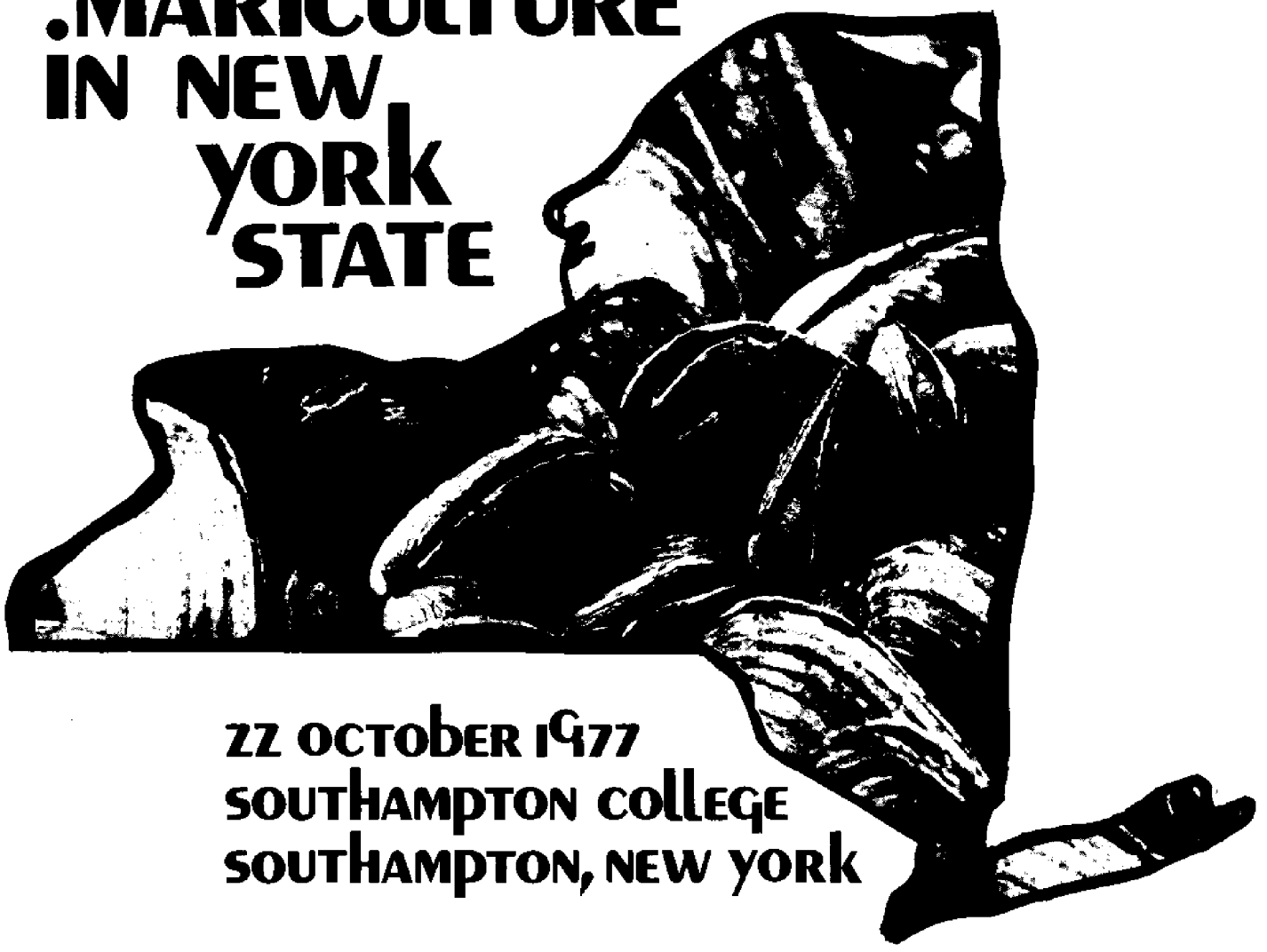
proceedings of the symposium

.MARICULTURE IN NEW YORK STATE



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edited by
Orville W. Terry and David M. Chase

Proceedings of the Symposium

M A R I C U L T U R E I N N E W Y O R K S T A T E

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New York Ocean Science Laboratory

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Mariculture Symposium Committee Members

Stephen Hendrickson
New York State Department of Environmental Conservation

John Baiardi
New York Ocean Science Laboratory

David Chase
New York Sea Grant Extension Program

Ronald Verbarg
Nassau-Suffolk Regional Planning Board

Orville Terry
Marine Sciences Research Center, SUNY

Larry Penny
Southampton College of Long Island University

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Introduction

As the following papers make clear, there is a real potential for the development of marine aquaculture (mariculture) in New York State. This is not to say, however, that new mariculture industries will blossom overnight. The gap between laboratory experimentation and successful field implementation takes time to bridge, and the legislative action necessary to provide a sound legal base for mariculture in New York will, because of divided public opinion, also take a lengthy period of time to develop. In New York, as in many other states, there is active competition for coastal space, fishery resources, and markets. Many current users of the marine environment feel that there will be a directly proportionate relationship between the expansion of mariculture and the decrease of available resources for themselves. Are these postulated losses real or apparent? If they are real, what methods can be provided to insure a well balanced allocation process which will insure the protection of the various user's interests? Which kind of mariculture - public service or private enterprise - is best, or should we have both?

A number of more or less organized interest groups have become involved with the mariculture issue, each with its own unique concerns. Their support or opposition to mariculture usually is based upon feelings of how a particular form of mariculture or government regulation would affect their specific interests, but is often expressed as support for or opposition to mariculture in general. The primary purpose of the symposium was to bring these conflicting viewpoints into the open and thereby provide an opportunity for public comment and legislative awareness.

Long Island's well established involvement in seafood industries is largely a consequence of good growing conditions in its surrounding bays and estuaries. The natural productivity of these waters has always been high and Long Island, as a result, has always been an important source of commercially valuable finfish, shellfish, and crustaceans. Although unavoidably dependent upon cyclic patterns of abundance, harvests of hard clams (the majority of U.S. hard clam production is from Great South Bay), scallops, mussels, striped bass, bluefish, flounder, lobster, and blue crabs from the wild have been reasonably consistent over the years. Productivity in the once important oyster industry, which declined to a point of almost nonexistence 25 years ago, is once again on the rise as a result of field and hatchery techniques. On Long Island, oysters and clams are the two most valuable species that are cultured. The same environmental conditions that have produced these successful fisheries may similarly provide an opportunity for the development of a broad and viable mariculture industry, producing a large variety of marine species for an undeveloped, yet highly potential, consumer market.

A panel of individuals representing various regulatory authorities at the state and local level, academic, scientific and public service organizations, as well as commercial and recreational interests, presented a series of papers describing their particular concerns and addressing pertinent issues. Following these presentations, an open discussion period between the audience and the panel brought to light a series of complex questions, some of which are outlined below:

- Is mariculture being seriously addressed by regional groups involved in the State Coastal Zone Management Program?

- Why is the production of seaweeds progressing more rapidly in Canada than in the United States?
- Does mariculture increase the overall productivity of marine underwater lands?
- Should minimum size limits, currently applied to finfish, shellfish, and crustaceans harvested in the wild, also apply to the products of mariculture?

Although some of these questions cannot be completely answered, many differences of opinion remain, and critical legal questions still need to be addressed by the state legislature and local governments, the organizers of the symposium hope that it has served to at least clarify some of the critical issues involved with the development of mariculture in New York State. The growth of mariculture, if it grows at all, will be slow, as is the character of any type of social change involving highly polarized issues. We hope the constructive discussions begun at the symposium will continue with as much public participation as possible.

O.W.T.
D.M.C.

THE NEED FOR MANAGEMENT GUIDELINES FOR MARICULTURE ACTIVITIES IN NEW YORK STATE

Stephen A. Hendrickson
New York State Department of Environmental Conservation

The purpose of today's symposium is to generate public and legislative concern about the future of marine aquaculture, or mariculture, as we have chosen to call it, in New York State. We are here to define the current status of mariculture, and then perhaps to explore some of the possible directions it may take in the future.

The various speakers today will, for the most part, be discussing their individual views, pro or con, as to current mariculture activities and the potential for expansion of the industry in line with the unique characteristics of New York State's marine environment. They will be discussing ongoing activities as well as advances in our technical ability to raise marine organisms under controlled or semi-controlled conditions.

Quite obviously the scientific, political, social and legal considerations to be dealt with before attempting to expand the mariculture industry, if it is to expand at all, are complex and, in many instances, highly polarized issues. One thing to keep in mind is that the Department of Environmental Conservation currently has, and will continue to have, the major responsibility, as defined by law, to oversee the management of the state's marine resources for the benefit of all its citizens. In addition, the Department cannot responsibly carry out this mandate without well-defined legal guidelines.

The various competing users, whether commercial or recreational, all have an equal right to use the state's marine resources. It is the job

of the Legislature to determine, through legislative action, the extent and nature of the uses to be permitted. It is our job today, and our job for some time to come, to indicate to the Legislature our individual feelings regarding the development of laws that will outline the direction and future of mariculture activities, keeping in mind that such activities, by nature, require allocation of a specific portion of the marine environment; also that this transfer of rights means excluding, to one degree or another, other parts of the community and their respective interests.

Before we begin to look at the present status of mariculture or its potential, we should quickly review the history of mariculture as it has developed in New York State.

The initial and still the most significant mariculture activity in New York is the oyster industry. Advanced oyster cultivation methods were developed in the late 1800's. Recognizing that if these new methods were to be applied in New York there would have to be some formal method for providing control of underwater lands to the shellfishermen, in 1884 and 1887 the Legislature passed laws authorizing the allocation of underwater lands in Gardiners and Peconic Bays and Long Island Sound, along with other places, for the purpose of oyster cultivation. Concurrently, local townships passed similar legislation. Originally, many acres of underwater lands were leased, granted or franchised to independent oystermen and private oyster companies. Since that time, the New York State Legislature has passed more than 27 laws and amendments relating initially to the oyster industry and later to the shellfish industry in general. As the oyster industry declined in the mid-1900's, due to a combination of environmental and industrial factors, many of the underwater lands that

had been granted for oyster cultivation were vacated. Some returned to public control and some, rightly or wrongly, came under the control of large shellfish corporations and remain so to this day.

Although the oyster industry is once again on the upswing in New York, due both the efforts of private hatcheries using artificial cultivation techniques and also to the availability of seed oysters from natural sets in the State of Connecticut, the primary shellfish industry today is the independent hard clam industry, an industry that completely rejects the concept of private control of underwater lands. Basically in agreement with the independent shellfishermen are members of the commercial finfish and lobster fisheries who, in a similar manner, make use of publicly controlled resources to obtain their harvest. Although their attitudes may be appropriate for the fishing industry as it exists today, it is important to recognize that just as the nature of the industry has changed in the last 30 years from one primarily dependent upon private control to one based on public control, it may very possibly change again. Legislation that we now develop must be flexible enough to absorb such changes. Recent amendments and new provisions of the Environmental Conservation Law have provided much protection for the interests of the shellfishermen and the finfishermen. The most recent section of the law regarding the leasing of underwater lands for shellfish cultivation, Section 13-0301, and sections regarding marine hatcheries and off-bottom cultivation of shellfish provide ample protection for the interests of these fishermen and their industries as they exist today.

In recent years the department has received increased numbers of requests from independent baymen, shellfish firms and other interested parties that they be allowed to undertake various mariculture activities.

Permission to raise hard clams, scallops, mussels, and other shellfish species through both conventional cultivation techniques and newly developed off-bottom culture methods have frequently been sought. We have also observed an increased interest in the potential for mariculture activities involving finfish, crustaceans and marine plants. Because of conflicting and undefined jurisdictional responsibilities between state, county, town and private ownerships, and the failure of the Environmental Conservation Law to address certain pertinent issues - as well as the use of ambiguous terminology in many sections of the law - the department has been, for the most part, unable to satisfactorily respond to these requests and inquiries. The opportunity to carry out mariculture programs has remained with those corporations or individuals who have previously obtained control of underwater lands, which are certainly necessary ingredients in most mariculture activities.

During the 1960's and early 1970's, the department carried out some investigative projects to determine the technological feasibility of certain mariculture activities. Projects concerning the suitability of raft culture techniques, as developed by the Japanese, and a project to explore the possibility of pond culture of seed oysters were carried out. One thing that became obvious as a result of these investigations was that despite the feasibility of these methods, their utilization would be limited to a few large companies presently controlling underwater lands until a system of allocating segments of the marine environment to the small businessman with limited financial resources becomes available.

If mariculture activities are to expand as a result of public demand, the major task now faced by state, county and town administrators, members of the fishing industry and the general public, is to work together to

coordinate their efforts in developing a meaningful management plan that provides for the responsible and controlled utilization of our marine resources.

Each town must determine the type of activities for which its own biological and social environments are suited.

The County of Suffolk must move ahead to assume and carry out the responsibilities it was given relative to the management of Gardiner's and Peconic Bays by Chapter 990 of the Laws of 1969.

Members of the fishing industry and the general public must work together to define and reach reasonable compromises on their differing needs and interests.

Certainly it must be true that there are many areas of our marine enviornment that are not suited for mariculture activities, but just as certainly there must also be many areas that are. Whether through zoning classification techniques or other means, their potentials and availabilities must be defined.

Questions of economic value as compared to aesthetic value, and questions of exploitation as compared to conservation will be addressed by different speakers with different points of view.

The decisions we make today and in the near future about these conflicting issues will determine whether or not mariculture will be developed in this state as an important, economically sound industry.

There must be a middle ground of compromise and it is the intent and purpose of this symposium to begin the exploration for it.

SHELLFISH MANAGEMENT IN THE TOWN OF ISLIP

Stuart C. Buckner
Department of Environmental Control, Town of Islip

For the purpose of this discussion, I would like to define mariculture as any activity that is intended to enhance the natural productivity of a marine resource. In the Town of Islip we have developed a program that has as its primary goal to maintain and, if possible, increase the long-term productivity of the hard clam resource in Great South Bay. In pursuit of this goal we have implemented several shellfish projects aimed at augmenting the natural supply of clams and additional projects to provide the informational requirements for intelligent management of the resource.

Fundamental to the implementation of any effective shellfish management program is information on the population dynamics of the resource, i.e., the standing crop and density distribution, natural recruitment, growth and mortality rates, and the effect of commercial and recreational harvest on the capacity of the resource to renew itself. In an effort to acquire some of the necessary information for management we have implemented several research programs that I would like to briefly discuss before getting into the actual seeding projects. These include:

- The Hard Clam Survey Program,
- The Economic Analysis of the Hard Clam Industry, and
- The Larval Sampling Program.

The primary objective of the Hard Clam Survey Program is to determine the abundance and distribution of hard clams in Islip Town waters. Surveys of certain closed shellfish grounds are necessary to prevent overharvesting of unworked areas by transplant operations. Surveys of the bay as a whole are needed to provide a broad data-base from which intelligent decisions can be made regarding transplants and associated shellfish management projects.

During survey work, sampling is performed with a clamshell bucket from a floating crane. Stations are located with a sextant; more than 800 stations have been established in the bay thus far. Preliminary data indicate an average density of approximately 67 bushels per acre in open waters, and 122 bushels per acre in closed waters.

In our economic analysis of the hard clam industry in Islip Town, we have been estimating the total annual harvest and value of hard clams from Town waters as well as analyzing pricing and production information to determine catch per unit effort and production trends. In order to establish the annual harvest of hard clams, questionnaires have been attached to commercial and residential permits. Analysis of answers to the questions, combined with data on the number of permits issued, allows an estimate of the annual harvest in bushels. Independent catch/effort and harvest estimates are also made utilizing information provided by commercial shellfish companies and by baymen's logs which have been maintained by several persons for the past 2 years. For 1976 we estimated a commercial harvest of approximately 524,000 bushels and a resident (non-commercial) harvest of 21,000 bushels in the Town of Islip.

In 1976 a larval sampling program was implemented to quantitatively determine the abundance and distribution of hard clam larvae in the water column and to qualitatively determine the abundance and distribution of spat set during the entire spawning season. Data are presently being summarized and should be available in the near future.

The aforementioned projects are designed to provide some of the necessary information on the population dynamics of the hard clam resource.

This information will allow us to gauge the appropriate level of effort for various seeding projects and to develop alternative strategies to implement the most cost-effective management program. Since the hard clam resource is already in real danger, however, we have already implemented several projects designed to augment the available population of clams in the bay. These include the following:

- hard clam transplant,
- spawner clam transplant,
- mariculture program, and
- shellfish hatchery.

The hard clam transplant project is presently considered one of the most effective management programs. The primary objective of the program is to move hard clams on an annual basis from uncertified to certified waters within the Town, for the purposes of reducing the attractiveness of closed waters to poaching and of supplementing the harvestable hard clam population.

In contrast to the traditional "dig and dump" operation, the Town has designed a transplant program to maximize the beneficial results of this management practice. Transplant areas are chosen on the basis of:

- Circulation studies which indicate that the spawn from an area is likely to be retained within the bay.
- Bottom type and water depth conducive to digging by local baymen.
- Hard clam survey data which indicate areas of low density clam population and environmental conditions which will foster survival and growth.

At least one area each year is located along the north shore of the bay to provide a "winter ground" available to local baymen during unfavorable weather conditions.

The size of transplant areas is decided on the basis of abundance and distribution data, and clams are spread thinly in order to avoid a "bonanza"

type harvest. The uncertified waters within the Town are being utilized as a "nursery ground" for hard clams until alternative strategies can be developed. Our intention is to see that these areas remain productive by avoiding overharvest. At times, specific areas are transplanted into and left fallow so they might produce a more concentrated spawning and thus increase the probability for a good set.

The objective of the spawner program is to increase the natural set of hard clams in Great South Bay. This is done by introducing on an annual basis ripe spawner quahaugs from cold northern waters to specified areas in the bay, after the native bay population has spawned.

Planktonic larvae of the hard clam generally remain in the water column for a period of 7-14 days prior to settling on the bottom. During this period the larvae are subject to great losses from predation and adverse meteorological conditions. Importing clams from a colder environment than local areas serves to reinforce native spawning with additional spawning and thus increases the probability for a good set. Spawner transplant areas are chosen on the basis of circulation studies that indicate that the spawn is likely to be retained within Great South Bay. Clams are ordered in several shipments to reduce the effects of possible adverse weather conditions.

The Town of Islip has adopted a mariculture system for growing the hard clam, Mercenaria mercenaria, that was developed by scientists at the Virginia Institute of Marine Science. The system involves the use of an aggregate base, baffles to regulate the current flow, and predator netting. The objective of this program is to augment the natural population of hard clams present in Town waters by providing an additional stock of seed clams that are grown in a protected area.

Great South Bay supports a large community of shellfish predators as well as a valuable hard clam resource. The blue crab is a major clam predator in the bay. Other crabs, cockles, whelks, boring snails, fishes, and waterfowl destroy many clams and often prevent natural reproduction from being successful. With the present mariculture system hard clam seed is protected from these natural predators.

Samples are obtained periodically to gain information on growth and mortality rates within the nursery area. Clams will be grown in this protected area until they reach a size at which they are no longer subject to great losses from predation. These clams will then be spread in specific areas of the bay.

The greatest problem in developing this program has been that of human intervention. Predator netting has been cut several times, crab traps have been stolen, several poaching attempts have been made, and many sunken boats have been pushed through the netting.

A preliminary evaluation of this program indicates that:

1. The production of seed clams, as described, could provide a valuable means of augmenting the resource.

2. Human interference is a detrimental factor in this and other studies.

3. Areas need to be selected and means employed to reduce the problems so far encountered.

Presently the Town is considering the construction of a shellfish hatchery. It is felt that a hatchery operated by Town personnel will provide a valuable means of supplementing the natural population of shellfish in Great South Bay. In the controlled environment of a shellfish hatchery clams will be grown past the setting stage. We will thereby eliminate the principal problems associated with natural reproduction and

the spawner program. In addition, the operation of an in-house hatchery will reduce our dependence on contractors for the implementation of shellfish seeding projects. The desired overall effect of seeding is to minimize the decrease in productivity due to natural reproductive failure and overharvesting of the resource. Preliminary calculations indicate that a better cost/benefit ratio can be attained with the hatchery process than with the existing transplant program. If final approval is obtained we will be gearing up for operation this spring.

SHELLFISH MARICULTURE IN NEW YORK STATE
[Edited text based on slide presentation]

H. Bulter Flower
Long Island Shellfish Farmers Association

The purpose of this presentation is to illustrate the present status of shellfish mariculture on Long Island. The activities of six businesses are shown. They are Shellfish Inc. of West Sayville, Bluepoints Oyster Co. of West Sayville, Shinnecock Indian Oyster Project of Southampton, Long Island Oyster Farms of Northport, Shelter Island Oyster Co. of Greenport, and Frank M. Flower and Sons Inc. of Bayville. All but the Shinnecock Indian Oyster Project have shellfish hatcheries and they have a hatchery in the planning stages. The slides do not cover the entire operation of each business, but segments of each are presented to give an overall picture.

Shellfish Inc. of West Sayville has a shellfish hatchery that is typical in design of most other hatcheries. The building is wood-framed and covered with fiberglass panels that allow sunlight to enter to foster algal growth. Conical and rectangular shellfish rearing tanks are used for larval and juvenile shellfish, respectively. Three-thousand-gallon water storage and algal cutlure tanks, along with 5-gallon algal inoculation cultures, are a vital part of the operation. This hatchery design can be used to grow many types of shellfish including oysters, hard clams, soft clams, scallops and mussels. Shellfish Inc. has chosen to concentrate on the hard clam because it has been the most successful to grow after seeding. The slides show hard clams spawning under controlled conditions in the laboratory.

Also in West Sayville is the Bluepoints Oyster Co. which has a hatchery devoted to hard clam culture. Larvae are grown to setting size in

the typical 100-gallon conical-shaped tanks. There are special tanks and flow tables for the holding of juvenile clams. When seed clams are ready for planting (at up to 1/2 inch) they are dyed and then spread on clam beds in the Great South Bay. The dye helps to distinguish hatchery seed from wild seed. After 4-6 years on the bay bottom the clams have grown to little neck size and are ready for the market.

The Shinnecock Indian Oyster Project will not have a hatchery until the spring of 1978. For several years, they have used a tray culture system in which they raise seed oysters to market size. Seed is obtained from natural sources and shellfish hatcheries and is grown to market size in trays at various sites on the bottom of Shinnecock Bay near the reservation. Shown in the slides are the trays of oysters and the offshore growing areas along with the on-shore processing area. An outboard raft is used for handling the trays in conjunction with a diver. Although they presently have a considerable oyster drill problem the Shinnecock project has great potential.

Long Island Oyster Farms is the only shellfish business on Long Island that uses heated effluent from a power plant. At the LILCO plant in Northport they have successfully raised both oysters and hard clams, although oysters are the primary product. The hatchery is the largest on the Island and has the most sophisticated equipment. Intensive algal culture is practiced and the resulting algae crop is used to feed shellfish larvae. Juvenile shellfish are grown in racks in the LILCO lagoon and are later planted on the bottom in Northport, Greenport and Oyster Bay.

The Shelter Island Oyster Co. has been experimenting with the possibilities of raising and storing shellfish in salt water ponds. The ponds

are shown in an aerial photo. They are supplied with water from Peconic Bay by a sluiceway over which a greenhouse dome has been constructed. Shellfish are held in racks in both the ponds and sluiceway. An experimental hatchery in Greenport has raised clams, oysters, scallops, lobsters, sandworms and squid.

Frank M. Flower and Sons Inc. is located in Bayville near Oyster Bay. The business is primarily centered around oysters which are cultured as larvae in the hatchery, as juveniles in trays on rafts, and to harvest size on leased shellfish bottom in Oyster Bay. The Town of Oyster Bay leases these areas and the leasing system is essential to shellfish farming. The original New York State Shellfish Hatchery was located near this site on the Bayville Bridge in the 1920's. The hatcheries today are an outgrowth of some of the early ideas formulated at this state shellfish hatchery. At the Flower hatchery cultured algae is used to grow oyster larvae as it is in many other hatcheries. The raft culture of juvenile oysters and the related mechanical processing are somewhat unique however. This procedure is shown on the slides from setting time to the planting stage, which takes place when the oysters are 8-10 weeks old and 1/2 - 1 inch long. The mechanical rotary screen is essential to this process. After 1 year of growth on the seed beds the oysters are transplanted to the harvest beds by dredge boats. The final harvest is made 1-2 years later. Predator control is important while the oysters are on the bottom. Major predators are starfish, crabs, and oyster drills. The hatchery plays a vital role in this business, since nature cannot produce the number of animals needed.

Commercial shellfish hatcheries are new to Long Island, having been developed in the last 15 years. They are still in the process of proving

that they are economically viable. The general feeling is that with accumulating experience and knowledge these hatcheries and new ones will aid nature in keeping the shellfish industry alive in the future.

MARINE PLANT AGRONOMY -- THE BASIS OF A DEVELOPING INDUSTRY

Iain C. Neish
Marine Colloids, Inc.

1.0 MOST MARINE PLANT HARVESTS PROVIDE FOOD OR FOOD INGREDIENTS

Most marine plants utilized by man are marine algae of the classes Chlorophyceae, Rhodophyceae and Phaeophyceae (generally referred to in English as the green, red and brown algae). These algae range in size from microscopic unicellular algae such as Chlorella spp. to the giant Pacific kelps such as Macrocystis, which may reach lengths of over 30 m (100 ft). The most significant uses of marine plants are:

a. The use of fresh, pickled, or dried algae as human food.

b. The use of fresh, dried, or hydrolyzed products of brown seaweeds as plant foods or animal feed supplements.

c. The extraction of structural polysaccharides such as carrageenan, agar, algin, and furcellarin from red or brown seaweeds. These cell wall materials are analoguous to the cellulose found in terrestrial plants. They may comprise over 50% of the dry weight of some seaweeds and they are useful as stabilizers or gelling agents for foods, industrial slurries, and a variety of other liquid-based systems.

d. In the past, seaweeds were dried and burnt to provide sources of potash and iodine. This is no longer widely practiced.

e. Marine plants are being considered as a substrate for biodegradation processes leading to the production of combustible gases (for example, methane), combustible liquids (such as alcohol) or lubricants. So far these processes are not being commercially utilized on a large scale, but "marine plant biomass-energy" studies are being actively pursued in many industrialized areas of the world.

f. Marine plants are also being evaluated as components of tertiary sewage treatment systems, particularly by Ryther, DeBoer and their coworkers in Massachusetts, Florida, and Texas. This work is at an experimental level.

Although industrial and biomedical uses of marine plant polysaccharides are developing at an expanding rate, food and agricultural applica-

tions still consume the bulk of marine plant biomass utilized by man. Utilization of cultured raw material outstips the use of wild stocks.

2.0 THE DEVELOPMENT OF MARINE PLANT AGRONOMY

The Food and Agriculture Organization of the United Nations (Michanek 1975) has estimated a total world harvest of approximately 2.1 million metric tons (wet weight) of red and brown algae. If we assume a mean wet:dry ratio of 7:1, this converts to about 300,000 metric tons dry weight, or only about one-third of the 1,054,793 metric tons estimated by FAO (Pillay 1976) as the world production of red and brown algae through aquaculture. Michanek (1975) has estimated that recent harvests amount to only about 31% of world red algae supplies and 8% of world brown algae supplies. In view of this, why has marine agronomy developed so spectacularly? The answer to this question is that with marine plants, as with terrestrial plants, man has specialized requirements that can be met only by having the right species growing at a desired location and producing raw material of adequate quality. Marine agronomy has developed in response to either localized or worldwide shortages of highly valued materials such as the following:

a. In Southeast Asia, carrageenan produceers could not obtain adequate supplies of Eucheuma cottonii, a marine red alga that produces a polysaccharide having desirable water gel characteristics. Joint efforts between the Philippine Government, the University of Hawaii, the U.S. Sea Grant Program, and Marine Colloids resulted in the development of a commercial Eucheuma culture industry which now produces all of the approximately 10,000 dry metric tons required by the world's carrageenan industry.

b. In Mainland China, kelp of the species Laminaria japonica has been an esteemed food for centuries, but this plant is not native to Chinese waters and was once purchased from Japan or Russia. During the past 2 decades agronomic research has led to the development of new strains and cultivation techniques which support annual production reportedly on the order of 300,000 dry metric tons per year.

c. Since World War II, the cultivation of marine plants for human consumption has developed into an industry worth over $250 x 10^6$ to the cultivation industry. The cultivated genera include Porphyra, Undaria, Laminaria, Monostroma, and Chlorella.

d. During the 1950's and 60's, the alginate extraction industry of southern California was threatened by extinction as a result of die-backs in natural beds of the giant kelp genus Macrocystis. Applied research by Dr. Wheeler North and his colleagues has led to restoration and maintenance of these beds and hence to expansion of the alginate industry.

These are only a few examples of instances where marine plant agronomy has developed.

3.0 THE PRESENT STATE OF MARINE PLANT AGRONOMY

Marine plant agronomy is a field that embraces the principles and procedures of water management and of crop and special-purpose plant improvement management and production. Although simple forms of this discipline were developed as early as the 18th Century in Japan, the rapid development of marine plant agronomy has occurred primarily during the last 30 years.

I have dealt with general aspects of marine plant cultivation in two previous papers (Neish 1976a,b). Briefly, marine agronomy strategies involve five levels of development:

a. Management and husbandry of natural stocks in order to ensure continued, stable harvests.

b. Alteration of the natural habitat by substrate provision, fertilization and other measures intended to increase the localized productivity of desired crops.

c. Live storage of detached, live, harvested plants for periods varying from a few days to many months in order to upgrade raw material quality or facilitate raw material flow through processing facilities.

d. Vegetative propagation of marine plant clones which are fastened to substrate (such as nets and lines) or are suspended in agitated tanks or pond cultures.

e. Cultivation of selected algal strains that are produced from

hatchery seed before attachment to substrate (nets for example) or suspension in agitated tanks or ponds.

A choice between the latter two strategies is primarily dictated by the life-cycle characteristics of the desired crop. Otherwise, any or all of the above strategies may be employed within various sectors of an industry producing any given marine plant species.

4.0 MARINE PLANT AGRONOMY IN CANADA AND THE UNITED STATES

In North America the restoration of Pacific Coast kelp beds (see above) represents the only highly developed application of commercial marine plant agronomy. This field has probably developed slowly because marine plants are directly consumed as food by only a small percentage of North Americans. The impetus for development of marine agronomy has therefore tended to come from extractors of polysaccharides such as Marine Colloids, Inc.; Stauffer Chemical Company, Inc. and the Kelco Division of Merck & Co., Inc. In addition, there has been interest from researchers in academic institutions who have perceived the high cost of marine polysaccharides such as agar, have observed the development of marine plant agronomy in other countries and hope to stimulate the development of similar technology domestically. We in the marine plant industry have long noted the tendency for North Americans to take photosynthesizing organisms for granted and to devote considerable attention to gourmet animal food items. We were therefore encouraged to note that the NOAA Aquaculture Plan (Glude 1977) lists marine plants as a member of the high priority group along with salmon, shrimp, prawns, lobsters, and oysters. In Canada, marine plant research has been conducted, stimulated or funded by a variety of government agencies including the National Research Council of Canada; the Department of Industry, Trade and Commerce; the Federal Department of Fisheries and Environment and various provincial

fisheries departments. The stimulation of marine plant agronomy research and development in North America has been reflected by developments and events such as the following:

a. In August 1977, the IXth International Seaweed Symposium was held in Santa Barbara, California, and attracted approximately 800 participants and 500 papers. A high proportion of the participants were North Americans and the Symposium was primarily oriented toward industrial applications.

b. In the U.S., Sea Grant funding has supported academic research on a number of species with actual or potential industrial uses. For the most part this research has dealt with basic biological problems closely related to the development of marine plant agronomy practices. Sea Grant funded research at the University of Hawaii was instrumental in stimulating the development of commercial Eucheuma culture in the Philippines.

c. Irish moss cultivation research conducted by the National Research Council of Canada has led to pilot-scale development by Marine Colloids and our competitors. We expect to commence commercial production within 5 years if our results continue to be encouraging.

d. Within the U.S., the search for energy sources has led to the initiation of projects in Florida and California which emphasize the cultivation of algae to provide feedstocks for the production of methane, alcohol, or other combustible fluids.

These examples and the Macrocystis work referred to above are a few examples of the ways in which marine agronomy is developing in North America. At present, however, it appears that this discipline is developing more rapidly in Canada than it is in the United States even though a great deal of useful research is being conducted in American universities and research institutions. I believe that the prime reasons for this are as follows:

a. Canada has large areas of sparsely populated, unpolluted coastline where aquaculture can develop.

b. Aquaculture development fits favourably with governmental objectives stressing the maintenance of decentralized, living resource based industries in coastal communities. Although aquaculture legislation is not yet fully developed in Canada, it appears that it will be oriented toward the stimualtion, rather than the restriction of aquaculture development.

c. In a reversal of the usual situation, Canadian research funds have been made available to contracting private companies while U.S. Sea Grant funds, the main source of marine agronomy research funding, have been made available primarily to academic researchers. This situation has caused Marine Colloids and Genu Products Canada (a Division of Hercules Chemical Company) to undertake their Irish moss culture development in Canada. Within the U.S., however, the promulgation of Bill HR1833, Section 7, would make some funding directly available to industrial firms. This form of funding would almost certainly accelerate the development of commercial marine plant culture in the U.S. (Bixler 1977).

During the next few decades, international developments in marine plant agronomy will almost certainly continue at a rapid pace. Within North America the major impetus for development will continue to be the chemical processing industry which is rapidly reaching the practically harvestable limits of wild stocks throughout the world and is already partially dependent on marine agronomy as a source of raw material supply. The use of seaweeds as human food will probably expand throughout the world although it may not be realistic to expect near term rapid development of this industry in North America. If practical means are found for converting marine plant biomass into energy there could be a truly massive development of marine plant agronomy. The likelihood of this occurring is impossible to predict at present, but one can predict with certainty the growth of chemical processing industries based on the extraction of biosynthetic products from marine plants.

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FISH CULTURE IN THE UNITED STATES - A GROWING INDUSTRY

Thomas L. Meade
Department of Animal Science
University of Rhode Island

Presented by Dr. Wayne Durfee

Introduction

Fish farming, or aquaculture, has been practiced in the Far East for centuries and in Europe since Roman times. However, it was not introduced into the United States until the 1870's. The abundance of fish in both coastal and fresh waters during the expansion and development of our country precluded the necessity for increasing the stocks of fish for either food or recreational purposes.

The development of fish hatcheries and production operations in the United States was largely in response to recreational demands. Most of the early hatcheries operated by state and federal agencies as well as private individuals were used for the production of trout. The introduction of brown trout from Europe and rainbow trout from the western states provided a welcome addition to the stocks of brook trout in eastern streams. These introductions, although providing for greatly improved fishing, can only be looked upon as poor substitutes for the Atlantic salmon that formerly spawned in nearly all of the major New England stream systems. After many years of half-hearted attempts to restore Atlantic salmon runs, through the release of hatchery-reared fish, a major effort is being mounted by state and federal agencies to reestablish runs on selected stream systems.

State and federal fish hatcheries can be found in every state, but the size and concentration of hatcheries in the Pacific Northwest com-

pletely overshadow the rest of the country. These hatcheries, which have largely been built since the Second World War, are used to help offset the losses of natural stocks resulting from the construction of power, irrigation and flood control dams. It is safe to say that without them our Pacific salmon fisheries would be greatly reduced. Farsighted legislation made it mandatory that when a dam blocked the spawning migration of Pacific salmon and steelhead trout, fish ladders, elevators or other devices for transporting the fish around the obstacle would be provided. When the dams were of sufficient height to make this impractical or when they caused excessive mortality of downstream migrants, fish hatcheries were constructed. The construction, operation and maintenance of these hatcheries has provided a wealth of experience and a well-developed technology that serve as a base for more advanced commercial fish farming enterprises.

Commercial Fish Farming

Development of the private sector was somewhat slower than the public sector because the key factor, profit, was not assured and early operations were closely linked to recreation. Most of the early production was channeled to facilities operated by sportsman clubs and private fishing preserves. Fish farming received its earliest push from the U.S. Department of Agriculture's Soil Conservation Service, which aided thousands of farmers in establishing small fish ponds. These served as a source of recreation and food as well as the conservation of water and reduction of soil erosion.

Early efforts at moderate scale production of fish as a supplement to a predominantly agricultural activity involved the rearing of carp and buffalo fish in flooded rice cropland. Production was never a seri-

ous problem, but general acceptance of these species was poor and eventually the practice declined.

Rainbow trout production has been carried on successfully for many years across the northern tier of states and in southern locations having an abundant supply of high quality cool water. The greatest concentration of trout farms is located in the Magic (Snake River) Valley of Idaho, where large volumes of high quality water are available from artesian wells throughout the year.

The newest and most rapidly expanding segment of the fish farming industry is catfish farming. Operations are largely located in the southern states, but are also found as far north as Kansas and as far west as California. Catfish production represents an excellent example of the extensive form of aquaculture, in that it is carried out in ponds that are comparatively lightly stocked and have an annual production capacity of from 2,500-3,000 pounds per acre. Ponds are normally stocked in the early spring and harvesting takes place in the late fall. Although catfish do not have national acceptability, the regional acceptability is great enough to provide for an expanding market that is in turn being supplied by increased production. The outlook for this industry is indeed favorable.

Many other species of fish are being produced commercially and range from bait fish to exotic ornamentals for home aquariums. Since all of these cannot be given the attention they deserve the remainder of this paper will be devoted to factors that affect the industry as a whole rather than any particular segment.

Water Requirements

All forms of fish farming have a substantial requirement for high

quality water. Trout and salmon, which are regarded as cold-water species, do best at temperatures around 55°F. Catfish, which are warm-water fish, do best at temperatures around 85°F. Departure from these temperatures result in reduced performance.

Intensive culture, which is widely practiced in the production of trout, places a heavy demand on available water resources. Where these resources are remote from demand areas and underutilized, their use for fish production poses no problem. On the other hand, the fresh-water resources of our more populated areas, particularly in the east and northeast, are more limited and large scale diversion for the production of fish poses definite problems.

Extensive culture, which is used in catfish production, also has a high requirement for water as the evaporation rate from ponds greatly exceeds the water added by rainfall in most areas.

Fortunately water conservation can be practiced in intensive culture systems through the introduction of appropriate water treatment methods that enable reuse of the water. Water treatment ranges from the removal of solid waste to the removal of all metabolic products. The degree of reuse possible is a function of the treatment processes employed and ranges from 80 to 100 percent. Quite obviously there is a cost factor involved and the degree of reuse employed is determined by the availability of water, cost of treatment, and discharge criteria.

Standards for Water Discharge

An increasing awareness on the part of the general public of our deteriorating environment provided the support needed by environmentalists to bring about major changes in our outlook and attitude toward the environment. Old laws have been dusted off and enforced and new regulations

introduced that are having a pronounced effect on industry, and fish farming is no exception. In developing guidelines for the establishment of water discharge standards for agriculture and fish farming, the Environmental Protection Agency attempted to separate these activities from industrial operations. With the transfer of authority for the development of regulations and enforcement to the states, we have witnessed a considerable departure from the EPA guidelines. In some states the discharge standards are so rigorous as to preclude fish farming development. Fortunately, other states have a more flexible policy and their discharge standards can be readily met by the use of available treatment technology. Any state wishing to foster the development of fish farming must approach the problem of discharge standards realistically in order to protect the public interest avoiding the imposition of unnecessary constraints on the fish farmer.

As a matter of general information, a set of standards established by one of our New England states follows:

WATER DISCHARGE QUALITY

VOLUME: VARIES WITH EACH FACILITY

OXYGEN: NOT LESS THAN 4 MG/L

SOLIDS

SUSPENDED: MAXIMUM MONTHLY AVERAGE 30 MG/L. PEAK WEEKLY AVERAGE NOT TO EXCEED 45 MG/L.

SETTLEABLE: NOT MORE THAN 0.1 MG/L.

COLIFORM ORGANISMS/100 ML: NOT TO EXCEED MEDIAN MPN OF 200

TEMPERATURE: MAXIMUM DISCHARGE TEMPERATURE 75°F

AMMONIA: NH_3-N CONCENTRATION NOT TO EXCEED 0.12 MG/L MAXIMUM AND AVERAGE DAILY LEVEL OF 0.09 MG/L.

pH: 6.0 - 8.5

These standards are reasonable and do not constitute a deterrent to the fish farming industry.

Fish Diseases

When large populations of fish are maintained in a restricted environment diseases will be encountered. With proper design and good management practices the disease problem can be reduced but it cannot be eliminated.

State and federal officials have long concerned themselves with fish disease problems and numerous pieces of legislation have been introduced that were aimed at reducing the incidence of disease transmission. In some cases these have been vigorously opposed by fish farmers. Measures taken in the case of some outbreaks have been rather drastic and involved the destruction of all fish on the premises and sterilization of all facilities. Unfortunately this is usually a case of locking the door after the horse has been stolen, as discharge water from the facility along with released or escaped fish provided for dissemination of the disease. There is little doubt that we need a national program for disease control, but such a program must be a realistic one.

As repugnant as the idea may be, we must accept the fact that fish production will be accompanied by fish diseases. Dealing with them in an effective manner is essential to economic success. Major advances are being made in the area of preventative medicine in that mass immunization against some diseases is now possible. Unfortunately vaccines have not yet been developed for many of the more common diseases. Treatment of fish diseases is largely limited to chemotherapeutic agents, as only one antibiotic has been approved and a second one is undergoing testing. The relatively low volume market for antibiotics for the treat-

ment of fish diseases has prevented pharmaceutical companies from making the expenditures in time and money required to obtain approval. This is most regrettable, but an unfortunate economic fact. Considerable effort is currently being directed toward establishing the relationship between stress and disease outbreaks. Environmental manipulation to reduce stress offers one of the more practical approaches to reducing the incidence of disease.

Fish Nutrition

The transition from natural foods to formulated feeds has stimulated interest in fish nutrition. Until recently, much of the research has been directed toward establishing the specific nutrient requirements of various species. Subsequent work has dealt with protein quality, digestibility and energy requirements. The most notable contributions have been in the field of lipid metabolism. The essential fatty acid requirements for fish are different from those of warm-blooded animals, and the inclusion of lipids containing unsaturated fatty acids with omega-three configuration in the diet have given dramatic responses.

Many of the feed ingredients that are well-utliized by warm-blooded animals are only poorly utilized by fish. Again, the relatively low volume of fish feed produced annually has prevented the adoption of ingredients that are most digestible by fish. With an increase in the demand for fish feed we can expect considerable improvement in quality. In the meantime, relatively poor quality commercial fish feeds will be the order of the day. Experimental feeds have been formulated that provide for feed-gain ratios of 0.8, while few commercial feeds provide ratios of less than 1.5. Obviously there is much room for improvement.

Potential and Conclusion

The potential for fish farming in the United States is very great. We have the market and the technological base to build on. Efforts are underway to develop a National Aquaculture Program. This program will provide for integration of the many supportive disciplines and hopefully will be administered by the U.S. Department of Agriculture. This agency with its well-developed national organization and its close affiliation with state universities, Agricultural Experiment Stations, and Cooperative Extension Service provides an ideal vehicle for implementation.

Fish farming of the future will be far more dependent upon advanced technology than it has been in the past. Its demand on our natural resources and its impact on the environment will require coordinated long-range planning to ensure its success.

CULTURE OF CRUSTACEANS AND OTHER INVERTEBRATES

Anthony D'Agostino
New York Ocean Science Laboratory

Introduction

Until recently the renewable resources of the sea were thought to be inexhaustible. In the past 2 decades, with the advent of innovative and progressively more efficient fishing methods, depletion of several of the most sought-after fish and shellfish is a likely possibility.

Management and aquaculture programs that were intended to safeguard against over-exploitation of wild stocks and the stimulation of fish farming were predicated on the belief that mankind would ultimately rely more heavily upon the aquatic environment as a source of food than it has in the past.

World harvest of marine crustaceans, molluscs, and a score of miscellaneous invertebrates was last estimated at 4.9×10^6 metric tons per year (FAO 1969). This was less than 9% of the total harvest from the sea. The current world-wide yield of invertebrates from mariculture is unmeasurably small. In the United States, aquaculture contributes approximately 2% of the fishery products for human consumption (Glude 1977).

Interest in the potential of invertebrate aquaculture is not fueled by these meager statistics, but by the fear that global overfishing and pollution may further reduce catches from wild stocks. It is sustained by the realization that, as in agriculture, intensive husbandry of a few species in coastal, estuarine and inland waters may prove more productive in the long run than fishing depleted grounds (Rawitucher and Mayer 1977).

Aquaculture as defined by NOAA in its 1975 review, encompasses

the husbandry of aquatic organisms by private industry for commercial purposes, and public agencies for the replenishment of natural stocks. Its practices are diverse and rarely adhere to precise protocols since they must be opportunistic with regard to the habitat and accommodating to the needs of the organisms. Depending on the species being cultured, they may involve simultaneous use of transplantation, hatcheries, and intensive culture in artificial enclosures or in entirely synthetic and highly elaborate rearing facilities.

Many species of invertebrates have been successfully grown in laboratories and in small-scale pilot projects. A few have been proven suitable for commercial operations. Oysters, mussels, and Japanese prawns are among the better-established species in the list of aquacultural successes.

At one time or another, fifteen species of invertebrates have been considered as suitable candidates for farming on the eastern seaboard. The list of the most notable includes 5 crustaceans, 8 molluscs, and 2 annelid worms (Table 1). Of these, the American oyster, hard clam, bay scallop, blue mussel, and American lobster offer the greatest potential for aquaculture. Technical and economic factors disqualify the remaining 10 species. Criteria used to determine their suitability for commerical aquaculture are predicated on both biological and economical factors.

Bardach and Ryther (1972) defined the biotechnical criteria required in assessing organisms for aquaculture. These include: adaptability to crowding; availability of seed stock either from the capture of juveniles from nature or from hatcheries; knowledge of growth rate, feeding habits, nutritional requirements; and availability of feed.

Table 1. Candidate species for culture and qualifying criteria

	Physiological Adaptability	Technical Knowhow	Natural Supply	Unit Price	Sale Volume
American lobster, *Homarus americanus*	F	A	D	H	H
European lobster, *Homarus gammarus*	F	A	D	H	H
Blue crab, *Callinectes sapidus*	F	A?	H	L	H
Rock crab, *Cancer irroratus*		A?	H	L	L
Northern shrimp, *Pandalus borealis*			L	H	H
Eastern oyster, *Crassostrea virginica*	F	A	H	H	H
European oyster, *Ostrea edulis*	F	A	L	H	L
Pacific oyster, *Crassostrea gigas*	F	A	H	L	L
Hard clam, *Mercenaria mercenaria*	F	A	H	H	H
Soft shell clam, *Mya arenaria*	F	A?	H	H	H
Bay scallop, *Aequipecten irradians*	F	A	H	H	H
Sea scallop, *Placopecten magellaniens*			H D	H	L
Blue mussell, *Mytilus edulis*	F	A	H	L	L
Blood worm, *Glycera dibranchiata*	F		H D	H	L
Clam worm, *Neanthes virens*	F		L	H	L

Key to symbols: F = favorable; A = adequate; L = Low; D = declining; H = high. Blank spaces indicate lack of adequate information. Question marks(?) indicate incomplete demonstration of technical knowhow.

Legend: Physiological adaptability is favorable (F) if the species was shown to tolerate a wide range of salinity, temperature and various other stressing conditions prevalent in hatchery environments and intensive culture systems.

Technical know-how is considered adequate (A) if the species has been reared in the laboratory through all of its life stages, can be made to reproduce in captivity or, eggs, larvae and juveniles are hardy, readily available from nature, and their food requirements are known and are easily met.

Commercial aquaculture is justifiable if natural supplies are low (L) or declining (D), but if high (H) and landings are well below the maximum sustainable yield, aquaculture may not be economically feasible.

Unit price and potential sale volume influence economic feasibility. Thus, if unit prices are high (H) and they are coupled to high potential sale volume species qualify for aquaculture. Species showing high unit price but low (L) sale volume or vice versa should not be considered a desirable candidate for aquaculture.

A candidate species that has been reared through all of its life stages and has met all other biotechnical criteria may not necessarily be suitable for commercial aquaculture if it is abundant in the wild or returns a low market price (Gates and Matthiessen 1974).

Techniques for the cultivation of the blue crab, rock crab, soft shell clam, and blue mussel are fairly well defined. Nevertheless, these species would presently appear to be unsuitable candidates on economic grounds; i.e., supplies are abundant and they receive a low market price. It is noteworthy that in spite of this, the blue mussel is currently being considered a prime target for aquaculture in the northeast. This species has not been in great demand in the United States even though it is a very popular food in Europe.

The techniques of raft and long-line culture that are currently being adapted for culture of mussels in the northeastern United States (Lutz 1974) and Canada (MacLeod 1975) have been in common usage in Europe for several decades. Success of a mussel aquaculture enterprise here may depend very much on how successfully mussels can be marketed in the future. A campaign to promote the mussel in a market dominated by very reluctant buyers has been underway for several years with limited success.

Life histories of the Northern shrimp, sea scallop, blood and clam worms are not sufficiently well known to permit commercial exploitation through intensive aquaculture. All three species command significantly high unit prices, but the latter two have low potential sale volumes. The lack of information on their life histories should be remedied, especially with regard to the Northern shrimp because it would appear *a priori* physiologically adaptable to the temperature regimens of the northeast and because it is in demand.

The economic feasibility of culturing the American lobster is being actively explored by several private groups and governmental agencies. The lobster has been reared through all stages of its life cycle under

laboratory conditions. Growth to market size, which requires 5 - 8 years in nature, can be attained in about 2 years under laboratory conditions (fed *ad libitum* and kept at elevated temperatures equal to or greater than 20° C).

The cannibalistic behavior of the lobster and the lack of an optimal artificial feed are current challenges to its commercial aquaculture. These impose the use of individual cages, automated feeding devices, appropriate grow-out facilities, and water quality control systems.

Alternate approaches are being sought that would avoid the cost of building and operating expensive rearing facilities. One of these calls for the planting of juveniles in highly productive, easily controllable, natural impoundments, the bottoms of which have an appropriate supply of artificial habitats. Losses due to cannibalism would be avoided by controlling standing stock densities.

Presently, at the New York Ocean Science Laboratory, we are exploring the possibility of growing juvenile lobsters in perforated cannisters submerged in laboratory raceways, outdoor spillways and in bays. No food is added. The lobsters feed on fouling organisms that attach to the walls of the containers. During the spring and summer months, growth of the experimental animals isolated in cannisters without feed was nearly equal to that of their siblings kept in open cages and fed *ad libitum* (D'Agostino 1977). With the beginning of winter, growth of the experimental animals began to lag, compared to that of the control animals. It is likely that during the spring and summer months an abundant set of fouling organisms kept the experimental animals supplied with food and that, as winter approached, recruitment of the fouling organisms may have diminished (Table 2). It is too early to

TABLE 2. - Survival and growth of juvenile lobster *Homarus americanus* in perforated cannisters[1] during spring and early summer.

Conditions	No. of Animals	survivors	Initial wet wt (g)	Final wet wt (g)	Mean % Gain	Mean Growth Days	Total % gain/days(g)
In cannisters (unfed)	12	9	Range 0.33-2.23 Mean 1.13	Range 1.21-3.01 Mean 2.13	160	79.5	2.21
Controls in cages (fed *ad libitum*)	6	5	Range 0.22-1.09 Mean 0.43	Range 0.80-1.93 Mean 1.33	287	73.3	3.62
In cannisters (unfed)	3	3	Range 0.33-0.41 Mean 0.36	Range 2.18-1.88 Mean 1.85	414	103.0	4.02
Controls in cages (fed *ad libitum*)	3	3	Range 0.34-0.37 Mean 0.35	Range 1.47-1.93 Mean 1.56	336	90.0	3.73

[1]Juvenile lobsters, stages 6-10, were kept individually in perforated cannisters, 40 cm long, with a diameter of 6 cm, stoppered at both ends by cement plugs. The cannisters were submersed in running sea water troughs. Controls were kept in cages, 8 x 8 x 5 cm, floating in running sea water and were fed *ad libitum*. Temperature varied seasonally from 15 to 20 C.

reach definite conclusions on the commercial application of this technique. Rearing of lobsters unattended in cages beneath the sea may be a viable alternative to intensive culture in cages housed in costly facilities.

One other interesting alternative for the aquaculture of the lobster relies on the timely exploitation of precocious molting which follows bilateral eyestalk ablation in most crustaceans. Removal of the eyestalk accelerates molting and enhances growth (Mauviot and Castell 1976). The procedure could find commercial application in the aquaculture of the lobster if the temporal aspects of the response were known. Doubts persist on the predictability of the phenomenon. Accordingly, we have underway several experiments with the objective of measuring post-operative survival, molting, and growth of different size classes of lobster eyestalk ablated at different times of the year.

Preliminary data indicate that healthy 1-pound lobsters operated upon during the winter undergo precocious molting 3-4 months after eyestalk ablation. The weight gain exceeds 40% of the initial weight. Control animals molt once a year and their weight gain is about 22% of initial weight. Mortality of eyestalk-ablated lobsters was negligible during the first 6 months, but increased drastically as the experimental organisms prepared to undergo the second post-operative molt. The results are very encouraging. But, it is obvious that the excisement of the eyestalk removes the source of MIH (molt inhibiting hormone) as well as other hormonal entities that perform essential regulatory functions in the preparation of the organism for the molt. Thus, in their absence the animal is not capable of undergoing a second precocious post-operative molt. The phenomenon needs to be studied with the view of by-

passing the harmful effects of total eyestalk ablation. Several new approaches are being tried in the hope of deactivating the x-organsinus gland complex without affecting the associated neurohormonal functional sites.

The art of aquaculture is in a transitional stage; it has had a definite past, but looks to an uncertain future. It is an idea whose time has come (Weatherly and Cogger 1972). It will be regrettable if, by focusing on the cost-benefit analysis of the most costly and technically sophisticated culture systems proposed to date, it were to be made to appear economically unfeasible.

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Remarks of The Honorable Senator Bernard C. Smith

We're here today to discuss the symposium on mariculture. If any of you have dictionaries and you wonder what the word means, you'll probably learn that it isn't even in the dictionary. In fact, if you want to find out about aquaculture you'll discover that most dictionaries don't include that word except perhaps in connection with aquiculture, spelled with "aqui-" which refers to hydroponics. Now, actually the science of trying to cultivate the living things in the sea goes back more than 2,000 years and what we're going to discuss today is the status of where we are with this business of mariculture - namely, trying to introduce into the marine environments of the sea certain conditions that will allow that sea to produce more than it does under normal natural conditions. So that's what we mean by mariculture. It is manipulation of the natural order of things to allow us to produce something in a more efficient manner than the natural forces might produce it themselves.

I'm sure you're all aware of what is happening in many areas of your own activity. Just recently Sports Illustrated had an interesting article on raising bluefin tuna in Nova Scotia. Tuna were netted during the summer when they weren't very fat, corralled in large enclosed nets, fattened and then, when they were good and fat, and much heavier, sold at a much higher price than could have been obtained earlier. Well, that's one aspect of mariculture.

I recently came back from a trip to California. One of the major stories there last month was that Weyerhauser Corporation, a major corporation involved with the timber industry is expanding now. They want to spend as much as $10,000,000 in salmon ranching. What does that mean? Well, in this case it means raising thousands, millions, of smolt salmon

and releasing them with the premise that perhaps one-third of those that mature will come back to the point of release, and making it profitable for Weyerhauser. Now $10,000,000 is a lot of money. Yet when you see the price of salmon on the West Coast where a salmon cutlet costs $5.50 a pound and salmon in the round is $3.00, you can see why folks might be interested in this kind of operation. In California they're also involved with abalone, lobster (our own lobster) and the pismo clam. Many things are happening and I guess one reason for that is the growing demand for seafood. And of course with the growing demand comes a diminishing supply. The cost of seafood today, as we all know, is increasing rapidly. It is becoming more of a gourmet food rather than what was traditionally regarded as a common everyday food.

This has certainly been a varied week for me, one where I have had extensive contacts with the Department of Environmental Conservation (D.E.C.) and others interested in our environment. As I indicated to some of the people before whom I appeared, Peter Berle, the Commissioner, and I see eye-to-eye on most things, but whenever we don't, it's not for lack of trying. It's always great to meet with the fellows from D.E.C. and have an opportunity to share some thoughts as a legislator with these people who represent the executive branch of government. Even more important for me is the opportunity to share some of our legislative problems with the professionals that are here in this room this afternoon and the students who are interested in the very important topic of Marine Resource Management. Hopefully, and I mean this in all sincerity, we can get some help from the combined efforts of the people who have some of the primary and informed interests in this particular field.

I said that I had a number of contacts with the Department of Environ-

mental Conservation. These were in quite a contrast to my meeting with the Solid Waste Management Association of the State of New York the other night here in Suffolk County and also to one I attended last night in Indianapolis. There I was talking to a group of legislators along with another speaker who is a good friend of mine and a tremendous fellow in the environmental field, Elvis Starr, Chairman of the National Audubon Society. He gave an exceptionally fine talk about the responsibilities of those of us who are in government both to our environment and even more importantly to the people generally in our dealings with environmental management matters.

At one time I chaired the National Task Force on Marine Fishery Management. I undertook that responsibility feeling rather inadequate to deal with the people who were members of that particular task force. We had some great, great people. There was Frank Grice, who was then the Director of Marine Fisheries in the Commonwealth of Massachusetts, and a fellow by the name of E. J. Huizer who was with the Department of Fish and Game from Alaska. We had professionals from all over the United States working on and developing what we thought would be an effective marine resource management program for our respective states and we attempted to develop nationwide uniformity in our legislative plans.

This morning I listened to the last part of the panel composed of scientists who know their field and what the technial prospects are. I don't pretend to know the technicalities of the field, but I do feel a need for more effective management of this marine resource. I think that I have a responsibility in the legislative field and that's why I'm asking for help from those of you who are actually out there and have an interest in the business and scientific aspects of mariculture, and from

all of you who come to a meeting of this sort.

Sometimes I think that a politician, whether he is dealing with marine resource management, solid waste management, social welfare, or what have you, has a great deal of difficulty establishing his credibility. In the present-day atmosphere, politicians as such really aren't enjoying any great deal of credibility, and I have my own personal problems in this area. For example, I was a great proponent of making the striped bass a game fish, a hook-and-line fish, and I encouraged one of my good friends, something of a politican in our county, Perry Duryea, to join in my efforts. We developed some differences of opinion in this area and it doesn't help when you go to only one side of the picture as I did in that particular instance. I'm reminded of something that Mr. Starr said last night, relating a story about Oliver Wendell Holmes who was being asked about his tremendous ability as a philosopher and student of law. He was asked, "How do you account for the fact that you have this tremendous mind?" "Well," he said, "I have a tendency to be, ah, as unbiased as I possibly can and yet not totally unbiased. I guess it's that I have a tendency, ah, to be impartial, and yet not to be totally impartial."

You think about that a little bit, and there's a lot to be said for it. We talked about Marine Resource Management. We have had some fantastic programs developed of recent date here in this state. We have tidal wetlands legislation, which, Don, in my opinion, you still have not carried as far as you could have, toward implementation of the program and purchase of tidal wetland. I've tried to tell the Department of Environmental Conservation many times that I think there's more that could be done and faster. I think that there has unfortunately been a

great division, both from local government and from business, in the implementation of this legislation which is so important to us. I hope that we all believe in our marine resources and the type of support that they should have. We have a coastal zone management program that I have been trying unsuccessfully to shepherd through the legislature for the past three and a half years. Unfortunately, we don't see too many of the professionals in this field coming forth and giving the type of support that's necessary for the ultimate success of this program, a program which is so vitally important to good marine resource management. It's a very controversial piece of legislation because you have all of your local governments saying, "Here's the State again, attempting to dig into and infringe upon our home rule prerogatives." Some of the biggest problems that we run into in any of these comprehensive programs - and of course you've got to have comprehensive, far-reaching programs when you're dealing with a resource such as marine fisheries - are the objections of local government. Our marine fisheries management program, which we managed to pass in the Senate during this current 1977 session, suffered those same objections.

Let me reflect for just a minute on some of those programs that I just quickly mentioned to you without going into any of the details. I'm sure you're familiar with all of them. It occurs to me that in spite of the dedicated people that we have in this field of marine biology and marine resource management, there has been little of the outspoken and active support that we should have had for these programs if they were to move on forcefully. Maybe that's a type of scolding. It's probably nice to be able to stand up here and scold without any fear of reprisals from the group that I'm speaking to because you are professionals or

aspiring to be professionals. When you think about this nation that has the fourth largest marine fishery and the third greatest continental shelf area in the whole world, it mystifies me that we don't pay more attention to these opportunities through the legislative vehicle. We can and must take positive steps to protect the tremendous interest that we have in our coastline and our continental shelf.

It's distressing, too, in a different way. I've felt this so much in working with the task force and the professionals in the field who, very frankly, align themselves primarily with commercial fishing interests. That's the way most of these fellows look at their responsibilities in state government, because the commercial fishing industry as such adds so much to their respective economies in the coastal states. Perhaps this is one of the things that bothers them, too. For they are aware of this tremendous resource off of our shores that is not being harvested as it should be. More importantly, the foreign fishing fleets were taking a tremendous share of the harvest that should have been ours.

By the way, when we were working in the task force, I might just add, we were absolutely certain that we were going to have an extension of our 200 mile limit. We had Federal people with us all the time, and we obtained their assurances that it was going to be accomplished. As you know, the 200 mile limit legislation had a checkered career in Congress for awhile until some righteous indignation really did come from the people who said we've got to do it, and it was done. Now, for example, off our shores there's about 40 to 50 billion pounds of fish, what the professionals call the optimum sustainable yield. We and our fleets are taking approximately one-tenth of that yield. We talked a great deal about why that was so. We had to consider all of these factors and try

to develop the type of management program that we were going to suggest to our states. One primary consideration was that we just didn't have a fishing fleet that had the potential to go out there and properly share in that harvest. More importantly, we didn't have the type of governmental backing that would really enhance that fleet and give them the wherewithal to go out and take their proper share. And there was nothing new on the horizon as far as the federal government was concerned that was really going to change that situation even after we extended our limit. I think that's pretty sad.

We've got to be more realistic in making available to our commercial fishermen the capital that's necessary to go into this type of expansion. It must be designed so that we don't merely get them going after one species on a specialty approach that will decimate that species, but do equip them for broader participation in the overall harvest. This is again part of the management consideration that we were concerned with. To help them, we need more than the existing loan programs which really aren't any good if you look at them. Loans are used primarily to repair worn-out, antiquated ships and antiquated gear. The type of government subsidy that I'm talking about is in the form of programs where we're going to make more low-cost money available to the people who want to be in the fishing business. We must do it the right way under proper control. We should make it easier for them to get into fishing and to develop the type of equipment, the types of ships, and so forth that will enable us to compete with the foreign fleets.

The ultimate product of that task force was the so-called uniform legislation, designed to give the legislatures of coastal states a series of alternatives. They could fit in the suggestions that we made with

their existing structures and hopefully improve the situation nationwide.

If any of you are interested, I think we still have copies of the report that came out of the Task Force called, "To Stem the Tide." You can get them from the Council of State Governments, Lexington, Kentucky, at a nominal charge. The report details a lot of the things that I'm just touching on here pertaining to the development of this marine resource management program.

Now, what about legislation in regard to the subject of your particular symposium here today? Mariculture, or aquaculture, is of great concern to all of the professionals from each of the states interested in encouraging its development. Simply stated, legislation should be designed to encourage and not deter the development of mariculture programs. I was speaking to Dr. Baiardi here in connection with this. I made a trip 3 years ago to Japan as a guest of the Japanese government to look over their aquaculture operations. Frankly, I was tremendously impressed with what they were doing, and perhaps even vaguely discouraged as to our lack of progress here in this country concerning the development of this particular type of farming. I said to Dr. Baiardi "What we've really got to do is develop a system whereby we get some of these operations going in the field, not only in the laboratory, and really encourage people in business to get out there and do it." Of course, he pointed out to me that one of our problems is that we don't have the people in this country who enjoy fish as much as they do in some of the other nations. Obviously per capita consumption in the United States is substantially different from the per capita consumption in Europe, by at least 7 or 8 pounds per person a year which is an awful lot. Of course there is also a dramatic difference between our per capita con-

sumption and that which occurs in the Asian countries. But that is another problem I'm not going to get into. We still have to do something because it's not always going to be that way. We're not always going to be able to afford beef on all of our tables, as we have it today. We've got to do some tough market development to insure that there is a greater consumption of fish in these United States. There is consequently a need for really getting out in the field and getting some economically viable operations underway. I think that this would help the people in the laboratories who are doing such a tremendous job in developing new strains, or at least attempting to develop new strains, new techniques, disease control, or whatever it might be.

Seeing the actual problems that are encountered in the field, in the operation of one of these mariculture projects, would cause anybody concern. When we get in the field, and we've got to do this - we've done it in the farms throughout this country - we are confronted with the problem of waste control or waste management. I have a son who happens to be doing a doctorate at Michigan State in that very field and it made me feel good to hear how important people in aquaculture think this work is. I'm sure that's a problem we'll be able to contend with; it's a problem we've contended with in other farm areas and if we're going to do it, we're going to do it the right way. We can't just say that this is a problem, and therefore we're going to hold off until we have an absolute answer to that problem. I hope you have a group here interested in developing solutions to this problem, and I hope that they will diligently pursue them.

I also hope that you'll take a challenge from me. Before I give you this challenge I'd like to comment on the particular piece of legis-

lation, S.5704, which represents the work of my staff on this marine resource management program in New York State. There is no pride of authorship in this legislation that would affect my willingness or ability to make practical changes that will show us a better way to do the job, do it right, and really to give to the D.E.C. the tools that they need in order to fulfill their responsibilities in the management of our marine resources. We need help in achieving passage of this program and this help must come from the scientific community, the business community, and others. The D.E.C. has told me that we have laws on the books today that can permit us to handle, as a regulatory agency, a mariculture operation. I agree, and I think that could be done, but you're going to be flipping back and forth, hither and yon, in attempting to put various sections of the law together in order to give some direction to those who want to go into this type of operation. There's one thing that this new bill does; that is to pull it all together, put it down in black and white, and in effect announce to all of the people of this state that the State of New York is interested in fostering mariculture here. It tells businesses interested in going into mariculture how they can go into it, and establishes a state policy. We believe this is a must, in the interest of our economy, in the interest of feeding this nation, and to help fulfill the task that we so often take upon ourselves to feed other nations that are less fortunate than we are. The need warrants our granting to individuals under specified controlled situations the right to use public lands for the production of a food crop. That's really what we're talking about and what we try to do in this legislation. Even if D.E.C. told me that they already had all of the rights and powers to implement this regulatory responsibility I'd still say that

we should enact this legislative program. We will thus establish the absolute guidelines for those who are interested in building a mariculture operation, and are willing to invest substantial sums of money in the same.

Rather than go into the details here, I'd prefer that you look at the legislation itself. Of course, I'd be happy to take any questions regarding what I've said here today. Let me tell you, though, what the biggest criticisms of the proposed legislation have been. Such comments have come from people who have seen fit to write to us, call us, and make editorial commentary. They indicate we haven't discussed it enough with people, that they still don't know what it is all about, nor do they understand the basic intent of the legislation. An almost unanimous criticism that's made of this legislation is that it gives to the Department of Environmental Conservation too much power. I am well aware of this type of criticism as I am chairman of the Senate committee that handles every bill that affects the Department of Environmental Conservation. This criticism I hear all the time, and it comes mostly from local governments. I hope that there are people here from local governments. As much as I appreciate and as much as I agree with local government that your own prerogatives must be guarded, at the same time you must also ask yourself, can I really do this job? As one single municipality can I regulate a resource as important as this is to all of the people of this and adjoining states? I think that's really what you've got to ask yourself, and attempt to find a reasonable and objective answer.

If we don't give to the Commissioner of the Department of Environmental Conservation the right to promulgate rules and regulations with

regard to this type of operation - who is going to do it? Would you entrust it to the members of the New York State Legislature, each of whom have their own provincial interests - depending upon the area of the state in which they work? None of them has the staff with the technical abilities to do the type of thing we're talking about here. Now this is one of the necessary evils of government to grant an executive agency the right to promulgate such rules and regulations in spite of the fact that experience tells us on many occasions they have abused that right. It's the responsibility of the legislator to make certain we spell that out in the legislation. We should make sure they can't abuse that right and that the hearing procedures as provided require the input of people in the community, of local government and of the scientist in making those regulations. More importantly, and I've said this to some of those who have been critical of this legislation, we now have additional control through our administrative rules and regulations review legislation which was passed in the Senate this session. This bill did not make it into the Assembly, but I think it will in 1978. This type of review structure will make it virtually impossible to abuse regulatory power in the development of these rules and regulations. Ladies and gentlemen, I know of no other way that this type of regulating can be done, because we don't have the mechanism to do it any other way.

Another criticism is that we provide in this legislation an advisory committee with representation from people who know about our marine fisheries, making certain that there is equalized representation between the sports fisherman and the commercial fishermen. Part of the criticism, and perhaps it's a good one, is that the advisory committee created by this legislation cannot and will not have the final word on those rules

and regulations. I'll tell you right now, however, that I can't think of any instance in government where we would abandon our responsibilities and powers, whether legislative or executive, to a non-elective advisory group. I therefore think that the most we can do is to put that committee in an advisory role. Each and every one of our coastal states that have these committees have them in an advisory status. They say that they do a fantastic job in reflecting the interest of the people in the community.

The message that I'm trying to bring home here is this. We in government, because of our association with the professionals, get some ideas of what the problems are in a particular field. We try to react to those problems to the best of our ability. So, if you're going to do a thorough and complete job and if we're really going to do the best job for all of the people in our community (the community being the entire state), we have to have your help and particularly help from those of you who are experts in the field. Unfortunately, we often have a lack of input on the very basic problems and questions. If we can gain your input then we will be able to go ahead with our best effort in developing what we think meets the needs of all the people.

It's great being down here in Southampton. We have a beautiful day and I appreciate the invitation to come here and participate in this forum. I think some good things are going to come out of here and I hope that there will be some follow-up. I understand that you are planning to publish papers that are being given here today and I hope that you'll have some input into what we're trying to do in the state's coastal zoning management program, preservation of wetlands, and marine resource management. Let us hear from you. I'm sure that you will have good constructive suggestions. Thanks very much.

Opening Remarks - Afternoon Session

DeWitt Davies
Nassau-Suffolk Regional Planning Board

The Nassau-Suffolk Regional Planning Board is under contract with the N.Y.S. Department of State to develop a coastal zone management program for Nassau and Suffolk Counties pursuant to the Coastal Zone Management Act of 1972 (P.L. 92-583) as amended (P.L. 94-370). The coordination of federal, state, and local programs and activities, the designation of priority uses, and the development of site specific land use and activity proposals are primary areas of concern addressed by the Board in its development of the coastal zone management program. Segments of the program include land use; recreation, shore access and historic preservation; energy; dredging and spoil disposal; coastal erosion; land capability and natural resource analyses; implementation; and marine fisheries. Key principles that have served as guides for developing the facility, land use, access, mariculture and management proposals contained in the marine fisheries segment are:

- multiple use of marine resources.
- sustained use of marine resources.
- equitable distribution of marine resources.

Two draft recommendations that are germane to the topic of this symposium and relate specifically to the future of mariculture in the Nassau-Suffolk region are shown below in their entirety.

" I. New York State, Suffolk County and towns in Nassau and Suffolk Counties should adopt policies on aquaculture and related activities in Long Island marine, fresh and brackish waters. These policies should be based on an analysis of the potential of aquaculture as an aquatic based industry in Nassau and Suffolk Counties, and the social and economic costs and benefits of implementing alternative management strategies. Some of the information supporting this analysis is not readily available to decisionmakers.

The culture of oysters on Long Island bay bottoms controlled by private interests has been very successful, and this activity supports an important local industry. The artificial or controlled propagation of other marine species should be the subject of additional research. This research should identify the physical, chemical, and biological marine environments suitable for various types of aquaculture. Other questions that should be addressed include.

1. What opportunities exist for the artificial or controlled propagation of shellfish, finfish, marine plants, and other species in Nassau-Suffolk marine waters?; 2. How does shellfish (oyster, hard clam) production on leased ground compare with natural shellfish production on public underwater lands?; 3. Is there a demand for additional leased underwater acreage for aquaculture purposes in the Nassau-Suffolk marine environment?; 4. What are the costs, to the public (both in terms of monetary cost, e.g., restricted access of commercial fishermen and aquaculturists to work specific areas, and non-monetary cost to other traditional users) attributable to the implementation of a leasing program?; and 5. What are the benefits in terms of jobs, income and food production that are expected to accrue to the region should an aquacultural program be encouraged and broadened?

Since definitive information on these matters is not readily available, this plan recommends that the appropriate authorities reserve the option of allocating a portion of their respective marine areas for oyster culture and the conduct of other aquaculture projects under public and private management. Potentially productive marine areas should be reserved and maintained for sole use by the two groups - the general public and aquaculturists.

II. Suffolk County should implement that portion of Chapter 990 of the Laws of New York State pertaining to the preparation of a survey map showing titles to underwater lands in the Peconic and Gardiner Bays. The principal benefits of survey, title search, and mapping would be the identification of underwater tracts covered under previous grants, and the identification of underwater lands open to full public access."

CURRENT ISSUES IN N.Y.S. - GEOGRAPHIC FACTORS

Richard C. Ryan
New York State Department of Environmental Conservation

I was asked by A. S. Taormina, in July 1977, to give a general discussion on "geogrpahic factors affecting underwater land allocation for maricultural purposes."

The topic implies that such factors exist, and they do. They take on many forms and are applied in many different ways, by many different segments of our society.

I should like to briefly outline and discuss the recent involvement of my office in an effort undertaken by the Enviornmental Conservation Department to identify some of the factors.

In March 1976, we undertook a task to map the limits of federal, state, county, town, and other local municipalities jurisdiction and ownership of underwater lands in the Marine District of New York State.

The purpose of the maps is to provide essential information needed to deal with the on-shore impacts of Outer Continental Shelf oil and gas exploration and development and to determine boundaries among and between government jurisdictions.

The maps were prepared as part of the work program of the Outer Continental Shelf Study Program in the New York State Department of Environmental Conservation. Their preparation was financially aided through a federal grant from the Office of Coastal Zone Management, National Oceanic and Atmospheric Administration, under the Coastal Zone Management Act of 1972.

These maps are expected to be utilized also in state shellfish transplant programs, in conjunction with possible underwater sand and gravel

mining permits, and for assessment of liability in the event of major oil spills.

Each accompanying report cites relevant federal and state laws, judicial decisions and intergovernmental agreements that have established present boundaries, jurisdicitions, and ownership of underwater lands. The reports also identify conflicting jurisdictions and problems with boundaries. Specific documentation regarding each boundary and jurisdiction has been assembled in separate appendices.

The maps, and their accompanying reports, are produced in three series. The first map series details federal and state coastal boundaries and their jurisdictions; the second details state, county, and town boundaries, underwater lands and their jurisdictions; the third details ownership of underwater lands in New York State.

Map Series #1 shows the New York State Marine Region and immediate environs including appropriate state boundaries, county and city jurisdictional boundaries as well as the Three- and Twelve-Mile Limits. The relationship of the major shipping lanes to the various boundaries as well as their general proximity to the New York region is quite evident in this series.

The New Jersey/New York, Connecticut/New York, and Rhode Island/New York State boundary lines have all been fixed by respective state laws and ratified by the U.S. Congress.

The Three-Mile Limit and the Twelve-Mile Limit are lines showing the limits of various State/Federal jurisdictions. These lines are projected from a national baseline, which is the Mean Low Water Line. This map shows the baselines and delimitation lines utilized by the Ad Hoc Committee on U.S. Coastline Delimitation, May 1, 1971, in provisionally

delimiting the territorial sea, contiguous zone, and certain internal waters of the United States. The committee is chaired by the U.S. State Department. The lines prepared by the interdepartmental committee represent its interpretation of relevant legal principles as applied to geographic information shown on U.S. Coast and Geodetic Survey (now National Ocean Survey) charts.

The sourthern boundary of New York State is the Three-Mile Limit drawn from the mean low water line of the shore. This is the limit of state authority into the Atlantic Ocean. The Three-Mile Limit is documented by international convention (U.N. Law of the Sea Conference, 1958), the Submerged Lands Act, and New York State Law § 7-a (McKinney's 1952).

The Contiguous and Exclusive Fishing Zone extends 12 nautical miles from the national baseline and is in fact a 9-mile extension from the 3-mile territorial sea. The Contiguous Zone was created by the 1958 U.N. Treaty. The Exclusive Fishing Zone was established by a U.S. Congressional Act in 1966.

The Fishery Conservation and Management Act of 1976 provides for a Fishery Conservation Zone which will extend 200 nautical miles from the national baseline. This in essence will supersede the Exclusive Fishing Zone Twelve-Mile Limit; the Contiguous Zone will remain at 12 miles for the purpose of customs, immigration, fiscal, and sanitary regulations. The new 200-Mile Fishery Conservation Zone was established effective March 1, 1977.

When considering the ownership of lands underwater in the territorial sea, the states have the ownership of the bottom. Initially, the U.S. Supreme Court held that paramount rights over the ocean waters and their seabed were vested in the federal government, an incident to which was

full dominion over the resources of the soil under that water area, including oil. But the Congress then passed the Submerged Lands Act of 1953, which transferred to the states the rights to the seabed underlying the territorial sea.

Map Series #2 depicts federal, state, county, and local boundaries, jurisdictions and ownership of lands underwater in the Marine District. The report provides documentation of boundaries, ownership, and jurisdiction for each of the six map sheets in Map Series #2. Each discussion of documentation is accompanied by a legal analysis of any boundary and ownership problems that appear on the individual map sheet.

Map Series #2 shows the state boundaries depicted at a larger scale and in greater detail. Other boundaries and jurisdictional lines shown in this series are those of counties and townships.

Another important aspect of this map series is the clarification and demarcation of ownerships of underwater lands in the New York Marine District on the governmental level. From this series, a quick glance should provide the information needed to determine who should be contacted concerning questions involving real property ownership and use by the public. Base title to land underwater should be readily evident. Due to the large scale of this map series, a set of six sheets is needed to give coverage to the whole New York Marine District. The Marine and Coastal District is defined in Environmental Conservation Law § 13-0103 to include "the waters of the Atlantic Ocean within three nautical miles from the coast line and all other tidal waters within the state, including the Hudson River up to the Tappan Zee Bridge."

The ownership of underwater lands (submerged lands) in the New York State Marine District is a conglomeration of federal, state, county, town

and private titles. It must be understood that all lands underwater in the area of study were at one time under the sovereign, which, except for the short duration of Dutch control, was the British Crown. All base titles are derived from this beginning. During the 1600's, colonial governors gave patents (charters) to individuals of wealth and importance, as well as to populations in local areas called townships, which were comprised of groups of settlers represented by trustees.

These colonial patents gave title to land and listed the benefits to be derived from that title. In most cases the grants to individuals were upland grants only. The grants to the trustees of the townships, however, were much more comprehensive and specified the benefits derived.

With very few exceptions the lands underwater within the Marine District are in three forms: (1) town ownership, (2) individual or corporate private ownership, either by grant from the state or by original patent, or (3) with New York State having title.

The interpretation of the legal boundary of New York State's waters may conflict with the exercise of jurisdiction over fishing, shellfishing, and lobstering in those waters where the state has historically exercised regulatory jurisdiction, i.e., those waters in Block Island Sound westward of the New York-Rhode Island boundary (as originally legislated) and eastward of the baseline and closing line drawn above in accord with the Convention on the Territorial Sea and Contiguous Zone (see Environmental Conservation Law § 13-0329(2), § 13-0311, § 13-0333, § 13-0335, § 13-0339). Without exception, all of the above statutes represent regulatory powers exercised by the state since at least 1911, and thus rest on a significant historical foundation.

It is submitted that in the absence of specific federal action that preempts historic and traditional powers of the state, such as the regu-

lation of fishing, shellfishing, and lobstering, the state should continue to exercise those historic and traditional powers in order to protect the public interest.

Map Series #3 is at the initial production stage. The maps and report will not be produced until the necessary funding and staffing are provided.

I note that the maps and reports for Series #1 and #2 are qualified as "preliminary" until those maps and reports have been approved by the N.Y.S. Department of State.

In closing I should like to stimulate your intellect as follows: I suggest that if you perceive an advantage or an inequity to your own personal or professional interests, as they are affected by the present status of underwater land ownership or jurisdiction, that you exercise your social, economic, physical and political influences to either promote the status quo, or to obtain an agreeable change thereto. To that end, I invite your participation.

SOME LEGAL CONSIDERATIONS RELATING TO NEW YORK MARICULTURE

Gary C. Newton
New York Sea Grant Law Center
State University of New York at Buffalo

Several legal restraints to mariculture are (1) obtaining property rights in the sea and its bed and (2) obtaining the necessary permits to utilize those rights. Does any federal or state legislation respond to these problems?

Only one federal statute specifically mentions aquaculture. Section 318 of the Federal Water Pollution Control Act Amendments of 1972 (33 U.S.C.A. § 1328 (Supp. 1977)) authorizes the EPA to grant permits providing for the controlled discharge of pollutants "associated with an approved aquaculture project under federal or state supervision." These permits are administered only by the federal government. They allow water quality standards to be exceeded within a project area. The Control Act Amendments also provide that pollution produced by a fish farming operation discharged into the waters outside the project area is subject to state administration (42 Fed. Reg. 25480, May 17, 1977, to be codified as 40 C.F.R. § 115). The availability of these permits fosters mariculture. The FWPCA does not, however, deal with the allocation of property rights in the sea.

Several other statutes concern marine resource utilization and are of interest to the mariculturist. Among these are the provisions of Chapter 9A of Title 16 of the United States Code--Preservation of Fishery Resources (§ 755 to 760g)--and the National Sea Grant College and Program Act of 1966 (33 U.S.C. § 1121 et seq.). These statutes enable the Departments of Commerce (NOAA), Interior, and Agriculture to support fisheries research. Other relevant enactments include the Outer Continental

Shelf Lands Act (43 U.S.C. § 1331 et seq. (1970)), The Coastal Zone Management Act Amendments of 1976 (16 U.S.C.A. § 1451 et seq. (Supp. 1977)), and the Submerged Lands Act of 1953 (43 U.S.C. § 1301 et seq. (1970)).

The Outer Continental Shelf Lands Act (OCSLA) declares "that the subsoil and seabed of the Outer Continental Shelf appertain to the United States and are subject to its jurisdiction, control, and power of disposition. . ." (§ 1332). Although the act declares that the United States has complete jurisdiction over the shelf, existing statutory provisions only allow the Secreatary of Interior to lease the shelf for extracting oil, gas, sulphur, and other minerals (§ 1337). A mariculture lease cannot be granted pursuant to the OCSLA.

The Coastal Zone Management Act (CZMA) authorizes the federal government to assist the states in developing management programs for their respective coastal zones. Although the act does not prohibit the states from including mariculture within their development scheme, it is clear that the CZM program was not designed to foster mariculture but to deal with our nation's energy needs (16 U.S.C.A. § 1451(i), § (1456(a) Supp. 1977)).

Although the federal legislation does not prohibit mariculture, it fails to respond to the needs of the commercial mariculturist.

How have the state legislatures responded to these needs in light of the lack of an adequate federal program?

The Submerged Lands Act of 1953 (43 U.S.C. § 1301 et seq. (1970)) left the regulation of coastal fisheries to the police power of the states. The Act provided that it is

> "in the public interest that (1) title to and ownership of the lands beneath navigable waters within the boundaries of the resepective States, and the natural resources

> within such lands and waters, and (2) the right and power to manage, administer lease, develop, and use the said lands and natural resources all in accordance with applicable State law be, and they are, subject to the provisions hereof, recognized, confirmed, established, and vested in and assigned to the respective States. . . . (§ 1311)."

Consequently, statues enacted in several states address the mariculturist's legal problems and may serve as models for future New York enactments.

Massachusetts has an aquaculture licensing provision limited only to shellfish cultivation. The statute authorizes an appropriate local official to "grant to any person an aquaculture license to grow shellfish by means of racks, rafts, or floats in waters of the commonwealth below the line of extreme low tide." (Mass. Gen. L. Ann. 130 § 68A (1974)). Licenses are initially granted for 10 years and may be renewed. The statute also affords the shellfish aquaculturist the exclusive use of lands and waters within 100 feet of his racks.

The Massachusetts legislation is significant. It seems to permit the use of the entire water column and not just the bed. It also provides the farmer with some protection for his property and product. Unfortunately, the act is limited in its application to shellfish culture. The pen rearing of finfish is not contemplated.

Florida's provisions are not limited to shellfish cultivation. The Florida statute empowers the state to lease submerged lands. It also permits the state to grant exclusive use of the bottom and the water column making pen rearing of finfish possible. (Fla. Stat. Ann. 253/68 (1975)). The provision for granting exclusive use of the water column makes the Florida legislation unique.

In order to obtain a lease or permit under the Florida statute, an

applicant must establish that his plan is consistent with the public interest. Furthermore, public hearings are required to provide the leasing authority with evidence of the public's concern and riparian owner's needs.

One other provision of the Florida statute is of interest. In consideration for a mariculture lease, the state either charges a fixed rent or a rental in combination with royalties from the profits of the enterprise.

The California approach is perhaps the most expansive. It has separate laws concerning mariculture, oyster cultivation, and domesticated fish. The California Mariculture Law (Cal. Fish & Game Code § 6480-6504 (Supp. 1977)) requires licensing of all mariculturists. The statute provides that the state may lease its water bottoms to the highest bidder in a public auction (§ 6492). The lessee is granted exclusive use of the area for a maximum term of 25 years.

The lessee is granted protection. He has exclusive rights to non-native marine life in the culture area (§ 6484). It is a misdemeanor for anyone other than the lessee to take or destroy this marine life (§ 6500). The state may even extend this protection to native species--if it is found to be in the public interest (§ 6484).

No lease shall be granted unless it is found to be in the "public interest" (§ 6487). Furthermore, in order to obtain a lease, the lessee must establish that the anticipated activities will be compatible with other uses (§ 6504). The mariculture act also directs the game and fish department to designate all public clamming areas and prohibit the leasing of such areas.

The oyster cultivation legislation (Cal. Fish & Game Code § 6510 et seq. (Supp. 1977)) is similar to the mariculture law. There is no pro-

vision, however, that would allow oystermen exclusive use of native oysters although non-native oyster species can belong to the cultivator.

The Domesticated Fish Law (Cal. Fish & Game Code §§ 6570-76 (Supp. 1977)) provides that licensed domesticated fish breeders may obtain permits which allow them to capture, breed, rear, and release anandromous fish in state waters (§ 6570). Since domestically raised fish are indistinguishable from wild fish, they cannot belong to the fish "rancher." Instead, they become property of the state upon release and may be taken by sport and commercial fishermen (§ 6573).

The New York statutory provisions, in contrast to those of Florida, are rather limited. They only provide for the lease of underwater lands for shellfish cultivation. (N.Y. Environ. Cons. L. § 13-0301(1)(McKinneys 1973)). There is no provision allowing one to lease a water column for the cultivation of finfish.

The statute provides a procedure for granting shellfish cultivation leases. The state delineates an area for lease and then surveys its shellfish population (§ 13-0301(6)). Residents of the state for at least 1 year prior to an application for a lease (§ 13-0301(3)) may bid at a public auction. Bids of less than one dollar per acre per year are not considered. Any bid may be rejected. Ordinary leases must comprise at least 50 acres. Leases for off-bottom culture of shellfish must cover at least 5 acres (§ 13-0301 (McKinneys Supp. 1977)). To protect the state interest, a bond equal to the total 10-year rental is required. If rent payments are not paid when due the bond and the lease may be forfeited to the state (§ 13-0301(12)).

New York also grants permits to raise and breed food fish in marine hatcheries (N.Y. Environ. Cons. L. § 13-0311 (McKinney Supp. 1977)).

These hatcheries have to be located on land, however, as there are no provisions granting leases to the marine bed for non-shellfish cultivation. Although hatcheries can be used in a fish "ranching" space operation, New York (unlike California) does not provide for the capture and release of these domestically raised fish.

There is little federal legislation that encourages or even permits commercial mariculture. Instead, Congress has been more concerned with exploiting the ocean's resources for national mineral and energy needs. Furthermore, with the passage of the Submerged Lands Act in 1953, Congress relinquished to the coastal states much of its authority over the territorial sea.

Coastal states have responded by passing laws governing mariculture operations. These laws tend to emphasize the production of shellfish. The Massachusetts and New York statutes provide only for shellfish cultivation. California has the most expansive law but does not provide for the leasing of water columns necessary to pen-rear finfish. Only Florida expressly grants use of the water column over the sea bed.

New York adequately provides for shellfish production but the statutes fail to contemplate the cultivation or "ranching" of marine finfish. If New York decides to develop finfish mariculture it must:

- Grant exclusive use to the water column as well as the sea bed.
- Afford, to the extent that it is possible, the mariculturist some property rights to his fish.
- Permit the capture of native species for use in marine hatcheries and subsequently provide for the release of the domestically reared fish.

Any new legislation would, of course, require that the mariculturists' use of public waters be reconciled with the many other uses.

A VIEW THROUGH THE PORTHOLE BY A COMMERCIAL FISHERMAN

Richard H. Miller
Long Island Fishermen's Association

I'm sure most of you people in attendance expect positive statements from the representative of commercial fishermen. I apologize now if I disappoint you. I and those in the industry have as many if not more unanswered questions about aquaculture as you.

Before all else, we would like people to define exactly what they mean when they say aquaculture, mariculture, shellfish farming, fish farming, etc. It appears that this field can be as varied in its application as the commercial fishing industry of today and will in turn have as many if not more problems as the current marine users.

It has been advertised from high places that aquaculture is the wave of the future. Most commercial fishermen will point out to you that there is only very limited success in this field in the United States. The greatest success to date appears to be in receiving grants. The publications on successful aquaculture systems in some foreign nations have left many of our commercial fishermen with a case of the frights. Many of these publications have pictures of embayments completely covered with rafts, or coves blocked off with net barriers. They visualize free access being denied. They wonder where they will fit in this great wave of the future. I'm sure they will all tell you they are not prepared to go away or step aside. Their will to survive and their desire to remain should not be considered lightly.

If you will allow me, a few personal comments! The waters of New York State must be considered as one of the most important natural resources in control of the state - perhaps even more important than the living resources in it. Today it is available in most instances to all

who wish to share in its use: the marine traffic that move goods in commerce, the recreational and commercial fishermen, those that honor it for its esthetic value, the bathers, and others. All use it in imperfect harmony. They all use, but none own it nor do they have exclusive use of it. We all leave footprints in one fashion or another and we have many laws on the books. If boiled down they say "recognize the rights of others to use." I ask how does aquaculture fit into this? Does it say it wants a place amongst the crowded users? Does it say because it's a promise for the future, it should be given special consideration? Or does it say because of its promised importance it should be given sole use?

Although I've been allotted 5 minutes to address you, I would prefer that the remainder of my time be allotted to discussion. I need to be educated; perhaps you can help.

FISH FARMING - THE STATE OF NEW YORK AND MULTI AQUACULTURE SYSTEMS, INC.

Robert J. Valenti
Multi Aquaculture Systems, Inc.

As a representative of a new aquaculture concern we have for the past 2 years attempted to acquire federal, state and county permits necessary for operation of our particular fish farm. These permits include a well permit to pump subsurface seawater, a tidal wetland permit to place a land based fish hatchery adjacent to the coastal zone, a State Pollution Elimination Discharge permit necessary to discharge our hatchery water back into navigable waters, and an Army Corps of Engineers permit to moor floating net pens in navigable waters. In addition we have had to obtain various local zoning and planning approvals in order to site our land base operation on the east end of Long Island. A complete rendition of our struggles to exist are well documented in some thousand pages of public record which was compiled from over 15 public hearings dealing with various aspects of our project. Rather than describe the specific problems faced by our organization in the short amount of time allocated for this presentation I would prefer rather to make specific recommendations which might serve as guidelines for future legislation to aid the aquaculture industry in New York State.

I. A major obstacle to acquiring our permits, which I understand has been corrected somewhat, is the duplication of effort and expense resulting from segmenting the public hearing portion of the permit process for one operation instead of unifying it. For example, it should be possible to publish public notices and hold one public hearing for state well, tidal wetlands, and SPEDS permits. This will necessitate changing the various

response times after publishing public notices so that they are the same. Presently the response time runs from 11 to 30 days depending upon the specific permit applied for.

II. Permit agencies should be made aware of the nature of various forms of operation within the aquaculture industry. Much of the delay that Multi Aquaculture Systems, Inc. encountered was due to a lack of understanding as how to treat a fish farm within the confines of the present permit statutes. However, it might be expected that the learning processes acquired by all parties concerned during our applications will make it somewhat easier for other finfish aquaculture ventures to establish within the state in the future. For example, it took us 6 months to determine that a fish hatchery effluent permit was in existence and that we should file under this category. Prior to this we were told we would be considered under duck farm guidelines. Furthermore, the entire question of floating net pens anchored in sheltered waters had to be addressed by the Army Corps of Engineers to determine what category to consider them under. Many of these problems might be avoided if the various permit agencies were aware of the treatment accorded to the aquaculture industries in other states such as Maine and Washington. The problem of how permit agencies should treat an aquaculture industry is worsened by the emotional stand taken by various environmental groups, as well as advisory industries such as real estate. The difficulties presented by working on coastal zones with adjacent high residential property values is monumental and will prove to be a major impediment to the mariculture industry. Shrewd zoning allowing the existence of marine industrial parks may be one answer to this problem. Another would be the consideration by the State that aquaculture is a preferred use in coastal zones.

III. The present N.Y. State laws prohibit the sale of aquaculture products, in particular specific finfish, unless they meet minimum legal size limits. These minimum market sizes are a result of the Department of Environmental Conservation's efforts to protect the wild resources and were not intended to restrict aquaculture. Nevertheless, one of the prime finfish aquaculture candidates in New York State, the striped bass, is severely restricted from culture due to the inordinate growing time involved to meet the minimal size standards. The production of "pan-sized" striped bass has been proposed by Multi Aquaculture Systems, Inc. and production from egg to a 1-pound, 12-inch fish can be accomplished within 16 months. In order to reach the present legal size limits it will take approximately 30 months of intensive culture. It is our suggestion that the present marine hatchery law which is enforced by the Department of Environmental Conservation be modified to allow the sale to commercial markets for consumption or resale of any sized farmed organism, as long as they are cultured from embryos, collected and cultured within the confines of a controlled environment. In the particular case of striped bass, in order to differentiate cultured and wild caught products in the market, it would be a simple procedure to have coded tags issued by the Department of Environmental Conservation (at the aquaculturists expense) and inserted on the product at the time of harvest. It should be clearly stated that these proposed revisions in the Marine Hatchery Law would have no bearing on the commercial or sport fishing minimum standards since these are dealing with a wild resource.

IV. Lastly, I fell it essential that in the eyes of the law, aquaculture and agriculture should be equated so that aquaculturists may reap some of the benefits associated with other food production industries. To some extent

this is already being done on a federal level with recent approval by a House-Senate Conference Committee of a new agriculture bill. (S. 275/H.R. 7171). This bill will greatly expand the role of the U.S. Department of Agriculture in the development of the aquaculture industry in the United States. It is my hope that New York State will support these measures so that the well established agriculture research, extension, and economic assistance programs can be provided to this new industry.

COMMENTS OF A BAYMAN

Thomas B. Rhodes
Great South Bay Baymen's Association, Inc.

Throughout the history of Long Island, people have turned to the sea during periods of economic hardship. Today is no different. Record numbers of shellfishing permits have been issued over the past year. Faced with unemployment, more and more people are turning to the Great South Bay as a means of providing support for their families. Shellfishing in Suffolk County is a major and basic industry in terms of employment and impact on the local economy. The shellfish industry's effect on the community, both socially and economically, is considerable.

The shellfish resource of our bay is finite, but renewable. Without proper management, however, the industry will be threatened by overfishing, pollution, and destruction of habitat. The baymen do not believe that leasing acres of our bay bottom to private companies is the answer to these problems. In our estimation, leasing will only create greater problems for the baymen than those that presently exist.

The average bayman has neither the equipment nor the finances to become involved with leasing plots of bay bottoms to farm shellfish. It would be impossible for him to compete with the larger companies. In effect, the individual bayman would become obsolete. Large companies would eventually monopolize the entire bay.

We have already lost a great deal of bay bottom to pollution. If leasing were to become a reality, public clam beds would be virtually non-existent. Even if the individual baymen were still able to work in public beds, it would be impossible to compete with the large companies, once the shellfish were harvested. The market would become flooded by the efforts of the companies. The price of a bushel of clams would be

driven down so low, it would be impossible for the bayman to earn a living. The economic impact of this is obvious, not only for the bayman, but also for the entire community.

One has only to look at the oyster industry to see my point. A few companies have a monopoly on the oyster industry. Harvesters of natural oysters cannot compete with the harvestors of cultured oysters.

Instead of leasing, we would rather see the towns increase their spawning programs and perhaps even begin seeding programs of their own. Conservation and management must be fair, equitable, and take into account the needs and attitudes of all fishermen and citizens. It is our opinion that leasing will not accomplish these goals. I pray that we can work together to find suitable measures to protect the future of our bay. We must preserve the shellfish industry for the thousands of people who depend on it as a means of support, rather than turning it over to a rich few.

POLYCULTURE IN PRIVATELY OWNED TIDAL BASINS

William H. Swan, Esq.
Dolphin Lane Associates, Ltd.

This morning we had a superb pictorial presentation by Butler Flower of the Long Island Shellfish Farmer's Association. He showed what is going on at Long Island's --and I assume New York's-- only established private shellfish mariculture enterprises. There are five of them: the Frank M. Flower & Sons plant at Bayville; the giant Long Island Oyster Company, whose operations include the Northport hatchery, pictures of which we saw, as well as a large processing plant at Greenport and thousands of acres of oyster grounds extending along the shores of Connecticut; the Great South Bay operations of the Bluepoints Company; and the Hart family's Shellfish, Inc. All four of the above have large areas of leased or owned bottoms in otherwise public waters, on which they grow and harvest their shellfish products. We also saw pictures of the fifth mariculture operation, John Plock's Shelter Island Oyster Company farm, operated largely out of private ponds dug into privately owned land in Southold Town.

I represent an aquaculture venture similar to Plock's in that it operates in private lagoons, ponds, and raceways. Dolphin Lane Associates, Ltd., owns large tracts of partially diked, dredged, and filled marshes and meadows on the barrier beach side of Shinnecock Bay in Quogue and East Quogue, New York. That bay, which was in nature closed, has been opened by man to the tidal influences of Peconic Bay and the Atlantic Ocean.

Dolphin Assoicates came into the mariculture field indirectly. In 1972 the New York Tidal Wetlands Act was conceived. Seemingly the only permitted and potentially profitable use to which Dolphin could put its marshes and

meadows was aquaculture. As Dolphin's manager I'm a lawyer, not a marine biologist or farmer. Thus I had to seek out informed advice on how to go about the development of a successful aquaculture venture. Since 1972 I've followed the aquaculture star. It's been like a mirage that recedes in the distance as one approaches. From a profit point of view, the mariculturists' track record has not been good. But here in America under the impetus of Sea Grant funding and around the world under government and private funding, technological breakthroughs are reducing mariculture risks and opening new opportunities.

Out of some 200 acres of wetlands, we decided that an existing 50-acre marina-restaurant-recreational complex offered us our best starter location for data collection and experimentation. This area had been partially diked, dredged, and filled. In addition to shallow natural ponds there were deep dredged lagoons. On the east a dredged navigable channel led into the basin from a natural public channel. On the west a small non-navigable drain led through the marshes to the bay. Our circulation was thus not dead-ended. With but slight dredging and tide-gating we could develop tidally flushed circulatory patterns.

The trail and error path of Dolphin explorations was darkened by my own near total ignorance of aquaculture. First, I had to find out what types of aquaculture might be suitable to our situation. This meant finding out what we had and what would grow there. We studied available data on Shinnecock Bay, its hydrodynamics, its biota. By contract with National Ocean Survey of the United States Department of Commerce we installed a tide gage. Through the good offices of Drs. John Baiardi and Anthony D'Agostino of New York Ocean Science Laboratory at Montauk, I attended the Tenth European Symposium on Marine Biology at Ostend, Belgium, in September 1975. There I

entered into a whole new world of mariculture experiences. The week-long affair covered two topics: The first, "Mariculture at Laboratory and Pilot Scale", emphasized the culturing of food and culturing to recycle biodegradable wastes. The second topic, "Population Dynamics of Marine Organisms in Relation to Nutrient Cycling in Shallow Waters", was especially of interest to me. I had to learn a new language.

The scientists took me into their rap sessions and were most considerate in explaining in layman's language things I did not understand. After Belgium, I went to the Netherlands, France, and England, then on the advice of American scientists I met in Europe I immediately attended our Estuarine Research Federation biennial meeting in Houston, Texas. Thereafter I studied what the small operators were doing on the Atlantic coast. The following year I had a visitation from Dutch scientists and shellfish buyers. I was able to reciprocate the hospitality they had extended to me. We visited all the Long Island and Connecticut shellfish farming endeavors, including those Butler Flower referred to. We also visited Dr. D'Agostino's lobster experiments at Montauk. Out of these experiences I came into an awareness, first, of a potential European market for European oysters (Ostrea edulis) and other products we might grow in our basins, and, second, of the possiblities of polyculture that would combine farming of molluscs and crustaceans.

With Professor Larry Penny of Southampton College as our guide, Dolphin embarked on growth data gathering for off-bottom culture of trayed clams (hard and soft), European oysters, mussels, and scallops. The growth results were very encouraging. Our only major disappointment came in the severe 1976-77 winter which caused total mortality for our European oysters.

We are still gathering growth and market data. Our next major step will be in the field of engineering. It appears that both scallops (Aequipecten

irradians) and European oysters (Ostrea edulis) can be grown to market size in our basin within the year if started in nursery conditions during the winter. We need a properly designed physical plant including greenhouses and water control devices. The flow-through circulation in our basins will have to be modified appreciably to reduce handling costs and to accommodate enhanced growth under high density conditions. We have yet to explore the use of fertilizers and nutrient additives to enhance plankton density for feeding. The location we have on the beach barrier has the advantage of combining shelter with a better than 2-foot average tide. Our plans call for the development of solar, wind, and tidal energy sources to provide for:

-food chain dynamics,
-movement of water horizontally and vertically for nutrient and gaseous exchange, and
-temperature control for maximizing growth, over-wintering, and maintaining oxygen levels in summer.

Our greatest asset is that we own the land we farm. These are private, not public areas. But our investment risks are high, and financing is difficult. We need all the technical and financial support we can get from governmental agencies if we are to realize the multi-use potential of our polyculture project. I would recommend that low-interest governmental loans and crop risk insurance be made available to the mariculture farmer even as they are available to the terrestrial farmer.

MARICULTURE AND THE COMPATIBILITY OF MULTIPLE USERS INTERESTS

Dr. William A. Muller
Editor, The Long Island Fisherman*

Mariculture today is a concept and practice that stimulates many ambivalent feelings among people as we have seen here today. Mariculture is a reality and in some countries like Japan, Norway, and the United States, the heritage of mariculture is more than 80 years old.

Today, there are about a dozen major countries engaged in mariculture projects and the list grows each year. Furthermore, it would be unfair to single out shellfish as the major creatures of interest since the history of finfish and plant culture is diverse and well established too. More than 85 years ago Norway began mariculture of the Atlantic codfish and that technology has the ability to produce about 150 million larvae on a biannual basis. Similarly, Japan rears salmon for release into the Pacific, and other countries have either investigated or are culturing mullet (Italy), tarpon (Ceylon and India), shad (U.S.), and the U.S.S.R. has begun an experimental project with haddock.

It is true that most marine finfish culture works towards the goal of the release of juveniles into the ocean; nonetheless, scientists in each of those countries are convinced that their programs significantly enhance the harvest of those species by their domestic commercial fishermen.

However, one should not hold to the idea that finfish cannot be successfully cultured from either the egg or larval stage to marketable size in closed systems. Certainly enough evidence indicates that many

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*Dr. Muller is also Chairman, Dept. of Life Sciences, New York Institute of Technology and President of the New York Sportfishing Council

species of marine finfish are suitable for controlled culture. In Japan for example, 91 metric tons of puffer (Fugu), 101 metric tons of black porgy (Mylio), and more than 20,000 tons of eels (Anguilla) are produced annually on closed system farms. Furthermore, in Southeast Asian countries, multiple species (mostly milkfish) can be raised in ponds for human consumption. The technology produces about 150 kg/ha/year. The United States has a similar technological capacity to produce croaker (300 kg/ha/year) and a multi-species approach (mostly mullet) in South Carolina has a productivity of 206 kg/ha/yr.

Admittedly, the degree of citizen concern about mariculture activities varies considerably from country to country. In Southeast Asia, the principal concern of the layman is the potential food produced by such operations. In France, Japan, Spain, and Australia where shellfish culture is an established industry, the main concern is jobs that are created for the people by the industry, and export of the products.

However, in the United States we must recognize that we have a pattern of life styles that does not parallel those in other countries. For one thing, our great personal wealth and available leisure time have turned many areas of the coastal ocean into a playground, where we dive, fish, sail, powerboat, water ski, swim, and engage in a host of other related activities. Second, we are a country of rugged individualism and we have learned to work from the land, not just as terrestrial farmers, but as baymen and finfish harvesters. Our shellfish- and finfish-rich estuaries have helped to promote this way of life. Yet, the first and the second items were destined for conflict from the outset.

The nature of our affluent life styles leads us in the direction of owning property in proximity to our playgrounds. Therefore, our play-

grounds soon become our homes. Nowhere is this more true than on Long Island where several million people have succeeded in achieving their dream of living minutes from the water, only to discover that their dream was not unique and that many of the privileges and benefits that they sought were either lost or diminished under the crunch of millions. The result has been poor water quality, less space, dwindling access, increased pressures on our sportfisheries, increased pressure on our shellfish grounds, and the evolution of a plethora of rules and regulations that interfere both with the realization of dreams and the exercise of commerce. This has been true not only for the suburban homeowner, but also for the descendents of original settlers who choose to live with the sea rather than the factory or the farm.

The declining quality of our environment and its resources has brought about a significant level of awareness. We have all learned which questionsto ask! "What will that do to me?" "Will I still catch striped bass if you pass that law?" "Will I still be able to make a living for my family digging clams if bed after bed is allowed to become contaminated and then closed?"

These are justified concerns. There seems to be little flexibility left. In the early days of this century, pollution and population eliminated many commercial areas in western bays. These same factors brought about drastic declines in the availability of western areas for recretional activities as well. However, it was possible to move east. Today, we have reached a point where we cannot go any further eastward unless we grow gills and learn to breath sea water. No, we must face the reality. We must learn to both understand and use the resources together. This will not be easy but it is not impossible either.

Let's make no mistake. Mariculture is here to stay. Perhaps it is a fledgling barely out of the nest and perhaps the technology can only be characterized as basic and primitive but it is a fledgling that will soon grow to its full adult potential. Now is the time to plan so that we may approach mariculture projects and technologists in such a way that they will become servant to man rather than man's harassing conquerer.

The potential benefits for man are staggering. Even in the toddler stage of development, tremendous quantities of shellfish can be produced on an annual basis. Consider the following statistics. As of around 1970, France produced about 47,000 metric tons of mussels, 9,000 metric tons of flat oysters, and 60,000 metric tons of Portuguese oysters. Spain produced 150,000 metric tons of mussels annually. The Philippines' annual production of mussels was 2,000 metric tons with a similar production of oysters. Japan produced 45,000 tons of oyster meat and 1.2 million metric tons of wet algae annually. Australia produced 1 million kg of oyster meat annually, and the United States produced 5,000 kg/ha/year of oysters.

Is this kind of cultured production meaningful and significant? Does it really feed people? Does it really employ people? Raw numbers are often impressive, but what do they really mean? How does mariculture production compare with nature? I have previously offered the statistic that in the United States we produce about 5,000 kg/ha/year of oyster. For comparison, production on public grounds by natural processes was between 10 and 100 kg/ha/yr. Thus in 1970, the capabilities of mariculture production were between 50 and 500 times greater than public grounds!

This should be taken as evidence that mariculture offers great future potential. However, this should not be taken to mean that future mariculture projects will replace the need for natural harvesters. Mariculture will probably always be merely supplemental to natural harvest simply because the technology can only be applied to limited areas.

If we are limited in the areas that can be used for mariculture, where are these? Power plant effluents immediately come to mind, as do the bottoms of estuarine areas where natural production is either minimal or non-existent. Then, too, we must consider the feasibility of using remote and sparsely populated areas for closed-system cultivation of marine organisms.

This brings us to the concept of leasing. Should we permit bottom leasing? If so, where, when, and how? Again, there is nothing new about leasing estuarine areas for the purpose of mariculture! There are at least four major countries with leasing programs. France employs 25-year term renewable leases, Spain also has renewable leases for 10-year terms and the user pays a modest fee. Australia and the United States also have leasing rules, regulations, and procedures.

Do we need mariculture? Will mariculture provide significant food for tomorrow's world? Will mariculture create jobs? Will mariculture spin off technology that will benefit recreational activities and natural harvesting? I believe that the answers to these questions are YES!

The key to achieving compatibility between these elements is planning and management. The decision to lease should be based upon a number of factors. Some of these include:

- Will the operation interfere with navigation?
- Will the operation remove valuable public grounds from access?

- Will the operation interfere with recreation?

To answer these questions, bottom leasing does not interefere with navigation. Second, finfish farms might be limited to salt ponds constructed for that purpose or we might designate "dead end" areas of estuaries for that purpose. As far as public access to public grounds, this could become a problem, but we could easily avoid this concern by limiting lease areas to unproductive bottom with the provision that when a natural set of other than the cultured species occurs, the culture operation be removed until harvesters have had reasonable time to work the area.

Recreational activities are least likely to be affected. Most shellfish cultivation is best done in fairly deep water so that surf fishermen, swimmers, and water skiers should not be significantly affected.

Furthermore, bottom shellfish beds usually encourage the establishment of populations of fish especially porgy, seabass, flounder, fluke, and other bottom dwellers. Presence of the smaller species attracts the larger predators such as striped bass, weakfish, and bluefish. In short, fishing usually improves in these areas and public access could be assured through mandate of the law.

Thus, the management of future interests of multiple user groups can be made compatible through the exercise of intelligent and mature planning. Regulations and laws can be written to protect the basic rights of all interest groups. I believe that this can be achieved. However, we should be on guard that in our zeal to protect the rights of the human species we do not overlook our primary responsibility to the environment. We must not spend all of our energies on ourselves to the exclusion of marine species. They too must be remembered as part of the "MULTIPLE

USER GROUP" and the way I see it they have first rights!

We have already drastically altered our marine environment through the destruction of wetlands, chemical and human waste pollutants, and overharvesting. The key is planning and management. We have the potential technology to achieve all of these goals, but effective implementation will require the use of calm and knowledgeable deliberation.

MARICULTURE SYMPOSIUM SUMMARY

Anthony S. Taormina
Director of Marine Resources
NYS Dept. of Environmental Conservation

From what we have heard, it is apparent that the business of mariculture exists and is actively thriving in parts of Europe and Asia. From our point of view, mariculture can be defined into two basic categories:

1. Public management of public lands to maximize production of a resource, such as what the Town of Islip is doing in Great South Bay for the hard clam resource as reported by Mr. Stuart Buckner;

2. Private development of a resource on either privately-owned or leased public land, such as the culture of oysters in Oyster Bay as reported by Mr. Butler Flower.

Considering that the oyster is the second most valuable marine resource harvested (based on landings) on Long Island, one must conclude that its value is derived from intensive private mariculture activities. Although we tend to think of mariculture primarily as an animal program, in terms of worldwide productivity plant mariculture significantly exceeds that of animals, according to Dr. Neish. Dr. Neish anticipates that the interests of mariculturists on the Atlantic Coast will soon be moving in a similar direction.

Currently, profitable mariculture operations include the rearing of oysters, mussels, and the Japanese prawn. As Dr. D'Agostino said, solving bio-technical problems in mariculture is of little value if the total operation cannot become economically feasible.

Beyond the bio-technical and economic restraints to successful mariculture, there are also two significant legal restraints: 1) obtaining rights to the sea bed and the water column; and 2) obtaining the required permits.

Perhaps one of the most important points to be recognized today is that there is a great reluctance on the part of fishermen, baymen, and others to allow one party to obtain exclusive sea bed rights. Inasmuch as many people turn to making a living from the sea in times of economic stress, baymen and other fishermen are opposed to leasing underwater lands to private companies or granting any one party exclusive use of any portion of the publicly-owned sea bed.

On the other hand, potential mariculturists such as Dr. Robert Valenti and Mr. William Swan believe that they should be given the opportunity to sea farm, inasmuch as their activities will provide food and jobs to the economy. The issues are complex, and are as much sociopolitical as they are bio-technical and economic.

Therefore, I suggest that we move in the following direction:

1. Continue the Mariculture Committee so that it can:

    a. Publish, and make available to the public, the papers presented at this meeting;

    b. Aid the various involved public agencies in developing mariculture policies.

2. Propose to the State Legislature, and in particular the Assembly, that a separate sub-committee on marine resources be established within the standing environmental committee under the chairmanship of Mr. O. Koppel.

3. Allow the creative talents in our society an opportunity to develop mariculture programs in line with reasonable guidelines.

4. Review and offer comment on Senator Smith's proposed Marine Fisheries bill, Senate No. S-5704, as it relates to aquaculture.

Addresses of Speakers and Panel Chairmen

Dr. John C. Baiardi
New York Ocean Science Laboratory
Box 867
Montauk, New York 11954

Stuart Buckner
Town of Islip
Department of Environmental Control
577 Main Street
Islip, New York 11751

David M. Chase
Sea Grant Extension Program
246 Griffing Avenue
Riverhead, New York 11901

Dr. Anthony D'Agostino
New York Ocean Science Laboratory
Box 867
Montauk, New York 11954

Dewitt Davies
Long Island Regional Planning Board
H. Lee Dennison Building
Hauppauge, New York 11787

Dr. Wayne Durfee for Dr. Thomas Meade
Department of Animal Science
University of Rhode Island
Narragansett, Rhode Island 02882

H. Butler Flower
Frank M. Flower & Son
P.O. Box 92
Bayville, New York 11709

Stephen A. Hendrickson
New York State Department of Environmental Conservation
Building 40
SUNY at Stony Brook
Stony Brook, New York 11794

Richard Miller
Executive Secretary
Long Island Fishermen's Association
Box 816
East Quogue, New York 11942

Dr. William A. Muller
The Long Island Fisherman
Long Island Fisherman Building
Bridge Street
P.O. Box 1994
Sag Harbor, New York 11963

Dr. Iain C. Neish
Vice President of Research and Development
P.O. Box 2610
Dartmouth, Nova Scotia
Canada B 2W 3E0

Gary Newton for Dr. Robert Reis
Faculty of Law and Jurisprudence
SUNY at Buffalo
O'Brian Hall, Room 425
North Campus
Amherst, New York 14260

Richard C. Ryan
New York State Department of Environmental Conservation
Building 40
SUNY at Stony Brook
Stony Brook, New York 11794

Thomas Rhodes
Great South Bay Baymen's Association
West Sayville, New York 11796

The Honorable Bernard C. Smith
New York State Senate
Franklin Street
Northport, New York 11768

William H. Swan, Esq.
Dolphin Lane Associates, Inc.
Box 758
Hampton Bays, New York 11946

Dr. Robert J. Valenti
Multi Aquaculture Systems, Inc.
P.O. Box 679
Amagansett, New York 11930