nutrition and diseases. Engineering analysis and economic analysis would be implemented at a later date, probably under contract, as new funding becomes available. Although continuous, year-round culture systems exist for the oyster, for example, various aspects of their life history are not fully understood. It is necessary to continue to improve culture systems in order to raise oysters at maximum production. This will necessitate the use of an experimental hatchery which can then be utilized in studies of genetics, nutrition and disease. Genetic studies will include selection and inbreeding experiments in order to develop a domesticated strain of oyster adapted to commercial production. Nutritional requirements of the various life stages of the oyster must be determined, while the development of artificial foods is necessary for a viable aquaculture operation. A program

will be developed and implemented for disease diagnosis, control and prevention. While biological problems are pertinent to the development of a viable aquaculture industry, concurrent engineering analyses during the research process will permit the design and construction of a highly automated, smooth-flow system, guaranteeing maximum production a a minimum cost. Economic analysis, concurrent with and participating in scientific and engineering research on molluscan aquaculture systems, will provide the single-unit (cost) equivalent, whereby the relative merits of competitive systems and their individual sub-systems can be compared for cost effectiveness.

Studies of nutrition, disease, and culture systems for oysters can be directly applied to scallops. Studies to identify and investigate artificial and natural environments that promote good survival and growth of juvenile scallops can be conducted concurrently with studies of culture systems for oysters. Methods for isolating and controlling such areas for large-scale rearing of post-hatchery scallops will be investigated.

3. Objectives -- FY 1977 (with initial increases in funding)

a. Nutrition - Continue maintenance and expand upon a stock culture collection of unicellular marine algae, purify strains, and make preliminary identifications of unclassified species. Continue operation of mass rearing of algae. Develop techniques for harvesting, storing and preserving large quantities of phytoplankton. Develop facilities for studying food preferences and uptake by oysters and other mollusks. Initiate studies on comparative effects of nutrition on cell composition of phytoplankton and on growth kinetics in the presence and absence of growth inhibitors.

b. Genetics - Inbreed new lines of oysters and study cross-incompatibility genes in these crosses. Use X-irratiation to induce parthenogenesis for pure absolute oyster inbreds in one generation and measure depression in these inbreeding lines. Conduct oyster selection experiments for various characters. Make individual crosses of oysters from various geographical locations and backcross inter-species hybrids to local types to introgress desirable genes from the foreign into the local types. Conduct cryopreservation studies of life male and female gametes.

c. Disease - Initiate studies of bacterial and other diseases of larval mollusks in culture systems. Implement diagnostic services of oysters on domestic level with several state conservation agencies and industrial organizations engaged in aquaculture operations. Begin diagnostic-histologic services on foreign and domestic level with oysters and other mollusks intended for transfer or import. Start major effort in development of in vitro tissue and cell culture systems for growth and cytopathology studies and for further study of fastidious microorganisms requiring living cells for their replication. These studies will be conducted at the MACFC Milford and Oxford laboratories and various state, university, federal and private agencies.

4. Objectives -- after FY 1977 (with further and substantial increases in funding). Continue each of statements mentioned in (3) and add:

a. Engineering Analysis - Develop and perfect generic concepts of efficient hatchery design as a basis for adaptation to and ultimate use on several different but commercially valuable mollusks.

Analyze and test all existing flow-designs for molluscan aquaculture systems. Determine critical engineering factors which adversely affect commercial feasibility. Initiate construction of prototype test modules for each critical factor. Develop one or more conceptual flow diagrams for molluscan aquaculture (oyster, scallops), emphasizing capital - intensive methods and covering entire aquaculture spectrum from spawning to marketing.

b. Economic analysis - Develop concepts and techniques whereby total of all costs can be determined accurately for all proposed systems and to utilize cost data to guide advanced research and engineering investments. Develop information on optimal commercially feasible molluscan designs by simulation analysis. Also, utilization of simulation analysis to demonstrate commercial feasibility of approved systems. Analyze and prepare total cost figures for available molluscan aquaculture systems and subsystems. Determine cost-critical factors in each system for application of scientific and engineering effort. Initiate cost-effectiveness studies on initial industrial engineering design proposals. Determine degree of economic gap between feasibility and failure for all existing systems.

SECTION III

MOLLUSCAN AQUACULTURE RESEARCH AND COMMERCIAL OPERATIONS

Research and development in molluscan aquaculture is being carried on by universities (with Sea Grant funds), by a number of states (partly with PL88-309 funds) and (on a very limited scale) by private aquaculture ventures. A summary of Sea Grant and PL88-309 efforts follows, as does a listing of commercial molluscan aquaculture operations.

It should be pointed out that commercially successful molluscan aquaculture today is characterized by high risks and many failures. An adequate technical base does not exist, and its development will depend on adequately funded integrated federal support and active research participation, particularly in achieving solutions to continuing basic problems of nutrition, genetics and disease. Sea Grant is funding a number of projects, but until recently there was little attempt at co-ordination and integration. Sea Grant is not funding, or is funding only marginally, the kinds of research outlined in previous pages. Coordination at the highest NOAA levels is critical to successful integration of research efforts in molluscan aquaculture. In the absence of such coordination it is important that a NOAA in-house group with active research in molluscan aquaculture be fully aware of all on-going research and take whatever steps are reasonable to insure co-operation and integration. This Center proposes to fulfill this function on an interim basis.

A. MOLLUSCAN AQUACULTURE RESEARCH IN THE UNITED STATES

Considerable past NOAA (NMFS and Sea Grant) effort and funding have gone into the development of molluscan (principally oysters) aquaculture. These funds and activities have gone into several biological studies related to aquaculture, such as developing methods for inducing spawning, interbreeding, environmental and nutritional aspects of rearing, and selection for fast growth, early setting, and spat capture. Federal funds have also supported more applied programs in harvesting techniques, transplantation operations, preservation, processing and packing methods, mechanization and off-bottom culture methods, and economics and marketing studies.

At the most recent SINA meeting, it was reported that approximately 7 million dollars were invested by Sea Grant for molluscan and crustacean aquaculture projects at several universities. More recently, information provided by Sea Grant personnel indicates that for FY'74 alone Sea Grant has supplied over $600,000 of federal funds with over $275,000 of matching funds for support of 18 molluscan aquaculture projects. The largest grants were to the University of Delaware to study various aspects of closed system aquaculture, including studies on spawning and rearing, feeding, processing, economics, and system design; to the University of Maine for aquaculture work on breeding, genetics, mechanization design for grow-out

systems, and marketing and economics studies; to the Virginia Institute of Marine Science for spawning and rearing various species of molluscs, for production of superior strains of oysters, for developing molluscan foods, and for management studies; to the University of Washington for improving methods for molluscan culture, genetic and disease studies, and for teaching and training purposes; to Oregon State University for developing shellfish hatcheries, genetic studies, and for devising methods to use heated effluents; to Columbia University for ocean aquaculture programs and energy conversion; and several smaller grants to such universities as Massachusetts Institute of Technology, University of Massachusetts, Florida State University, and the University of Georgia for utilization of waste materials in aquaculture, genetic and nutrition studies.

Exclusive of past in-house molluscan aquaculture research, the National Marine Fisheries Service has supported a large number of aquaculture projects primarily through PL88-309 and 88-304 funding. Since 1966, these Federal Aid grants to the States for aquaculture programs have amounted to over 2.5 million dollars with several of the projects directly involved with more applied aspects of molluscan aquaculture or shellfish farming. Thus, examination of the "Grant-in-Aid for Fisheries Program Activities" 1974 report indicates many

grants to almost every coastal State. The molluscan aquaculture programs and activities are too varied and extensive to describe in detail but they include such projects as hatchery construction, development of disease-resistant oysters, increasing harvesting efficiency and gear development, disease diagnosis of wild stocks, studies on environmental degradation and mortalities, economics and marketing analyses, technical assistance and extension services, shellfish bed rehabilitation and restoration, reef development, shellfish resource surveys, shell planting, spat capture, shellfish products technology (processing, packaging, byproduct utilization), sanitation studies, catch statistics, and operation and maintenance programs.

Other federal funding, such as those contributed by the Economic Development Authority and the U. S. Department of Agriculture, have also been used for molluscan aquaculture programs carried out by private industry, universities, and State resource management groups. Examples of such grant-in-aid programs are those awarded to the Windmill Point Oyster Company and to the Maryland Department of Natural Resources and the Maryland Center for Environmental Studies to develop spawning and rearing techniques and for hatchery construction.

B. SURVEY OF COMMERCIAL MOLLUSCAN AQUACULTURE OPERATIONS IN THE UNITED STATES (AS OF NOVEMBER 1974)

Maine - (Herbert Hidu)

Abandoned Farms (Edward A. Myers), Walpole - raft culture of mussels, no hatchery.

Maine Coast Oyster Corporation (Deane A. Richmond) - American and European oysters, hatchery and grow-out.

Acadia Aquacultural Enterprises, Inc., Mount Desert - pilot European oyster grow-out, commercial by 1975, no hatchery.

Maine Sea Farms, Harborside (Bob Mant) - concentrates on coho salmon but also grows oysters, no hatchery.

Marcrafts, Inc. (Harold Arndt), Freeport - experimental hatchery for oyster seed, will go commercial in 1975.

Tern Rock Ocean Products, Inc. (Newbold & Billings), Bass Harbor - pilot commercial culture of oysters (hatchery?).

Many of the above firms and several individuals not listed are growing Budge seed oysters experimentally and plan to become independent if trials are successful.

New Hampshire

No information requested.

Massachusetts - (George Matthiessen)

Aquadynamics, Inc. & Cotuit Oyster Co., Wareham and Cotuit, Mass. - oysters, seed from Fishers Island.

Marine Research Institute (Ben Marshall), Duxbury, Mass. - hard clams.

Environmental Devices (Ed Brainard), Marion, Mass. - bivalves.

Aquacultural Research Corporation, Dennis, Mass. - bivalves.

Rhode Island

No activity.

Connecticut - (Milford Lab.)

Shellfish Laboratories (Ed Fordham), Stratford, Conn. - oysters, clams, bay scallops. Main hatchery closed, some scallop culture in eastern Connecticut may be underway.

Bloom Bros., Oyster Co., Norwalk, Conn. - financed Fordham's hatchery and grew hatchery oyster seed on leased beds.

New York - (Paul Chanley)

Bluepoints Company, West Sayville, N.Y. - clams and oysters.

Frank M. Flower and Sons, Inc., Bayville, N.Y. - oysters.

Long Island Oyster Farms, Inc., Northport, N.Y. - oysters and clams.

Shellfish, Inc., West Sayville, N.Y. - clams.

Shelter Island Oyster Co., Greenport, N.Y. - oysters, clams and scallops.

New Jersey - (Mike Castagna)

Company name unknown, Richard Crema - manager, Great Bay, N. J. - oysters and clams.

Three other groups, unknown names, about to start operations in Great Bay area.

Delaware

No activity.

Maryland - (Mike Castagna & George Krantz)

Chesapeake Oyster Farms (Frank Wilde, owner) - mobile hatchery in the Choptank River - oysters.

Robertson Resources, Ltd., Salisbury, Md. - oysters and clams.

Dupuy and Wilkenson, St. Mary's County - cultchless oysters.

Virginia - (Mike Castagna & George Krantz)

Windmill Point Hatchery (C. Morgan et al), Urbanna, Va. - oysters.

No name company (Ed Powell, manager) - Rappahannock River - oysters.

L. L. Burton Co., Chincoteague, Va. - oysters and clams.

? Greer Co., Chincoteague, Va. - ?

John G. Warren, Quinby, Va. - clams.

North Carolina - (Mike Castagna & George Krantz)

Coastal Zone Management (David Adams), Wilmington, N.C. - oysters, clams and scallops.

Smith Products (Harvey Smith), Beaufort, N.C. - oysters and clams.

South Carolina - (Mike Castagna & George Krantz)

No activity.

Georgia - (Mike Castagna & George Krantz)

No activity.

Florida - (George Krantz and Winston Menzel)

No activity.

Mississippi - (Winston Menzel)

No commercial activity.

State is building a hatchery for oyster culture.

Alabama, Louisiana and Texas - (Winston Menzel & Richard Neal)

No activity.

Washington - (William Budge)

Lummi Aquaculture Project, Bellingham, Wash. - oysters and fish.

Joseph Engman, Paulsbo, Wash. - Japanese oysters.

Bay Center Mariculture, Willapa Bay - Japanese oysters.

Coast Oyster Co., Nahcotta, Wash. - Japanese oysters.

Oregon - (William Budge)

No activity.

California - (William Budge)

Tomales Bay Oyster Co., Pt. Reyes St. - oysters.

Pacific Mariculture, Elkhorn Slue - oysters and abalone.

International Shellfish Enterprises, Elkhorn Slue - oysters.

Pacific Ocean Farms, Monterey - abalone.

Marine Research Associates, Morro Bay - abalone.

SECTION IV

DETAILED PLANNING DOCUMENTS FOR MOLLUSCAN AQUACULTURE

The following Task Development Plans for Molluscan Aquaculture in the Middle Atlantic Coastal Fisheries Center were submitted for approval by higher offices on December 23, 1974.

AA FORM 32-14A
-74)

U. S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

PAGE O
1

NMFS TASK DEVELOPMENT PLAN

(See Detailed Instructions)

1. DATE PREP
December 9, ...

(Submit five copies by Jan. 2)

): Director, National Marine Fisheries Service, ATTN: Fx5
National Oceanic and Atmospheric Administration
Washington, D.C. 20235

FMC's - Submit a separate Task Development Plan for each task beginning, continuing, or ending in the current year, budget year, or budget year + 1. Reimbursable funds are not to be mingled with appropriated funds on any programmatic TDP; separate TDP's must be prepared. Submit one TDP itemizing the administrative support cost (Management Fund) for the FMC.

2. TDP NUMBER	3. OBJECTIVE CODES A	B	C	D	4. RANK BY TARGET	BY + 1 INC.
MAC-056-77-AQ A	-1 III-A					

5. TASK NUMBER	6. TASK TITLE
8826P1	Aquacultural Genetics

7. ORGANIZATION CODE	8. ORGANIZATION TITLE *(Responsible for execution of this task)*	9. PRINCIPAL LOCATION City	State
FB6300	Aquaculture Investigations	Milford	Ct

OBJECT CLASS Lines 10–18. Enter all dollar values as thousands and tenths of thousands. Lines 21–22. Enter as man-years and tenths of man-years.	COP LINE	CURRENT YEAR FY 1975 TARGET ALLOWANCE A	CURRENT YEAR FY 1975 INCREASE B	BUDGET YEAR FY 1976 TARGET ALLOWANCE C	BUDGET YEAR FY 1976 INCREASE D	BUDGET YEAR + 1 FY 1977 TARGET ALLOWANCE E	BUDGET YEAR + 1 FY 1977 INCREASE F
10. Total Direct Labor	15	19.9		41.3		41.3	31.6
. Travel	19	.2		.6		.6	
12. Rents, Communications, Utilities	21						
. Contracts *(To be let)*	51 52						
14. Grants *(Funds obligated)*	58						
. Supplies	53	1.0		.7		.7	1.1
. Capital Equipment	54						6.5
17. Other *(All other obligations)*		2.0		3.6		3.6	2.8
Total Direct Funds *(Add lines 10 through 17 above.)*		23.1		46.2		46.2	42.0
Positions, Full-time permanent *(Number applicable to this Task. Also, complete NOAA Form 32-14C.)*		3		3		3	3
. Positions, Other *(Number applicable to this Task.)*		1		1		1	
Man-years, Permanent		1.0		2.3		2.3	3
22. Man-years, Other		.5		.5		.5	
Reimbursable Support *(Reimbursable agreements only)*							

REMARKS

Reprogrammed FY'75 -- Ref MAC-014

OFFICIAL PREPARING REPORT *(Signature)*
ames E. Hanks

-34-

25. FMC DIRECTOR OR DESIGNATED REPRESENTATIVE *(Sig.)*
Carl Sundermann

(10-76) NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

PAGE 2 OF 12

NMFS TASK DEVELOPMENT PLAN

26. ACTIVITY, EVENT, AND MILESTONE SCHEDULE

TDP NUMBER: MAC-056-77-AQ-A-1

NUMBER EACH ACTIVITY, EVENT, OR MILESTONE

IDENTIFY BY ENTERING 'A' FOR ACTIVITY, 'E' FOR EVENT, OR 'M' FOR MILESTONE.

PLANNING PERIOD – Indicate by entering an "X" at the beginning and completion of subtask or selected operational activities that collectively define the task for the 7 year planning period. Connect "X's" with a solid bar. "Events" and "Milestones" occur at specific points in time. Indicate these significant achievements by placing an "X" in a single column.

NUMBER	A, E, OR M	NARRATIVE (Brief descriptive phrase of activity, event, or milestone)
1	A	Selective breeding, 2-way selection experiments.
2	E	Selective breeding demonstrations, and dissemination of information to industry.
3	M	Periodic (about yearly) development of experimental information on the following of use to industry regarding their hatchery selection: heritability estimates; duration of response to selection; inbreeding in selection; hybridization of selected lines for market.
4	M	Demonstrations of 2-way model selection experiments.
5	A	Inbreeding of lines by traditional means and by parthenogenesis.
6	A	Experimental hybridization of inbreds.
7	A	Reciprocal recurrent selection program for selecting inbreds on basis of test hybrids.
8	E	Dissemination of information on inbreeding to industry; also demonstrations on.
9	M	Regular (upon request) dissemination of information regarding effects of inbreeding in private selection programs in commercial hatcheries.
10	M	Dissemination to industry of experimental information regarding radical inbreeding followed by hybridization; evaluation of usefulness of such as a commercial technique for shellfish.

CY 75		BY 76		77 BUDGET YEAR									
				+1		+2		+3		+4		+5	
1	2	1	2	1	2	1	2	1	2	1	2	1	2
A	B	C	D	E	F	G	H	I	J	K	L	M	N
			X										
				X									
					X								
						X							
X													
					X								
					X								
			X										
X													
							X						

7. OUT YEAR COMMENTS

(Check appropriate boxes and enter applicable percentage.)

*Increases usually come from reprogramming within your FMC.)

a. Continued at same level ☐
b. Increase of ___ % * ☐
c. Reduction of ___ % ☐
d. Termination ☐

"X" APPROPRIATE COLUMN

REMARKS

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

NMFS TASK DEVELOPMENT PLAN

26. ACTIVITY, EVENT, AND MILESTONE SCHEDULE

PAGES: 3 | 12

TDP NUMBER: MAC-056-77-AQ-A-1

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NUMBER	A, E, OR M	NARRATIVE (Brief descriptive phrase of activity, event, or milestone)
1	M	Demonstrations of inbreeding and hybridization of inbreds.
2	A	Experimental hybridization of natural populations.
3	A	Field testing of natural population hybrids.
4	E	Demonstration of geographic population hybrids; dissemination of information on
5	A	Experimental between--species hybridization
6	E	Production of wide hybrid seed for industry; demonstration of, dissemination of information on, usefulness of.
7	M	Demonstration of results of hybridization of different geographic populations; dissemination of information on and usefulness of to industry.
8	M	Production of wide hybrid seed for industry; demonstration of; dissemination of information on and usefulness of.
9	A	Experimental mutation breeding.
10	A	Isolation of useful induced mutations.
11	E	Demonstrations of usefulness of mutation breeding.
12	M	Isolation of beneficial mutations induced by ionizing radiation and chemical mutagens.
13	M	Demonstration to industry of use of mutation breeding; dissemination to industry of information on & usefulness of.

CY 75		BY 76		77 BUDGET YEAR									
				+1		+2		+3		+4		+5	
1	2	1	2	1	2	1	2	1	2	1	2	1	2
A	B	C	D	E	F	G	H	I	J	K	L	M	N

7. OUT YEAR COMMENTS

(Check appropriate boxes and enter applicable percentage.)

*Increases usually come from reprogramming within your FMC.)

a. Continued at same level ☐
b. Increase of ___ % * ☐
c. Reduction of ___ % ☐
d. Termination ☐

"X" APPROPRIATE COLUMN

REMARKS

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

NMFS TASK DEVELOPMENT PLAN

26. ACTIVITY, EVENT, AND MILESTONE SCHEDULE

4 | 12

TOP NUMBER: MAC-056-77-AQ-A-1

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IDENTIFY BY ENTERING 'A' FOR ACTIVITY, 'E' FOR EVENT, OR 'M' FOR MILESTONE.

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NUMBER	A, E, OR M	NARRATIVE (Brief descriptive phrase of activity, event, or milestone)
24	A	Research on experimental cryopreservation of male and female shellfish gametes.
25	A	Development of gamete cryopreservation techniques suitable for commercial use.
26	M	Successful freezing and live recovery of male and female shellfish gametes.
27	M	Development of commercially suitable methods for cryopreservation of shellfish male and female gametes.
28	E	Conservation of important wild gene pools for future use.
29	M	Several separate instances of successful conservation of important wild gene pools for future commercial use.

CY 75		BY 76		77 BUDGET YEAR									
				+1		+2		+3		+4		+5	
1	2	1	2	1	2	1	2	1	2	1	2	1	2
A	B	C	D	E	F	G	H	I	J	K	L	M	N
						X							
								X					
									X				
											X		
								X					
										X			

OUT YEAR COMMENTS

(Check appropriate boxes and enter applicable percentage.)

*Increases usually come from reprogramming within your FMC.)

a. Continued at same level ☐
b. Increase of ___ % * ☐
c. Reduction of ___ % ☐
d. Termination ☐

"X" APPROPRIATE COLUMN

REMARKS

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

PAGE OF PAGES: 5 | 12

TDP NUMBER: MAC-056-77-AQ-A-1

NMFS TASK DEVELOPMENT PLAN
28. FULL-TIME PERMANENT POSITIONS

Reference NOAA Form 32-14A, Item 19. Identify all full-time permanent positions related to this Task for the budget year and all positions requested for budget year + 1 increases. Do not include support personnel; they should appear in the appropriate support Task Development Plan.

POSITION TITLE	GS LEVEL	NAME OF INCUMBENT (If no incumbent, enter "Vacant")	% OF TIME SPENT ON THIS TASK
Research Geneticist	13/4	004 Arlene (Longwell) Mazzone	75
Fishery Biologist (Res.)	11/1	011 Sheila (Stiles) Jewell	75
Fishery Biologist	7/1	019 James B. Hughes	75
Personnel Increase Required			
Geneticist	11/1	Vacant	100
Fishery Biologist	5/1	Vacant	100
Biological Laboratory Technician	4/1	Vacant	100

CONTINUE on plain 8x10½ paper. Identify "Page of Pages" and "TDP Number" in upper right corner. Comment on each of the following items, identifying by number. If item is not applicable, so indicate by entering "N.A":

29 STATEMENT OF NEED

30. ACTIVITY PLAN

31 TASK OUTPUTS AND BENEFITS

IMPACT OF TASK AUGMENTATION
a. Current Year
b. Budget Year

33. CRITERIA FOR TASK COMPLETION

34. BACK-UP DOCUMENTATION
a. Detail Documentation (Provide one sentence description.)
b. Related tasks and resources presently being employed.
* Indicate the Congressional legislative requirements.

29. STATEMENT OF NEED

Private Aquaculture - A general conclusion of the 1972 NOAA Aquaculture Survey (by Mardela Corporation), the Section on Economics, was that "economic factors in the U.S., combined with legal and technical inhibitions indicate that technologically intensive closed-cycle systems would eventually provide the best chance for U.S. aquaculture operation". To various degrees this conclusion might be argued. However, that the shellfish industry will be moving in this direction in regard to hatchery production is certain. Rearing successfully the oyster, other shellfish, any animal, under intensive, artificial conditions necessitates considerable alteration of the wild genotype. Part of the reason commercial shellfish hatcheries make no profit, even though basic hatchery techniques are well worked out, is the lack of organisms truly suited to artificial production. Applied genetic research could well aid industrial initiatives in their development of hatchery profitable strains. This work, however, must be supported and conducted along with applied work on nutrition and disease. Its success will be limited by advances in these other two areas. Along with the applied genetic work must be the advance of basic genetic knowledge about shellfish. The idea of continued successful application of the fruits of mission-oriented research to the fish industry without an increase in the base of the present limited genetic knowledge about fish is simply wishful thinking. Contrast all we know about plants and mammals, cereal, and poultry to what is known about fish to realize why fish breeders have a need to enlarge the base of information on which they operate - why indeed they have a right to have this work supported.

Public Aquaculture - Far too little is known about the genetics of shellfish for management of public beds to be conducted in such a way as to make maximum use of the full genetic potential of various commercial species. (Fishing these beds is still the main profitable enterprise of the industry.) This lack of knowledge makes for over-conservatism in attempts at improving wild stock beds, or results in simple neglect of presumed spawning beds. At the same time many of the wild gene pools that breeders will need to call upon for continued domestication of hatchery strains will probably risk loss in the future.

Specific Needs - Specific genetic needs of the shellfish industry to which this Task is addressed then can be broken down as follows: (1) Development of those areas of applied genetic research on shellfish (and other fish as the program evolves) that commercial hatchery producers will require in selecting their own hatchery strains - strains which will enable them to realize a profit from their hatchery enterprises. Just what will be required here has been determined on the basis of (a) what was required for the development of profitable agricultural plants and animals allowing for historic differences in agriculture and fisheries; (b) what sort of information is necessary to answer industry's specific request for information regarding their breeding endeavors. Commercial producers are presently mostly concerned about problems regarding selection and inbreeding. A shellfish

29. STATEMENT OF NEED (contd)

industry relatively unsophisticated in genetics, remains un-enthusiastic about any use of hybrids at all. Most attention accordingly would focus on selection and inbreeding. Some attention though must be given to wide hybridization. NMFS would be in error to follow industry's mood on hybrids. Almost all of our highly profitable food species in the U.S. derived from some original wide hybrid crosses which brought together the gene combinations necessary for their successful commercial exploitation, genes highly important as the species passed from wild to domesticated or cultivated state. (Moreover, hybrids are invariably what attracts most scientific, popular and sometimes new market attention.) Also an applied program of interspecies hybridization would certainly lead to the uncovering of much basic information on shellfish species of yet unpredictable but certain practical application in other breeding studies, as well as in industry.

(2) Concomitant with this required development of practical information is the need to enlarge the background base of genetic knowledge about shellfish essential to the long-range success of commercial breeding.

(3) There is a further need to understand the genetics of wild shellfish populations to open the possibility of maximizing profit from resource management that takes into full consideration the genetic potential of different wild populations.

(4) Lastly there is the need to promote the conservation of wild gene pools of shellfish that will become increasingly valuable in the future as sources of needed genes for hatchery strains. For example, genes to yet unknown hatchery diseases that will surely find expression as domestication advances and hatchery production takes precedence over the wild fisheries.

30. ACTIVITY PLAN

Methods employed will be those standard for mass selection programs, selection in two directions with randomly breeding control. Attention to population size, inbreeding intensity and selection intensity; computations of selection progress by standard genetic methods. Inbreeding by full-sib crosses, and in small closed populations. Also by induced parthenogenesis by radiation followed by experimental doubling of chromosome numbers. Hybridization, by necessity, by large numbers of single crosses. Some research on fertilization inhibition as a means of obtaining large-scale mass hybridizations. Experimental work aimed at forcing otherwise incompatible inter-species crosses. Backcrosses of wide hybrids to local commercial adapted types. Some use of special reciprocal recurrent selection program in inbreeding and hybridization work. Mutagenesis by gamma- and X-irradiation and with mutagenic alkylating agents. Some work on cryopreservation of live gametes as a means of facilitating genetic progress. Cytogenetics to be employed in appraising cross results, as in inter-species hybrids and intense inbreeding and sterility effects. Species, mostly oysters; also some other shellfish, possibly other fish as program evolves.

31. TASK OUTPUTS AND BENEFITS

1. Information on and demonstrations of progress by selective breeding - mostly oysters; other shellfish

For a large variety of commercially important traits (including possibly disease resistance) sound information would be developed for hatchery breeders regarding the likelihood of improvement by private selection programs within commercial hatcheries. This information would relate to different founding individuals, various degrees of inbreeding, and different selection potentials. Once set up, experiments would be continued from generation to generation to obtain continuous information on the presumed limits of improvement by selective breeding. There would also be test hybridizations of selected lines for superior market oysters. Such mass selection experiments with random breeding controls would serve as a continuous source of information to industry, provide scientific data on the oyster, and at the same time be a very visible demonstration of science at work for the fishery industry.

There would be accumulation of sufficient information on all the parameters involved in scientifically based selective breeding so that industry can be advised on their breeding problems without having to resort to new research except in limited instances; also enough information on selective breeding of shellfish for industry to plan more knowledgeably their own new breeding programs. This should take about 10 years with important milestones reached every other year on the average along the way. Advisory work based on the information developed and demonstrations could continue for years past termination of most of the experimental work on this Specific Task Output.

2. Information on and inbreeding demonstrations for industry application; also fundamental genetic information on results of inbreeding - mostly oysters; other shellfish

Inbreeding, both severe and rapid and mild and slow, of several lines would be conducted for various purposes. One of these would be to estimate how well shellfish that are natural outbreeders can tolerate inbreeding; how severe and what form inbreeding depression takes in pelecypod molluscs. Another purpose would be to appraise for industry the feasibility of producing superior hatchery lines by intensive inbreeding followed by cross-breeding of select inbred strains. Finally, inbreeding should result in the "surfacing" of genes useful in basic work and as genetic tags for other applied research. Also, it would make possible an in-depth study of cross-incompatibility genes which can determine the level of crossability in hatchery bred animals, and between different populations and species.

31. TASK OUTPUTS AND BENEFITS (Contd)

Sufficient information should be generated to evaluate for industry the usefulness and cost of inbreeding programs for eventual production of hybrids between inbred lines for market. This should take about seven years to complete, but benefits will accrue along the way. Advisory work based on the information developed, and demonstrations could continue for years past termination of the experimental part of this Specific Task Output.

3. Information on and demonstrations of the results of within species hybridization of natural oyster populations - mostly oysters; other shellfish

Different geographic populations of oysters within any one species would be collected and test hybridized with one another, then the hybrids experimentally or field-tested for specific uses. The purpose of this would be the combination of particular traits in the hybrid that could result in superior hybrid types for re-stocking on wild beds or growing for aquaculture. This could include hybrids with increased environmental range or adaptability, hybrids that will thrive better under stress of heavy pollution, particularly the larval phase, because of heterosis. Also, these hybrids would serve as seed stock for mass selection programs in which it was deemed best or was necessary to include an assortment of genes from a wide area, as for example, genes for disease resistance. As the applied aspects of this program develop, it can be expected that considerable basic genetic information on different wild populations would be uncovered of practical use in other aspects of the genetic program.

Sufficient information should be obtained to advise industry on value of hybrid crosses of wild stocks in hatchery breeding programs, also to advise managers of the wild resource about use of such hybrids on natural beds. Demonstrations and limited information would be presented before the six years ended. Advisory work based on the information developed, and demonstrations could continue for years past termination of the experimental part of this Specific Task Output.

4. Information on, demonstration of, and production of inter-species hybrids of oysters - mostly oysters - include genera other than Crassostrea; other shellfish

Inter-species hybrids would be experimentally produced, studied and tested for commercial value. This work would involve a wide variety of species of different genera, some distantly related, others suspect of not having a true species rank being merely genetically distinct populations of the same species. Commercial and non-commercial types alike would be explored. Information resulting should be of use to commercial hatcheries, and also for management and stocking of wild beds, and for the opening up of new beds. Probably greatest use of the hybrids would be in backcrossing programs with the favored prevalent commercial type. Backcrossing

31. TASK OUTPUTS AND BENEFITS (Contd)

would lead to the incorporation of desirable genes (as for example resistance to larval diseases) from a generally less desirable non-commercial or unadapted species into the popular commercial type. The possibility even cannot be excluded that some F_1 hybrid would itself be a superior market type under many circumstances. Some small amounts of especially difficult-to-come-by hybrid seed might be distributed to industry for experimental purposes.

Commercially practical methods should be developed to achieve wide species hybridization which cannot occur under normal conditions of laboratory or hatchery fertilization; also a large enough number of hybrid combinations should be tested to get a good enough evaluation of such hybrid usefulness. These should be a demonstration of the role of wide hybrids as one step in a hatchery program involving backcrosses of F_1 hybrids to local types with selection. Finally there would be the production of some initial hard-to-come-by seed for industry. Advisory work and demonstrations could continue for years after experimental portion of this Specif Task Output is completed.

5. Studies on experimental mutation breeding as applicable to unique problems of shellfish breeding - mostly oysters; other shellfish

Evaluation of the usefulness for applied breeding programs of inducing mutations in shellfish by ionizing radiation and recognized chemical mutagens. At the same time develop a basic understanding of mutations in these groups. Preserve any basically useful genetic markers that are induced. (Also use radiation as a means of inducing parthenogenesis by induction of lethal mutations in sperm.) While this is a more radical approach than the ones just listed above, it is justified by the primitive nature of shellfish, their enormous fecundity, and paucity of easily handled marker genes. Also, a very rapid domestication of the oyster in the genetic sense could probably well utilize genes readily available now in these species only through mutation. For example, a mutation expressing itself in some aspect of larval morphology or physiology might broaden the spectrum of micro-algae on which fastidious larvae must be fed in commercial hatcheries. (Such an approach - induced mutagenesis - has broad public and scientific visibility.)

Sufficient knowledge should be generated to evaluate mutation breeding as an approach to rapid domestication of wild shellfish for intensive, artificial culture There should be isolation of some induced mutations for commercial use and for basic research. Advisory work and demonstrations could continue for years after this Specific Task Output is terminated.

6. Cryopreservation of male and female gametes of shellfish

Research would be conducted on experimental cryopreservation and live recovery of both male and female gametes of the shellfish. There would be work on the development of gamete preservation techniques suitable for commercial use.

31. TASK OUTPUTS AND BENEFITS (Contd)

7. Conservation of important wild gene pools of shellfish for future commercial use

First the more important gene pools needing conservation would be identified in part from results of selection experiments, studies of hybrids between different geographic populations within a species, and of inter-species hybrids. Conservation would be by information disseminated to those responsible for the wild resources; by active collection and breeding of specimen groups; lastly possibly by cryopreservation methods.

Summary statement on Task outputs and benefits

This Task will develop the kind of genetic information NMFS needs to answer the specific questions industry poses concerning the development of their own hatchery strains - strains which will enable them to realize a profit from their hatchery enterprises. Such information will also enable NMFS to take the initiative in advising industry on certain aspects of breeding in advance of industr request for such. Special gene pools conserved in NMFS laboratories or under the Service's auspices would directly benefit industry. Industry and consumer alike would benefit from the improved management of wild shellfish beds that would be possible with increased knowledge of the genetic potential of different wild shellfish populations. As well as aid in future hatchery production, the information gained from the Task can so be applied by commercial shellfish growers, NMFS, and other federal agencies and state agencies in managing and protecting economically valuable shellfish resources.

32. IMPACT OF TASK AUGMENTATION

Requested increase is essential to accomplish most aspects of milestones outlined in TDP.

33. CRITERIA FOR TASK COMPLETION

34. BACK-UP DOCUMENTATION

(a) 1. NOAA Aquaculture Survey, 1972. Report to Participants. Mardela Corporation, Burlingame, California.

2. Oyster genetics and future role of genetics in aquaculture - A review manuscript by A. Longwell and S. S. Stiles. Malacological Review, 1973, 6: 151-177.

3. The genetic system and breeding potential of the commercial American oyster - A review by A. Longwell and S. Stiles which appeared in Endeavour, 29(107): May 1970.

4. Some impressions regarding genetics and the fisheries of Japan - A manuscript by A. Longwell - published as NMFS Circular 388, p. 123-133, as part of the Proceedings of the First Meeting of the US/Japan Aquaculture Panel of the Natural Resources Council, Tokyo, Japan, November 1971.

5. Oyster Genetics: Research and commercial application. Review by A. Crosby Longwell. Proc. Conf. Shellfish Culture. Selden, Long Island, April 1968, p. 91-104.

6. Evaluation of the mutagenicity of marine contaminants for marine species as affecting in-shore and off-shore fisheries. Informal, in-house report by A. Crosby Longwell, 1974.

NA FORM 32-74)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

PAGE OF P
1

NMFS TASK DEVELOPMENT PLAN

(See Detailed Instructions)

1. DATE PREPARED
December 9, 1974

(Submit five copies by Jan. 2)
TO: Director, National Marine Fisheries Service, ATTN: Fx5
National Oceanic and Atmospheric Administration
Washington, D.C. 20235

FMC's - Submit a separate Task Development Plan for each task beginning, continuing, or ending in the current year, budget year, or budget year + 1. Reimbursable funds are not to be mingled with appropriated funds on any programmatic TDP; separate TDP's must be prepared. Submit one TDP itemizing the administrative support cost (Management Fund) for the FMC.

TDP NUMBER	3. OBJECTIVE CODES				4. RANK	
	A	B	C	D	BY TARGET	BY + 1 INC.
MAC-057-77-AQ-A	1 III-A					

TASK NUMBER	6. TASK TITLE
8826P2	Aspects of Nutritional Requirements of Molluscs

ORGANIZATION CODE	8. ORGANIZATION TITLE *(Responsible for execution of this task)*	9. PRINCIPAL LOCATION	
		City	State
FB6300	Aquaculture Investigations	Milford	Ct

OBJECT CLASS Lines 10–18. Enter all dollar values as thousands and tenths of thousands. Lines 21–22. Enter as man–years and tenths of man–years.	COP LINE	CURRENT YEAR FY 1975		BUDGET YEAR FY 1976		BUDGET YEAR + 1 FY 1977	
		TARGET ALLOWANCE A	INCREASE B	TARGET ALLOWANCE C	INCREASE D	TARGET ALLOWANCE E	INCREASE F
10. Total Direct Labor	15	23.6		51.0		51.0	34.5
11. Travel	19	.1		1.0		1.1	
12. Rents, Communications, Utilities	21						
13. Contracts *(To be let)*	51 52						
14. Grants *(Funds obligated)*	58						
15. Supplies	53	3.0		2.2		2.2	1.5
16. Capital Equipment	54						
17. Other *(All other obligations)*		2.7		4.5		4.5	4.0
18. Total Direct Funds *(Add lines 10 through 17 above.)*		29.4		58.8		58.8	40.0
19. Positions, Full–time permanent *(Number applicable to this Task. Also, complete NOAA Form 32–14C.)*		2		2		2	3
20. Positions, Other *(Number applicable to this Task.)*		1		1		1	
21. Man–years, Permanent		1.1		2.3		2.3	3
22. Man–years, Other		.5		.5		.5	
23. Reimbursable Support *(Reimbursable agreements only)*							

REMARKS

Reprogrammed FY'75 Ref MAC013

24. OFFICIAL PREPARING REPORT *(Signature)*

James E. Hanks, Dir. of Investigations

25. FMC DIRECTOR OR DESIGNATED REPRESENTATIVE *(Sig.)*

Carl J. Sindermann, Center Director

FORM CD-346
(10-74)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

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NMFS TASK DEVELOPMENT PLAN

TDP NUMBER MAC-057-77-AQ-A-1

26. ACTIVITY, EVENT, AND MILESTONE SCHEDULE

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			1	2	1	2	1	2	1	2	1	2	1	2	1
			A	B	C	D	E	F	G	H	I	J	K	L	M
1	A	Advise and consult with industry personnel on improving food production methods in aquaculture.		X											
2	A	Conduct studies on techniques for obtaining axenic molluscan larvae for utilization in nutrition studies.		X											
3	A	Conduct studies on evaluation of feeding efficiency in different stages of the molluscan life cycle.		X											
4	A	Experiment with the utilization of living food sources by molluscs under controlled conditions.		X											
5	A	Experiment on the utilization of non-living foods by molluscs under controlled conditions.		X											
6	A	Conduct nutritional studies on molluscs under natural conditions.		X						X					
7	A	Maintenance of a stock culture collection of unicellular marine algae.		X											
8	A	Expansion of collection of unicellular algae collection by purification, isolation and identification of species.		X											
9	A	Investigation of methods for the long-term storage and preservation of cultured species.		X						X					
10	A	Maintenance of algal mass culture systems.		X											
11	A	Studies on the physiological parameters of phytoplankton growth.		X											
12	A	Studies on the nutritional parameters of phytoplankton growth.		X											

27. OUT YEAR COMMENTS

(Check appropriate boxes and enter applicable percentage.)

*Increases usually come from reprogramming within your FMC.)

a. Continued at same level ☐
b. Increase of ____ % * ☐
c. Reduction of ____ % ☐
d. Termination ☐

"X" APPROPRIATE COLUMN

REMARKS

NMFS TASK DEVELOPMENT PLAN

26. ACTIVITY, EVENT, AND MILESTONE SCHEDULE

NUMBER EACH ACTIVITY, EVENT, OR MILESTONE

IDENTIFY BY ENTERING 'A' FOR ACTIVITY, 'E' FOR EVENT, OR 'M' FOR MILESTONE.

PLANNING PERIOD – Indicate by entering an "X" at the beginning and completion of subtask or selected operational activities that collectively define the task for the 7 year planning period. Connect "X's" with a solid bar. "Events" and "Milestones" occur at specific points in time. Indicate these significant achievements by placing an "X" in a single column.

NUMBER	A, E, OR M	NARRATIVE (Brief descriptive phrase of activity, event, or milestone)
13	A	Investigate effects of pollutants on phytoplankton to ensure a good response of food species in culture and a healthy marine environment.
14	A	Develop the potential of microscopic algae for a new source of protein.
15	E	Evaluate potential for phytoplankton preservation and storage as a new source of protein particularly for aquaculture.
16	E	Evaluate the best cost efficiency for algal food production.

CY 75		BY 76		77 BUDGET YEAR +1		+2		+3		+4		+5	
1	2	1	2	1	2	1	2	1	2	1	2	1	
A	B	C	D	E	F	G	H	I	J	K	L	M	

27. OUT YEAR COMMENTS

(Check appropriate boxes and enter applicable percentage.)

*Increases usually come from reprogramming within your FMC.)

a. Continued at same level ☐
b. Increase of 50 %* ☐
c. Reduction of ___ % ☐
d. Termination ☐

"X" APPROPRIATE COLUMN

REMARKS

Funding of this Investigation must be increased in order to provide the information fundamental to the success of molluscan aquaculture. 'You are what you eat' is a dictum that is most apt for species in aquaculture.

NMFS TASK DEVELOPMENT PLAN
28. FULL-TIME PERMANENT POSITIONS

PAGE 4 OF 7

TDP NUMBER: MAC-057-77-AQ-A

Reference NOAA Form 32-14A, Item 19. Identify all full-time permanent positions related to this Task for the budget year and all positions requested for budget year + 1 increases. Do not include support personnel; they should appear in the appropriate support Task Development Plan.

POSITION TITLE	GS LEVEL	NAME OF INCUMBENT (If no incumbent, enter "Vacant")	% OF TIME SPENT ON THIS TASK
Research Microbiologist	13/5	005 Ravenna Ukeles	100
Microbiologist	7/2	022 William E. Rose	100
		Personnel Increase Required	
Microbiologist	11/1	Vacant	100
Microbiologist	7/1	Vacant	100
Biologist	5/1	Vacant	100

CONTINUE on plain 8x10½ paper. Identify "Page of Pages" and "TDP Number" in upper right corner. Comment on each of the following items, identifying by number. If item is not applicable, so indicate by entering "NA":

29. STATEMENT OF NEED

30. ACTIVITY PLAN

31. TASK OUTPUTS AND BENEFITS

32. IMPACT OF TASK AUGMENTATION
- a. Current Year
- b. Budget Year
- c. Budget Year + 1

33. CRITERIA FOR TASK COMPLETION

34. BACK-UP DOCUMENTATION
- a. Detail Documentation *(Provide one sentence description.)*
- b. Related tasks and research presently being conducted.
- c. Indicate the Congressional legislative requirements.
- d. Indicate the Environmental Impact Statement (EIS) requirements.

29. STATEMENT OF NEED

Pressures on land food resources demand that there be also an increased productivity from aquatic environments. The potential for increasing aquatic productivity through controlled aquaculture has been largely untapped because of fundamental problems in the methodology. The consensus of opinion is that an increase in aquatic productivity through aquaculture should be provided by the private sector but assistance in problem solving and the introduction of innovative procedures can best be provided by government scientific laboratories as a public service.

Commercial shellfish operators consistently urge that high priority emphasis be placed upon the problem of providing nutrition to the animals in aquaculture. Obviously, the ability to feed animals nutrients that will support growth, that are non-toxic and are economical is fundamental to the success of any aquaculture efforts.

At present unicellular marine algae are cultured for use as molluscan foods along the lines developed in the past at the Milford laboratory. The method has numerous inherent benefits to achieving the end goal but also presents many problems to the commercial aquaculture producer. The possibility of developing other food sources should be pursued. This information should be based upon information on the nutritional requirements of these animals as far as it is possible to determine them. Allied to the need for providing commercial aquaculture with information on nutritional requirements and how to provide this nutrition are other factors, such as cost, engineering of feeding system, acceptability of food material at different life cycle stages, and monitoring for the invasion of pathogens.

The intent of this Task is to provide information on the cultivation of marine phytoplankton for molluscan foods that will improve the method currently available and will provide an immediate benefit to the industry while a more ideal food is being sought. To accomplish this Task research will be conducted on the chemical and physical factors that affect phytoplankton growth. Nutritional requirements of molluscs will be investigated as they relate to living and non-living food sources.

30. ACTIVITY PLAN

This Task will utilize basic methods for studying the nutrition and physiology of marine phytoplankton food-chain organisms. This information will be applied to the development and improvement of existing large-scale culture methods. Methods for efficient harvesting and for long-term storage of this product will be sought to increase efficiency of mass culture operation. Activities will then proceed to experiments on replacing the living food with a partially or wholly synthetic food product. Simultaneously a critical system for evaluation of nutritional supplements will need to be developed.

31. TASK OUTPUTS AND BENEFITS

1. Information on the maintenance of a collection of marine unicellular algae under controlled conditions will become available.

2. Methods of obtaining and maintaining axenic phytoplankton cultures will be available.

3. Production of large quantities of algal foods for utilization by molluscs.

4. Information on the effects of various pollutants on algal growth will become available for determining potential productivity of natural bodies of water.

5. Information on certain aspects of nutrition and physiology of pure cultures of marine algae will be published.

6. Methods for obtaining axenic molluscan larvae for use in critical nutrition studies will be developed to support critical evaluation of molluscan nutrition.

7. Information on utilization of microscopic algae as food sources to extend the current options available in aquaculture.

8. Information on utilization of synthetic nutritional formulations as food sources to extend the current options available in aquaculture.

9. Consultation on best methods of providing nutrients for molluscan aquaculture will be available to industry.

32. IMPACT OF TASK AUGMENTATION

At the present level of funding work can continue on maintenance of the stock culture collection and maintenance of the algal mass culture food production unit with a minimum amount of experimentation in algal nutritional and physiological requirements. With the estimated potential increase in funding, in addition to the above work, investigations into methodology for evaluating nutritional food requirements in molluscan larvae can be conducted, e.g., the culture of axenic larvae, testing of algal species for which no information on food value is available, testing of synthetic nutritional formulation for evaluating nutritional requirements in larvae, and work can also be initiated into determining nutritional requirements for other life cycle stages.

33. CRITERIA FOR TASK COMPLETION

34. BACK-UP DOCUMENTATION

a) 1. NOAA Regional Aquaculture Workshop Project #A/a-01, Mardela Corp. Report.

2. Informal Report No. 4 - Middle Atlantic Coastal Fisheries Center, NMFS - Investigation Summaries - A summary of research in on-going programs within the Middle Atlantic Coastal Fisheries Center.

3. NOAA Week. NMFS Milford scientists develop algae culture for shellfish food.

4. NOAA Technical Report, NMFS Circular 388. Proc. First US/Japan meeting on Aquaculture at Tokyo, Japan.

5. Monograph - "Continuous culture - a method for the production of unicellular algal foods" - R. Ukeles. In: Handbook of Phycological Methods, J. R. Stein (ed.), Cambridge Univ. Press, pp. 233-254, 1973.

6. Monograph - "Nutritional requirements in shellfish culture" - R. Ukeles. In: Proc. Conference on Artificial Propagation of Commercially Valuable Shellfish, pp. 43-64, 1971.

7. Monograph - "Cultivation of unicellular algae" - R. Ukeles. To appear in a five-volume series in Marine Ecology.

8. Mass culture of phytoplankton as foods for metazoans - H. C. Davis and R. Ukeles. Science, 134: 562-564, 1961.

9. Dried unicellular algae as food for larvae of the hard shell clam, Mercenaria mercenaria - H. Hidu and R. Ukeles. Proc. Natl. Shellfish. Assoc., 53: 85-101, 1964.

10. A simple method for the mass culture of marine algae - R. Ukeles. Limnol. Oceanogr., 10(3): 492-495, 1965.

11. Influence of dinoflagellate trichocysts and other factors on the feeding of Crassostrea virginica larvae on Monochrysis lutheri - R. Ukeles and B. Sweeney. Limnol. Oceanogr., 14(3): 403-410, 1969.

b)

c)

d) This Task will have no adverse impact on the environment.

e)

NOAA FORM 32-74A
0-74)

U. S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

PAGE OF PA
1

NMFS TASK DEVELOPMENT PLAN

(See Detailed Instructions)

1. DATE PREPARED
December 9, 1974

(Submit five copies by Jan. 2)

TO: Director, National Marine Fisheries Service, ATTN: Fx5
National Oceanic and Atmospheric Administration
Washington, D.C. 20235

FMC's - Submit a separate Task Development Plan for each task beginning, continuing, or ending in the current year, budget year, or budget year + 1. Reimbursable funds are not to be mingled with appropriated funds on any programmatic TDP; separate TDP's must be prepared. Submit one TDP itemizing the administrative support cost (Management Fund) for the FMC.

TDP NUMBER	3. OBJECTIVE CODES				4. RANK	
	A	B	C	D	BY TARGET	BY + 1 INC.
MAC-058-77-AQ-A						

TASK NUMBER	6. TASK TITLE
8826P3	Aquaculture: Control of Molluscan Disease

ORGANIZATION CODE	8. ORGANIZATION TITLE *(Responsible for execution of this task)*	9. PRINCIPAL LOCATION	
		City	State
FB6410	Pathobiology Investigations	Milford	Ct

OBJECT CLASS Lines 10–18. Enter all dollar values as thousands and tenths of thousands. Lines 21–22. Enter as man-years and tenths of man-years.	COP LINE	CURRENT YEAR FY 1975		BUDGET YEAR FY 1976		BUDGET YEAR + 1 FY 1977	
		TARGET ALLOWANCE A	INCREASE B	TARGET ALLOWANCE C	INCREASE D	TARGET ALLOWANCE E	INCREASE F
10. Total Direct Labor	15	18.2		37.5		37.5	27.0
11. Travel	19	--		--		--	9.6
12. Rents, Communications, Utilities	21	--		--		--	
13. Contracts *(To be let)*	51 52	--		--		--	5.0
14. Grants *(Funds obligated)*	58	--		--		--	
15. Supplies	53	0.6		--		--	20.0
16. Capital Equipment	54	--		--		--	15.0
17. Other *(All other obligations)*		1.6		3.3		3.3	6.4
18. Total Direct Funds *(Add lines 10 through 17 above.)*		20.4		40.8		40.8	83.0
19. Positions, Full-time permanent *(Number applicable to this Task. Also, complete NOAA Form 32-14C.)*		2		2		2	
20. Positions, Other *(Number applicable to this Task.)*		1		1		3	1
21. Man-years, Permanent		1.0		2.0		2.0	
22. Man-years, Other		.5		1.0		2.0	1.0
23. Reimbursable Support *(Reimbursable agreements only)*		--		--		--	

REMARKS

Reprogrammed FY'75 - Ref. MAC012

24. OFFICIAL PREPARING REPORT *(Signature)*

Aaron Rosenfield
Director of Investigations

25. FMC DIRECTOR OR DESIGNATED REPRESENTATIVE *(Sig.)*

Carl Sindermann

Carl J. Sindermann, Center Director

NAPS TASK DEVELOPMENT PLAN

26. ACTIVITY, EVENT, AND MILESTONE SCHEDULE

TOP NUMBER: MAC-058-75-AQ-A

NUMBER EACH ACTIVITY, EVENT, OR MILESTONE

IDENTIFY BY ENTERING 'A' FOR ACTIVITY, 'E' FOR EVENT, OR 'M' FOR MILESTONE.

PLANNING PERIOD – Indicate by entering an "X" at the beginning and completion of subtask or selected operational activities that collectively define the task for the 7 year planning period. Connect "X's" with a solid bar. "Events" and "Milestones" occur at specific points in time. Indicate these significant achievements by placing an "X" in a single column.

NUMBER	Y, E, OR M	NARRATIVE (Brief descriptive phrase of activity, event, or milestone)	CY 1 A	CY 2 B	BY 1 C	BY 2 D	BUDGET YEAR +1 1 E	+1 2 F	+2 1 G	+2 2 H	+3 1 I	+3 2 J	+4 1 K	+4 2 L	+5 1 M	+5 2 N
1	A	Isolations of microbial pathogens from larval bivalve hatchery systems →	X	-	-	-	-	-	-	-	-	X				
2	E	Present reports			X			X			X			X		
3	M	Publish results					X			X			X			X
4	A	Develop methods to reduce pathogen entry or activity in bivalve hatcheries prevention/treatment →	X	-	-	-	-	-	-	-	-	-	-	X		
5	A	Assess effectiveness prophylactic curative methods		X	-	-	-	-	-	X						
6	E	Present reports to scientific meetings and workshops				X			X			X				
7	M	Publish results						X			X			X		
8	A	Continue to provide consultative and research services to Sea Grant, universities, industrial institutions engaged in aquaculture research	X	-	-	-	-	-	-	-	-	-	-	-	-	X
9	M	Publish joint reports and papers with 8A above			X		X		X		X		X		X	
)	A	Begin isolations of protozoan pathogens from larval bivalve hatchery systems		X	-	-	-	-	-	-	-	-	-	X		
1	E	Present reports to scientific meetings/workshops				X			X			X			X	
2	M	Publish findings					X			X			X			X
3	A	Begin studies of diseases in grow out systems; bivalve juveniles/adults fish, crustaceans					X	-	-	-	-	-	-	-	-	X

F.Y 77

7. OUT YEAR COMMENTS

(Check appropriate boxes and enter applicable percentage.)

*Increases usually come from reprogramming within your FMC.)

a. Continued at same level ☐
b. Increase of ___ % * ☐
c. Reduction of ___ % ☐
d. Termination ☐

"X" APPROPRIATE COLUMN

REMARKS

NMFS TASK DEVELOPMENT PLAN

26. ACTIVITY, EVENT, AND MILESTONE SCHEDULE

3 | 7

TOP NUMBER: MAC-058-75-AQ-A

NUMBER EACH ACTIVITY, EVENT, OR MILESTONE

IDENTIFY BY LETTERING 'A' FOR ACTIVITY, 'E' FOR EVENT, OR 'M' FOR MILESTONE.

PLANNING PERIOD – Indicate by entering an "X" at the beginning and completion of subtask or selected operational activities that collectively define the task for the 7 year planning period. Connect "X's" with a solid bar. "Events" and "Milestones" occur at specific points in time. Indicate these significant achievements by placing an "X" in a single column.

	A, E, OR M	NARRATIVE (Brief descriptive phrase of activity, event, or milestone)	CY 1 A	CY 2 B	BY 1 C	BY 2 D	BUDGET YEAR +1 1 E	+1 2 F	+2 1 G	+2 2 H	+3 1 I	+3 2 J	+4 1 K	+4 2 L	+5 1 M	+5 2 N
1	A	Isolations of microbial pathogens from laboratory and hatchery cultures, larval bivalves		X										X		
2	E	Present reports - scientific meetings/workshops				X			X			X			X	
	M	Publish findings						X			X			X		
4	A	Develop methods to reduce pathogen entry or activity (prevention/treatment) in bivalve hatchery/nursery systems		X												X
5	A	Assess effectiveness prophylactic/curative methods				X						X				
	E	Present reports to scientific meetings/workshops						X			X			X		
7	M	Publish results								X			X			X
	A	Provide consultative and research services to Sea Grant universities, industrial institutions engaged in aquaculture research		X												X
	M	Publish joint reports and papers with 8A above				X		X		X		X		X		X
J	A	Begin isolations of protozoan pathogens from laboratory and hatchery cultures larval bivalves				X										X
	E	Present reports: Scientific meetings/workshops						X			X			X		
?	M	Publish findings								X		X			X	

FY-76

OUT YEAR COMMENTS

(Check appropriate boxes and enter applicable percentage.)

*Increases usually come from reprogramming within your FSIC.)

a. Continued at same level ☒

b. Increase of ___ %* ☐

c. Reduction of ___ % ☐

d. Termination ☐

"X" APPROPRIATE COLUMN

REMARKS

29. PERMANENT POSITIONS

Reference NOAA Form 32-1A, Item 19. Identify all full-time permanent positions related to this Task for the budget year and all positions requested for budget year + 1 increases. Do not include support personnel; they should appear in the appropriate support Task Development Plan.

POSITION TITLE	GS LEVEL	NAME OF INCUMBENT (If no incumbent, enter "Vacant")	% OF TIME SPENT ON THIS TASK
Research Microbiologist	12/1	Blogoslawski, Walter J.	100% (*
Biologist	9/2	Brown, Carolyn	100% (*
Biological Laboratory Technician (BY & 1)	7/1	Vacant	100%

(*) 50% in F/Y 75; 100% thereafter

CONTINUE on plain 8x10½ paper. Identify "Page of Pages" and "TDP Number" in upper right corner. Comment on each of the following items, identifying by number. If item is not applicable, so indicate by entering "NA":

31. STATEMENT OF NEED

32. ACTIVITY PLAN

33. CRITERIA FOR TASK COMPLETION

34. TASK OUTPUTS AND BENEFITS

35. IMPACT OF TASK AUGMENTATION
- a. Current Year
- b. Budget Year
- c. Budget Year + 1

36. BACK-UP DOCUMENTATION
- a. Detail Documentation (Provide one sentence description.)
- b. Related tasks and interactions presently being conducted.
- c. Indicate the Congressional legislative requirements.
- d. Indicate the Environmental Impact Statement (EIS) requirements.

FB6410 - Aquaculture - Control of Molluscan Disease - FY 1977

29. Statement of Need

Increased exploitation of the nation's estuaries and coastal zones for industrial and residential development and recreational activities has markedly reduced the areas available for the production and harvest of fish and shellfish. More efficient and effective means to enhance U.S. seafood production must be found. Aquaculture methods require: 1) an adquate supply of genetically desirable brood stocks; 2) methods to increase larval survival and normal development; 3) methods to promote rapid growth. Disease is often a limiting factor to successful aquaculture operations. With increasing interest in aquaculture, where populations reach maximum density and the transfer of susceptible stocks (as eggs, larvae, fry, fingerlings) becomes a routine procedure, it is necessary to conduct scientific studies on the role of disease so that its effects can be prevented, minimized, or eliminated.

The successful application of disease research to the intensive propagation of fish and shellfish in controlled environments would increase industrial initiatives for commercial aquaculture. A program of disease research would involve: 1) the development and implementation of a research program for disease prevention and control, particularly in hatchery and nursery systems; 2) the development and implementation of an inspection system for routine diagnosis and identification of infectious agents; 3) contracts and interdisciplinary research projects in collaboration with industry, universities, State, and Federal agencies and other research institutions; 4) legislation providing a favorable climate for aquaculture research; e.g., specific NOAA appropriations, "coastal zone legislation," "ocean dumping act," and fish disease legislation, thus leading to coordinated programs with other NOAA elements such as Sea Grant and Federal Aid (88-309) projects. Information generated would be disseminated to all user groups and others interested in aquaculture operations, particularly industry, state, and some university laboratories who cannot do the work themselves.

30. Activity Plan

As far as possible, research will be integrated with ongoing Pathobiology Investigations now dealing primarily with diseases of wild fish and shellfish. Research emphasis will focus on prophylaxis and treatment of infectious and non-infectious diseases of larvae and juveniles of selected shellfish species produced under hatchery systems. Subsequently, diseases occurring in nursery systems and in adult and reproducing populations, both foreign and domestic, will be studied. Field and laboratory experiments will be implemented to test hypotheses on disease control and to test fishery management practices as they apply to various phases of aquaculture operations; particularly in hatchery systems. Techniques will be developed to: 1) monitor, isolate, identify, culture, and diagnose micropathogen presence; 2) determine the mechanisms of micropathogen transmission, penetration, infectivity, host specificity; 3) qualitatively and quantitatively measure micropathogen activity and host responses via biochemical, cytological, physiological, immunological, and biophysical studies.

30. continued

Long-range plans call for implementing research activities as described above to include species of crustaceans and finfish.

31. Task Outputs and Benefits

1. Outputs

A. Successful implementation of this task and consequent productivity therefrom will permit the NMFS to serve as a national and international clearing house and disseminator of technical information on disease control in aquaculture systems, including establishment of disease registries and publication of manuals, bulletins, brochures on diseases encountered in aquaculture and methods for disease control and prevention. It will permit NMFS to integrate inhouse research projects with Federal, State, university, and other research laboratories in order to provide training facilities and to implement and augment programs to prevent diseases in hatchery and nursery systems.

B. Research productivity and termination of task elements will be measured through successful operation of aquaculture programs of cooperating units and through communication of results in the scientific literature and in industry publications.

2. Benefits

Task outputs would substantially benefit those user groups whose success in various aquaculture operations are precluded because of problems related to disease. Examples are: inability to bring molluscan species through larval and juvenile stages on a mass scale to a point where they can be transplanted successfully; spreading of diseases through indiscriminate transfer of animals for farming or for use as brood stocks which may harbor infectious agents; inability to recognize signs of abnormal water quality conditions or the presence of infectious disease entities in the environment in which the animals are grown and inability to distinguish these organisms from innocuous ones; lack of reliable, objective, readily usable information for solving problems in disease related molluscan aquaculture.

32. Impact of Task Augmentation

FY 1975: This TDP represents a modified submission in which funds for the last half of FY 75 are to be reprogrammed. Specific actions for FY 75 include reprogramming part of the current Comparative Pathobiology task to the control of aquaculture diseases. The total FY 75 funding for this task is 20K. Of this 20K and 1 man year will be reprogrammed beginning January 1, 1975. This will obviously reduce the amount of available funds, activity, and output for Comparative Pathobiology Investigations at Oxford.

FY 1976: Specific reprogramming action for FY 76 include the same proportion of funds and personnel reprogrammed the previous year; i.e., 40K and 2 man years. The Comparative Pathobiology Investigation will decrease correspondingly in terms of funds, personnel, and output.

FY 1977: An additional 83K increase for this task is anticipated along with 3 new ceilings.

33. Criteria for Task Completion

34. Back-up Documentation

A. 1. Shellfish Institute of North America - resolution to reactivate molluscan aquaculture studies - genetics, disease, nutrition.

2. Mardela Corporation report to NOAA - includes NMFS needs to study molluscan aquaculture - disease, nutrition, genetics.

B. Related tasks - none on diseases

Inhouse (NMFS) aquaculture (hatcheries, nurseries)
Center, Milford, Conn. - Oxford to do cooperative disease studies
Sea Grant-University of Delaware - Oxford to do cooperative disease studies; 88-309/Federal Aid-State of Maryland - Oxford to do cooperative disease studies.

C. Legislation not required

D. No environmental impact statement needed.

DAA FORM 32-14A
0-74)

U. S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

PAGE OF PAGE
1 | 6

NMFS TASK DEVELOPMENT PLAN

(See Detailed Instructions)

1. DATE PREPARED
December 9, 1974

(Submit five copies by Jan. 2)

O: Director, National Marine Fisheries Service, ATTN: Fx5
National Oceanic and Atmospheric Administration
Washington, D.C. 20235

FMC's - Submit a separate Task Development Plan for each task beginning, continuing, or ending in the current year, budget year, or budget year + 1. Reimbursable funds are not to be mingled with appropriated funds on any programmatic TDP; separate TDP's must be prepared. Submit one TDP itemizing the administrative support cost (Management Fund) for the FMC.

2. TDP NUMBER	3. OBJECTIVE CODES A	B	C	D	4. RANK BY TARGET	BY + 1 INC.
MAC-059-77-AQ-A-	1 III-A					

TASK NUMBER	6. TASK TITLE
826P4	Spawning and Rearing of Molluscs

ORGANIZATION CODE	8. ORGANIZATION TITLE *(Responsible for execution of this task)*	9. PRINCIPAL LOCATION City	State
FB6300	Aquaculture Investigations	Milford	Ct

OBJECT CLASS *Lines 10–18. Enter all dollar values as thousands and tenths of thousands. Lines 21–22. Enter as man-years and tenths of man-years.*	COP LINE	CURRENT YEAR FY 1975 TARGET ALLOWANCE A	CURRENT YEAR FY 1975 INCREASE B	BUDGET YEAR FY 1976 TARGET ALLOWANCE C	BUDGET YEAR FY 1976 INCREASE D	BUDGET YEAR +1 FY 1977 TARGET ALLOWANCE E	BUDGET YEAR +1 FY 1977 INCREASE F
10. Total Direct Labor	15	37.7		84.4		84.4	15.8
11. Travel	19	1.2		2.2		2.2	2.5
12. Rents, Communications, Utilities	21						
13. Contracts *(To be let)*	51 52						
14. Grants *(Funds obligated)*	58						
15. Supplies	53	4.0		7.2		7.2	.3
16. Capital Equipment	54			2.5		2.5	
17. Other *(All other obligations)*		9.2		7.9		7.9	1.4
18. Total Direct Funds *(Add lines 10 through 17 above.)*		52.1		104.2		104.2	20.0
19. Positions, Full-time permanent *(Number applicable to this Task. Also, complete NOAA Form 32-14C.)*		5		5		5	2
20. Positions, Other *(Number applicable to this Task.)*		2		3		3	
21. Man-years, Permanent		1.5		3.2		4.0	2.0
22. Man-years, Other		1.2		3.0		3.0	
23. Reimbursable Support *(Reimbursable agreements only)*							

REMARKS

Reprogrammed FY'75 Ref. MAC012

24. OFFICIAL PREPARING REPORT *(Signature)*
arren S. Landers, Investigation Chief
James E. Hanks, Director of Investigations

25. FMC DIRECTOR OR DESIGNATED REPRESENTATIVE *(Sig.)*
Karl Sindermann
60-arl J. Sindermann, Center Director

OAA FORM 32-14B
6-74)

U. S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

PAGE OF PAGES 2 | 6

NMFS TASK DEVELOPMENT PLAN

TDP NUMBER MAC-059-77-AQ-A-1

26. ACTIVITY, EVENT, AND MILESTONE SCHEDULE

NUMBER EACH ACTIVITY, EVENT, OR MILESTONE

IDENTIFY BY ENTERING 'A' FOR ACTIVITY, 'E' FOR EVENT, OR 'M' FOR MILESTONE.

PLANNING PERIOD – Indicate by entering an "X" at the beginning and completion of subtask or selected operational activities that collectively define the task for the 7 year planning period. Connect "X's" with a solid bar. "Events" and "Milestones" occur at specific points in time. Indicate these significant achievements by placing an "X" in a single column.

NUM	A, E, OR M	NARRATIVE (Brief descriptive phrase of activity, event, or milestone)
		All activities, events and milestones contribute to Objective 3, Subgoal A, Goal III of the P.E.D.
1	A	Developing method for rearing surf clams to minimum market size in controlled laboratory environment. Base funding
2	A	Developing commercially practical, large-scale rearing of the surf clam to market size. Funding increase
3	A	Developing method for rearing the bay scallop through the juvenile stage in controlled laboratory environment. Base funding
4	A	Developing method for pilot hatchery level rearing of bay scallop to the field "grow-out" stage. Funding increase
5	A	Developing field methods for growing juvenile bay scallops to market size. Funding increase
6	A	Determining amenability of the calico scallop to controlled culture through the juvenile stage in the laboratory. Funding increase
7	A	Rearing bivalve larvae and seed as a service function for other Aquaculture Investigations Tasks. Base funding
8	E	Complete laboratory method for rearing surf clam to minimum market size by December 1976. Base funding
9	E	Complete laboratory method for rearing bay scallop through the juvenile stage by December 1978. Base funding

CY 75		BY 76		77 BUDGET YEAR +1		+2		+3		+4		+5	
1	2	1	2	1	2	1	2	1	2	1	2	1	
A	B	C	D	E	F	G	H	I	J	K	L	M	
X				X									
				X				X					
X								X					
				X						X			
						X							
										X			
X													
				X									
								X					

OUT YEAR COMMENTS

(Check appropriate boxes and enter applicable percentage.)

*Increases usually come from reprogramming within your FMC.)

a. Continued at same level [ ]
b. Increase of ___ %* [ ]
c. Reduction of ___ % [ ]
d. Termination [ ]

"X" APPROPRIATE COLUMN

REMARKS

NA FORM 52-16
-74)

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

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NMFS TASK DEVELOPMENT PLAN

TOP NUMBER: MAC-059-77-AQ-A-1

26. ACTIVITY, EVENT, AND MILESTONE SCHEDULE

NUMBER EACH ACTIVITY, EVENT, OR MILESTONE

IDENTIFY BY ENTERING 'A' FOR ACTIVITY, 'E' FOR EVENT, OR 'M' FOR MILESTONE.

PLANNING PERIOD – Indicate by entering an "X" at the beginning and completion of subtask or selected operational activities that collectively define the task for the 7 year planning period. Connect "X's" with a solid bar. "Events" and "Milestones" occur at specific points in time. Indicate these significant achievements by placing an "X" in a single column.

NUMBER EACH ACTIVITY, EVENT, OR MILESTONE	IDENTIFY BY ENTERING 'A' FOR ACTIVITY, 'E' FOR EVENT, OR 'M' FOR MILESTONE.	NARRATIVE (Brief descriptive phrase of activity, event, or milestone)	CY 75		BY 76		77 BUDGET YEAR +1		+2		+3		+4		+5	
			1	2	1	2	1	2	1	2	1	2	1	2	1	2
			A	B	C	D	E	F	G	H	I	J	K	L	M	
	M	Complete a method for large-scale rearing of the surf clam to minimum market size in controlled environments by December 1978. Funding increase									X					
	M	Complete a method for large-scale rearing of the bay scallop to the field "grow-out" stage by December 1979. Funding increase											X			
12	M	Complete field methods for growing juvenile bay scallops to market size on a commercial scale by June 1981. Funding increase														

27. OUT YEAR COMMENTS

(Check appropriate boxes and enter applicable percentage.)

*Increases usually come from reprogramming within your FMC.)

a. Continued at same level [X]
b. Increase of ___ % * [ ]
c. Reduction of ___ % [ ]
d. Termination [ ]

"X" APPROPRIATE COLUMN

REMARKS

(10-74) U. S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

PAGE OF PAGES: 4 | 6

TDP NUMBER: MAC-059-77-AQ-A-1

NMFS TASK DEVELOPMENT PLAN
28. FULL-TIME PERMANENT POSITIONS

Reference NOAA Form 32-14A, Item 19. Identify all full-time permanent positions related to this Task for the budget year and all positions requested for budget year + 1 increases. Do not include support personnel; they should appear in the appropriate support Task Development Plan.

POSITION TITLE	GS LEVEL	NAME OF INCUMBENT (If no incumbent, enter "Vacant")		% OF TIME SPENT ON THIS TASK
Director of Investigations	15/6	001	James E. Hanks	25
Tech. Publ. Editor (Fish. Biol.)	9/8	014	Rita Riccio	25
Fishery Biologist (Res.)	13/6	003	Warren S. Landers	100
Fishery Biologist	11/1	009	Edwin W. Rhodes, Jr.	100
Fishery Biologist	9/1	018	Wayne D. Cable	100
Personnel Increase Required				
Fishery Biologist	7/1		Vacant	100
Fishery Technician	4/1		Vacant	100

CONTINUE on plain 8x10½ paper. Identify "Page of Pages" and "TDP Number" in upper right corner. Comment on each of the following items, identifying by number. If item is not applicable, so indicate by entering "NA":

29. STATEMENT OF NEED

30. ACTIVITY PLAN

31. TASK OUTPUTS AND BENEFITS

32. IMPACT OF TASK AUGMENTATION
- a. Current Year
- b. Budget Year
- c. Budget Year + 1

33. CRITERIA FOR TASK COMPLETION

34. BACK-UP DOCUMENTATION
- a. Detail Documentation *(Provide one sentence description.)*
- b. Related tasks and research presently being conducted.
- c. Indicate the Congressional legislative requirements.
- d. Indicate the Environmental Impact Statement (EIS) requirements.

29. STATEMENT OF NEED

This Task will contribute to Objective 3, Subgoal A, Goal III of the P.E.D.

As the world demand for food, including that from the sea, increases, it becomes apparent that the contribution from the wild stocks of marine fish and shellfish is limited by natural restrictions on the populations over which man has little control. A new approach to fish and shellfish production which will supplement the wild harvest must be developed. The most promising appears to be aquaculture - the rearing of aquatic animals for human consumption under the complete control of the culturist. To be successful, the life history of the species being considered for commercial culture must be completely understood and the physiological, nutritional and ecological requirements of each stage of development determined and satisfied.

The most dependable, year-round culture systems for molluscs that now exist are for several species of oysters and the hard clam, Mercenaria mercenaria; but even with these species, there are aspects of their early life history, such as nutritional requirements and susceptibility to disease, that are not fully understood. With other species, such as the bay scallop, much more life history work is needed.

The intent of this Task is to develop laboratory techniques for maintaining and spawning commercially valuable and potentially valuable marine molluscs and rearing their embryos, larvae and juveniles in the laboratory. These investigations will be directed toward the development of aquaculture systems which can be used by the industry for commercial-level production.

30. ACTIVITY PLAN

Standard methods available at this laboratory and in the literature which have proven successful for culturing the oyster and the hard clam will be used initially in attempts to develop hatchery culture methods for other bivalve species of known or potential commercial value. Because each species has certain unique requirements, these methods may have to be modified or new technical approaches developed. Attempts will be made in logical sequence (inducing gametogenesis, spawning the adults, rearing the larval stages, growing the post-set stage immediately after metamorphosis and finally rearing the juveniles to the "grow-out" stage in the field) to adapt proven techniques, many of which originated at Milford Laboratory, to the culture of new aquaculture candidates, modifying these techniques when necessary.

31. TASK OUTPUTS AND BENEFITS

The reproductive habits and early development of commercially valuable marine molluscs will be determined in the laboratory. Subsequently, environments in which various marine molluscs can be spawned and their embryos, larvae and juveniles can be reared to the adult stage will be developed in the hatchery and in the field at commercial levels of production.

The information obtained from this Task will be of direct benefit to the development of aquaculture in general in the United States and to molluscan aquaculture in particular. Life history data will be useful in the management of wild stocks of the species involved and will be an aid to the nationwide NMFS effort to protect our living marine resources.

32. IMPACT OF TASK AUGMENTATION

C. An increase in funds for BY + 1 will allow this Task to expand its activity, which will be committed exclusively to the development of laboratory culture methods during the Current Year and the Budget Year, to the problems of scaling up culture methods to the pilot hatchery level and to field "grow-out" methods.

33. CRITERIA FOR TASK COMPLETION

34. BACK-UP DOCUMENTATION

(a) Informal Report No. 4 - Middle Atlantic Coastal Fisheries Center, NMFS - Investigation Summaries.

Report of the Mardela Corporation, January 1973.

Sea Grant studies on rearing of marine organisms at numerous universities.

A Draft Outline for the National Fisheries Plan, Dept. Commerce, NOAA, NMFS, August 1974.

Aquaculture in the National Oceanic and Atmospheric Administration, Special Emphasis Document - Harold L. Goodwin, Program Manager, September 1973.

A Coming of Age - David H. Wallace. In "Aquaculture Section", NOAA, Vol. 1, No. 4, 1971.

34. BACK-UP DOCUMENTATION (Contd)

Ocean Harvests: Promise and Practicality - C. P. Idyll. In "Aquaculture Section", NOAA, Vol. 1, No. 4, 1971.

Aquaculture in New England - Gates, Matthiessen and Griscom, Univ. of Rhode Island Sea Grant Marine Technical Report Series No. 18, 1974.

Aquaculture: A New England Perspective - T. A. Gaucher (Ed.). New England Marine Resources Information Program, 1971.

The Status and Potential of Aquaculture, Vol. 1 - John H. Ryther, 1968. Clearinghouse, Springfield, Va.

Marine Aquiculture, William McNeil (Ed.). Selected Papers from Conference on Marine Aquiculture, 1970, Oregon State University Press.

Shellfish Hatcheries: Present and Future - H. C. Davis. Trans. Amer. Fish. Society, Vol. 98, No. 4, 1969.

(b) No related NMFS Tasks. Sea Grant sponsoring related research.

(c) No additional Congressional Legislation needed to complete Task.

(d) This Task will have no adverse impact on the environment.

(e) This Task will not contribute to the Extended Jurisdiction initiative.

TASK DEVELOPMENT PLAN, FY 1975

1. [illegible] F33300	2. Div. Aquaculture Investigations	3. Task 2
4. Task Title	Aquaculture Research and Technology; Engineering Analysis; Capital-intensive Flow of Materials and Products	5. Task Number

OBJECT CLASS	FY 73	FY 74	FY 75	FY 76	FY 77	FY 78	FY 79
6. Total Labor	-	-	-	-	-	-	-
7. Contract Services	-	-	57.5	47.5	47.5	-	-
8. Major Equipment	-	-	-	-	-	-	-
9. Boats and Facilities	-	-	-	-	-	-	-
10. All Other Direct Classes	-	-	-	-	-	-	-
11. TOTAL DIRECT COST	-	-	47.5	47.5	47.5	-	-
12. Support	-	-	2.5	2.5	2.5	-	-
13. TOTAL TASK COST	-	-	50.0	50.0	50.0	-	-
14. Positions, Permanent	-	-	-	-	-	-	-
15. Positions, Other	-	-	-	-	-	-	-
16. Man Years, Permanent	-	-	-	-	-	-	-
17. Man Years, Other	-	-	-	-	-	-	-
18. Vessel Time (days)							

19. EVENT	FY 73		FY 74		FY 75		FY 76		FY 77		FY 78		FY 79	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2
(a) Initiate contract studies														
(b) Deliver first generic conceptual flow charts														
(c) Deliver first simulation analysis														
(d) Construct and test first prototype models														
(e) Deliver first capital-intensive flow models														
(f)														
(g)														
(h)														
(i)														

[illegible] Approved [illegible signature]	Date [illegible] 73

F33300 - AQUACULTURE RESEARCH AND TECHNOLOGY: ENGINEERING ANALYSIS - CAPITAL-INTENSIVE FLOW OF MATERIALS AND PRODUCTS - FY 75

A. STATEMENT OF THE PROBLEM

Increased exploitation of the nation's estuaries and coastal zones for industrial and residential development and recreational activities has markedly reduced the areas available for the production and harvest of fish and shellfish. More efficient and effective means to enhance U. S. seafood production must be found. Aquaculture methods require: 1) an adequate supply of genetically desirable brood stocks; 2) methods to increase larval survival and normal development; 3) methods to promote rapid growth; 4) smooth flow of raw materials and products, with a minimum of manual labor, and 5) identification and resolution of cost-critical factors in the aquaculture system. Many aquaculture feasibility trials have been unsuccessful for reason of failure to provide capital-intensive substitutes for manual labor, particularly for slow-growing stationary animals such as oysters, clams and scallops.

B. PROGRAM REQUIREMENTS

Concurrent contract engineering analyses during the research process will permit the design and construction of a highly automated, smooth-flow system--guaranteeting maximum production at a minimum cost. Such a system, ensuring lost costs and adequate supply to the consumer public is in the public interest and would do much to recapture the domestic markets from foreign suppliers. These and follow-on studies, coupled with concurrent biological and contractual econometric studies will permit the early design and demonstration of a commercially viable molluscan shellfish hatchery.

C. TASK OBJECTIVES

1. Long Range

Develop and perfect generic concepts of efficient hatchery design as basis for adaptation to and ultimate use on several different but commercially attractive molluscs. Duration (approximate) of Task: 3 years.

Criteria for Task termination will be submission of final system-designs which have been tested successfully against prototype systems. Progress will be measured against 1) completeness of design concepts; 2) provision of capital-intensive substitutes for labor-intensive stages and/or phases of long-duration; 3) demonstrations, or prototypes, of feasibility of each substitute; 4) adaptation of systems under development to take advantage of all useful results of other research and 5) demonstration, by simulation analyses), of the relative merits of all proposed systems and subsystems.

2. For Budget Year

a. Analyze and test all existing flow-designs for molluscan maricultures.

b. Determine critical engineering factors for each which adversely affect commercial feasibility

c. Initiate construction of prototype test modules for each criticial factor.

d. Develop one or more initial conceptual flow diagrams for molluscan mariculture (oysters, scallops), emphasizing capital-intensive methods and covering entire mariculture spectrum from spawning to marketing)

This is a task to be initiated in 1975. No accomplishments realized in '73 or '74. Preliminary steps toward implementation planned for FY 74:

a. Assemblage of complete set of scientific and engineering literature on molluscan mariculture.

b. Contractual engineering proposals will have been solicited, received and evaluated to permit award early in FY 75.

D. WORK PLAN

Initial activities will utilize the industrial engineering approach. After analysis of time-units, energy (electrical, mechanical, human) inputs, and of capital costs of the several available systems, all units, with assistance of concurrent econometric studies, will be reduced to equivalent costs in dollars and equated against 1) current costs for "wild" molluscs and against dollar-elasticity of consumers.

Best aspects of each existing system and of results of concurrent biological research will be incorporated into generic conceptual systems, each to have effective subsystems for cost-efficient treatment of effluent pollution.

Each system will be analyzed for the possibility of automation, for installation of easily-maintained sanitary and disease-preventative subsystems, for incorporation of growth-promoting nutritional subsystems and for the degree to which large-scale, high-density commercial operators could be facilitated. Incorporate data in data-bank for later retrieval and simulation testing.

Studies will include the development of partial systems for use by those interested in "cultchless" or in spot and juvenile culture only.

F33300 - AQUACULTURE RESEARCH AND TECHNOLOGY: ENGINEERING ANALYSIS - CAPITAL-INTENSIVE FLOW OF MATERIALS AND PRODUCTS - FY 75

Test critical aspects of all systems against prototype systemic modules for feasibility.

Improve modules and retest.

Incorporate all pilot-test data in data-bank and devise best system through simulation studies.

Recommend best system for full-scale design and demonstration of a commercially viable molluscan shellfish hatchery.

E. JUSTIFICATION

1. The successful culmination of this Task, in collaboration with concurrent economic studies, will afford the information necessary to resolve two of the five major factors militating against successful commercial molluscan aquaculture operations. Hopefully, concurrent findings in related biological and contractual economics studies will resolve the other three factors in the same time-frame.

2. Benefits (ranked in priority order)

   a. Abatement of pollution (public health hazards).

   b. Allocation of environmental uses among competing demands.

   c. Commercial fishermen.

   d. Knowledge

3. The Task outputs will reduce the public health hazards associated with consumption of raw molluscs, which hazards have closed down many existing beds and limited the market supply of molluscs. Increased emphasis on molluscan aquaculture would reduce the competitive demand for commercial use of certain very desirable onshore environments.

4. This study would initially affect the oyster fishery and secondly, the bay-scallop industry; possibly other molluscan resources.

F. EFFECT OF DIFFERENT FUNDING LEVELS.

1. This work would be delayed from 2 to 4 years at 75% of requested funds.

2. This work could not be effectively completed at 50% of requested funds.

3. This work could not be initiated at 25% of requested funds.

F33300 - AQUACULTURE RESEARCH AND TECHNOLOGY: ENGINEERING ANALYSIS - CAPITAL-INTENSIVE FLOW OF MATERIALS AND PRODUCTS - FY 75

G. BACK-UP DOCUMENTATION

1. Aquaculture, Support Paper No. 71-1e. NMFS Program Memorandum (7/29/69)

2. The Role of NOAA in Aquaculture, Recommendations of NMFS Standing Committee on Mariculture, La Jolla, California, August 1970.

3. NOAA Aquaculture Workshops, Mardela Corporation, Burlingame, Calif. Held at Milford, Conn., Summer 1972.

4. NOAA-NMFS Program Statement, Fiscal Year 1974-78, February 1972.

5. The Potential of the Estuary for Shellfish Production. John B. Ryther, Woods Hole Oceanographic Institution, Science 1971.

We know of no directly related systems-oriented aquaculture economic engineering analyses underway in other agencies or institutions. Some attempts to clarify the degree to which current commercial practices are handicapped by an enormously complex, labor-intensive, biological-environmental-hydrographic-human system, have been made under Sea Grant.

a. Systems Engineering for Shellfish Production, Sea Grant Project R/M-4, University of Delaware, 1972 (F.A. Costello).

TASK DEVELOPMENT PLAN, FY 1975

1. Org. Code F33300	2. Div. Aquaculture Investigations	3. Rank 22
4. Task Title Aquaculture Research and Technology; Economic Analysis - Identify Cost-critical Factors in System.		5. Task Number

OBJECT CLASS	FY 73	FY 74	FY 75	FY 76	FY 77	FY [illegible]	FY [illegible]
6. Total Labor	-	-	-				
7. Contract Services	-	-	47.5	47.5	47.5		
8. Major Equipment	-	-	-	-	-		
9. Boats and Facilities	-	-	-	-	-		
10. All Other Direct Classes	-	-	-	-	-		
11. TOTAL DIRECT COST	-	-	47.5	47.5	47.5		
12. Support	-	-	2.5	2.5	2.5		
13. TOTAL TASK COST	-	-	50.0	50.0	50.0		
14. Positions, Permanent	-	-	-	-	-		
15. Positions, Other	-	-	-	-	-		
16. Man Years, Permanent	-	-	-	-	-		
17. Man Years, Other	-	-	-	-	-		
18. Vessel Time (days)							

19. EVENT	FY 73		FY 74		FY 75		FY 76		FY 77		FY [illegible]		FY [illegible]	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2
(a) Initiate contract-economic analysis														
(b) Develop total cost input system														
(c) Evaluate existing "mixed" and new systems														
(d) Deliver simulation analysis														
(e) Determine cost-effectiveness of new concepts														
(f) Deliver final cost analysis of optimum systems														
(g)														
(h)														
(i)														

20. Prepared by [illegible]

21. Date 3/73

F33300 - AQUACULTURE RESEARCH AND TECHNOLOGY: ECONOMIC ANALYSIS - IDENTIFY COST-CRITICAL FACTORS IN MOLLUSCAN SYSTEMS - FY 75

A. STATEMENT OF THE PROBLEM

Increased exploitation of the nation's estuaries and coastal zones for industrial and residential development and recreational activities has markedly reduced the areas available for the production and harvest of fish and shellfish. More efficient and effective means to enhance U.S. seafood production must be found. Aquaculture methods require: 1) an adequate supply of genetically desirable brood stocks; 2) methods to increase larval survival and normal development; 3) methods to promote rapid growth; 4) smooth flow of raw materials and products, with a minimum of manual labor; and 5) identification and resolution of cost-critical factors in molluscan aquaculture systems. Many aquaculture feasibility trials have been unsuccessful for failure to determine the individual cost-critical factors in the system and to initiate remedial cost-cutting researeh on engineering studies.

B. PROGRAM REQUIREMENTS

Contractual economic analysis, concurrent with and participating in scientific and engineering research on molluscan aquaculture systems will provide the single-unit (cost) equivalents whereby the relative merits of competitive systems and their individual sub-systems can be compared for cost effectiveness (in addition to productivity). No systems research proposals should be carried beyond the bench-level stage without, at least, an overall cost-effectiveness analysis. In the last analysis, this task is necessary to 1) provide the concrete evidence of commercial feasibility (maximum productivity at minimal cost), 2) give guidance on where and when to invest dollars and effort in research and engineering and collaborate with concurrent engineering analysis to effect simulation studies on relative impacts of proposed subsystems on the feasibility of the overall system(s).

C. TASK OBJECTIVES

1. Long Range

a. Develop concepts and techniques whereby total of all costs can be determined accurately for all proposed systems and subsystems.

b. Utilize cost data to guide advanced research and engineering investments.

c. Develop information on optimal commercially-feasible molluscan aquaculture designs by simulation analyses, also utilizing simulation analysis to demonstrate commercial feasibility of approved systems.

d. Provide the economic basis for recommendations to industry on useful and feasible systems.

e. Duration of task (approximate:) 3 years.

Criteria for Task completion will be submission of final economic and econometric data which, together with scientific and engineering data, will afford a base for Federal recommendations to industry.

Progress will be measured against 1) completion of cost-assessments on available overall systems; 2) completion of cost-assessments against individual proposed subsystems; 3) submission of data for simulation analyses; 4) demonstrations, by iterative simulation analyses, the optimal economic mix of competitive systems and subsystems.

2. For Budget Year

a. Analyze and prepare total cost figures for all available molluscan aquaculture systems and subsystems.

b. Determine cost-critical factors in each system for application of scientific and engineering effort.

c. Initiate cost-effectiveness studies on initial industrial engineering design proposals.

d. Determine degree of economic gap between feasibility and failure for all existing systems.

This is a Task to be initiated in 1975. No accomplishments to be realized in '73 or '74. Preliminary steps toward implementation planned for FY 74:

a. Solicit contractual economic research proposal for review and evaluation with a view toward award early in FY 75.

D. WORK PLAN

Initial activities will, in collaboration with concurrent industrial engineering analysis, identify all inputs into available systems and subsystems, translating such inputs into cost-dollars. Evaluate, through econometric techniques, relative cost-effectiveness of each system and subsystem. Inform all interested parties of findings and indicate areas meriting special research effort. Develop data for data-bank with view to subsequent retrieval and use in simulation analyses. Evaluate relative cost-effectiveness of proposed remedial sybsystems. Initiate and complete simulation studies for optimal mix of subsystems. Submit final report, defining by econometric techniques, the economic validity of the recommended design for a commercially feasible molluscan aquaculture system(s).

F33300 - AQUACULTURE RESEARCH AND TECHNOLOGY: ECONOMIC ANALYSIS - IDENTIFY COST-CRITICAL FACTORS IN MOLLUSCAN SYSTEMS - FY 75

E. JUSTIFICATION

1. The successful conclusion of this Task, in collaboration with concurrent scientific and engineering studies, will afford the information necessary to resolve two of the 5 major factors militating against successful commercial molluscan aquaculture operations. The remaining three critical factors are amenable to solution by scientific research.

2. Benefits

   a. Abatement of pollution (public health hazards).

   b. Allocation of environmental uses among competing demands.

   c. Commercial fishermen.

   d. Knowledge

3. The Task outputs will reduce the public health hazards associated with consumption of raw molusscs, which hazards have closed down many existing beds and limited the market supply of molluscs. Increased emphasis on molluscan aquaculture would reduce the competitive demand for commercial use of certain very desirable onshore environments.

4. This study would initially affect the oyster fishery and secondly, the bay-scallop industry; possibly other molluscan resources.

F. EFFECT OF DIFFERENT FUNDING LEVELS

1. This work would be delayed by from 2 to 4 years at 75% of requested funds.

2. This work could not be effectively completed at 50% of requested funds.

3. This work could not be initiated at 25% of requested funds.

G. BACK-UP DOCUMENTATION

1. Aquaculture, Support Paper No. 71-1e. NMFS Program Memorandum (7/29/69)

2. The Role of NOAA in Aquaculture, Recommendations of NMFS Standing Committee on Mariculture, La Jolla, California, August 1970.

3. NOAA Aquaculture Workshops, Mardela Corporation, Burlingame, Calif. Held at Milford, Conn., Summer 1972.

4. NOAA-NMFS Program Statement, Fiscal Year 1974-78, February 1972.

5. The Potential of the Estuary for Shellfish Production. John B. Ryther, Woods Hole Oceanographic Institution, Science 1971.

We know of no directly related systems-oriented aquaculture economic engineering analyses underway in other agencies or institutions. Some attempts to clarify the degree to which current commercial practices are handicapped by an enormously complex, labor-intensive, biological-environmental-hydrographic-human system, have been made under Sea Grant.

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