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AN OVERVIEW OF THE INDIAN RIVER CLAMMING INDUSTRY AND THE INDIAN RIVER LAGOON

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FLORIDA SEA GRANT COLLEGE

AN OVERVIEW OF THE INDIAN RIVER CLAMMING INDUSTRY AND THE INDIAN RIVER LAGOON

A collection of papers prepared in connection with the Brevard County Clam Industry Workshop held September 7, 1985 at the Florida Institue of Technology, Melbourne, FL.

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INTRODUCTION

OVERVIEW OF THE INDUSTRY

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The Indian River is, in fact, a lagoonal system extending one hundred and forty miles along the eastern coast of central Florida and separated from the Atlantic Ocean by an extensive series of barrier islands. It is connected to the ocean by four man-made inlets which exchange some 10 billion gallons (less than 5% of the Lagoon's volume) of water with each tide (Ryther, 1984). The fact that the Lagoon is open to the ocean and diluted by freshwater inputs from natural tributaries (as well as a system of managed canals) qualifies the Indian River Lagoon as an estuary.

Estuaries, such as the Indian River Lagoon, where freshwater and saltwater interact, are among the most productive ecosystems on earth. In Florida, estuaries provide food and shelter for over 70% of the State's catch taken in commercial and recreational fisheries (Haddad, 1984). Many species are dependent upon the estuary during some, if not all, of their life cycle. One such species which has recently experienced a rapid growth in production and value is the hard clam, Mercenaria mercenaria.

Generally, the term "clam" is applied to a wide variety of two-shelled (bivalve) mollusks such as the quahog, northern hard shell and southern hard shell or venus clam. A clam is a mollusk with two shells and two abductor muscles which are used to open and close the shell. Adult clams also have a muscular "foot" which is used to burrow into sand or mud substrates. Additionally, clams have siphons or "necks" which draw seawater into their mouths where microscopic plants, animals, and oxygen are removed through filtering (Stewart).

The northern hard shell clam carries the scientific name of Mercenaria mercenaria and the southern hard shell is Mercenaria campechiensis. Mercenaria comes from the Latin word for money or reward. In the past, the shells of these bivalves had monetary value as Indian wampum. Campechiensis is derived from Campeche, Mexico where the original specimen used to describe the species was obtained in the late 1980's (Stewart).

The word "clam" has been derived through time. Early American settlers couldn't pronounce the name used by the Narragansett Indians, "Poquahock". They referred to quahogs (a bastardization of "poquahock") as "clamps" which was later shortened to "clam" (Stewart).

The east coast of Florida comprises the southernmost extent of the range of the northern quahog which extends as far north as Nova Scotia and the Gulf of Saint Lawrence. These clams have also been introduced to the waters of Florida's west coast near St. Petersburg and a small fishery now exists there. Southern quahogs occur from the Chesapeake Bay to as far south as the St. Lucie Inlet. They also are found in the Gulf of Mexico, the Yucatan and Cuba.

The Indian River Lagoon provides excellent habitat for clams who prefer moderately hard sandy bottoms and salinities from 20 to 35 parts per thousand. The calm, shallow flats of the Lagoon are ideal for the clam which may be found from just below the surface to depths as great as 50 feet (Stewart).

As the Autumn season approaches and water temperatures within the Lagoon fall to approximately 23 degrees centigrade (73 degrees fahrenheit) spawning begins. Females are stimulated to release eggs by the discharge of sperm by the males. Clams are protandric hermaphrodites meaning that they change sexes during their lifetime. Approximately 8% of them begin life as males with half later changing to females (Stewart).

Fertilized eggs quickly produce a free-swimming larvae ringed with tiny hair-like cilia and within six to ten days the foot, shell and body begin to develop. The animals are widely dispersed during this free-swimming stage by wind-driven tides and currents prevalent in the Lagoon. As the shell develops, the young clam (veliger) falls to the bottom where it secretes byssal threads to allow temporary attachment to seagrasses, algal mats or sediments. Once the foot is developed, the clam can burrow into the sediment.

Growth rates in Florida waters may be three times that of clams living in northern waters. In Tampa Bay, clams have attained a size of 2 1/2 to 3 inches by the end of their second year (Stewart).

Economic Importance

Florida, commercial hard clam production was first described in 1880. A large increase in production was reported in 1908 when extensive beds in the Ten Thousand Islands area were being harvested. These beds were in excess of 150 square miles. Since then, clam harvests have fluctuated with a low of 4000 pounds being recorded in 1960. Historically, Statewide annual harvests have averaged around 69,000 pounds with an average dockside value of $53,000 (Stewart). In Brevard County since 1975, landings have averaged 246,785 pounds worth $786,235 dockside (NMFS). However, changing climactic conditions within the last few years have contributed to significant increases in clam populations within the Indian River Lagoon. Since 1982, clam harvests have rocketed with 1,708,379 pounds of meats worth $6,130,783 landed value reported for 1984 (NMFS).

In the past, increases in the clam population have been attributed to increased salinities within the Lagoon favorable to clams. Now, however, some researchers believe that the increase in nutrient level entering the Lagoon, due to man's influence, may serve as additional food sources allowing for more mature and young clams (see Ryther in this publication). Also, contributing to this phenomenal increase in production, is the advent and practical application of depuration technology. Depuration is a method which allows for the rapid cleansing of clams harvested from polluted waters.

The Florida Department of Natural Resources establishes acceptable bacteria levels for waters from which clams are harvested in line with federal guidelines. The Department continually monitors harvest areas and establishes areas from which clams may be sold directly to consumers (approved areas) or from which clams must be cleansed (unapproved areas or conditionally approved areas when closed by D.N.R. biologists) prior to sale.

The two methods used to cleanse clams are depuration and relaying. Relaying consists of transferring clams from polluted areas to areas within approved zones where bacteria levels are low enough to allow sale of harvested clams to the public.

Clams are placed within these areas for approximately two weeks on submerged lands leased from the State. Presently, there are 96 shellfish leases covering some 786 acres of State owned bottom in Brevard County. These range in size from less than 1 acre to 92 acres (Ednoff). Testing by State-certified laboratories allows harvesters to know when clams have acceptably low levels of bacteria and are eligible for sale. The relatively slow turnaround time associated with relaying clams has brought about the application of depuration methods. Depuration is a process where clams are placed in land-based tanks and water is pumped through the tanks. The water is cleansed by subjecting it to ultraviolet light which kills bacteria. Using this method, the clams will generally purge themselves of undesirable bacteria within 72 hours and actually be "cleaner" than clams harvested for direct sale or harvested after relaying.

Within the last 2 years, there has been a marked increase in the number of depuration facilities operating in Brevard County. In 1983, there was only one such facility operating, whereas there are now five facilities within the County. This rapid increase in the use of depuration coupled with clam population increases may be credited for the phenomenal growth in production since clams may now be harvested from areas unapproved for direct sale and during times of high rainfall when conditionally approved areas are closed by F.D.N.R.

Management Problems

This tremendous growth within the industry has not been without its accompanying problems. As previously mentioned, the advent of depurationtechnology has caused nearly relentless fishing pressure to be exerted on the clam beds. Additionally, the economic success of the clamming industry in the Lagoon has attracted clammers from many other clam producing states. Daily earnings in excess of $300 have brought clammers from as far away as Massachusetts. Florida does not have a residency law as do many northeastern states which would forbid out-of-state clammers from entering the fishery before first establishing residency. This has allowed large numbers of transient clammers to come to Brevard County and harvest clams during the winter months when northern beds are inaccessible. While some have stayed to make their homes in the warmth of the Florida climate, many more have taken their harvests and their earnings back to their home states when beds there reopened. While many local clammers credit the northerners for their industrious natures and for introducing more efficient harvesting methods and techniques to Florida, many also feel a degree of animosity towards these out-of-staters. The locals feel that these clammers (who do not have a vested interest in the resource) simply do not care about how it is treated or whether it will continue to provide a dependable livelihood in the future. They feel that the additional pressure created by the northerners will cease only when the resource is depleted and the out-of-staters return to their home states, leaving behind nothing but a memory of what once was.

This influx of northern clammers has also placed additional burdens on the enforcement branch of the Florida Department of Natural Resources. The Florida Marine Patrol is responsible for enforcing rules and regulations relating to marine resources including clam harvesting and relaying. With a limited number of officers to patrol the entire length of the Lagoon, and with the numbers of clammers sometimes approaching a thousand during the winter months, the Marine Patrol has been severely taxed.

A Marine Patrol officer must be present when clams are harvested from

conditionally approved or unapproved waters for the purpose of relaying to leased areas in approved waters. Even though the "relay teams" will consist of ten or twelve boats, the large numbers of clammers present during the winter makes it difficult for the Marine Patrol to insure that all clams harvested from polluted waters are, in fact, relayed or depurated prior to sale. This situation has necessitated that off-duty officers be employed (at the expense of the clammers themselves) to monitor these activities.

While this association of clammers and officers is seen by some as constituting a conflict of interest, others argue that this practice has actually improved enforcement since the officers have become increasingly familiar with the clammers, their methods, and the resource itself.

As with any fishery, basic information about the biological functions of the species involved is needed to make sound management decisions. A basic problem facing the fledgling Indian River clamming industry is a lack of knowledge and research applicable to the resource. Information about such factors as size and locations of beds, migration of beds, survival rates of seed clams in different habitats, recruitment rates, seeding success and predation are needed to help understand how much fishing pressure the resource can withstand.

Recently, the opening of a flood control canal by one of the water management districts caused decreased salinity levels in clam harvesting areas and was sited by industry as causing a 10-20% die-off in harvested clams for a two-week period following the opening. The water management district has expressed great concern over the effects of canal openings and has turned to the scientific community to help determine such effects. Unfortunately, at this time, that kind of specific information does not exist and serves to illustrate the need for increased efforts to gather solid background data. Additionally, an ongoing monitoring system of the size and extent of beds and numbers of clams would be extremely useful in making management decisions and would play an important role in protecting the resource from over harvesting.

Future Outlook

In attempting to predict what will happen to the Indian River Lagoon clamming industry, it must be remembered that the health of the industry is intimately tied to the health and well-being of the Lagoon itself. The Lagoon, and the industry which it nourishes, are now entering a new period in their history. Awareness about the Lagoon and the natural systems comprising it is on the upswing.

Serving as a focal point for research and information about the Lagoon, is the Marine Resources Council of East Central Florida. The MRC has launched the Indian River Lagoon Initiative to investigate and research the environmental, social, and management problems facing the Lagoon as a whole and to serve as a catalyst for present and future research within this region. Funding from State and local governments, as well as private industry and individuals, is used to supplement other sources of money and draw attention to ths issues of the Lagoon. Also, the MRC is involved in educating the public about the Lagoon and is developing a bibliography of Lagoon-related source materials. These efforts cannot be completely separated from occurrence in the clamming industry. As awareness and understanding of the Lagoon increase, people coming into contact with its resources will, hopefully, obtain a desire to protect the Lagoon and the resources dependent upon it.

In lieu of a Statewide clamming license, the State Legislature has, within the last year, approved a Brevard County clam-diggers license to give local control over clamming activities. This license is only available two months of the year (in the summer when northern clam beds are open) and carries an increased fee of $500 for non-resident clammers. Resident clammers, who have resided in the State for a year or more, can obtain the license for $100. Money from the increased licenses is to go to improved research and enforcement activities.

Such legislation is a step forward and it is hoped that it will go a long way toward alleviating or, at least, aiding in regulating the extreme pressure now being placed on the resource. However, legislation alone cannot solve the complex interaction of natural and social systems affecting this industry. Other management possibilities need to be explored and applied research needs to be focused on industry-related problems.

One idea under consideration is the application of mariculture techniques to the production of clams. Some of this type of work has already begun, but the potential of mariculture to create a steady supply of high-quality shellfish to local and, perhaps more importantly, to export markets has yet to be fully realized. Yet, the knowledge and technology exists. The fast-growing nature of the clam in southern waters, as well as the pricing structure of the clam industry (where the smaller "little necks" fetch higher prices than the large "chowders") lend themselves perfectly to mariculture and fast turnaround times in production cycles. Additionally, mariculture may be seen as a means of protecting and even enhancing the resource by channeling the labors of those now employed within the industry away from the traditional harvesting methods of raking and treading into the farming-type activities involved in mariculture activities. This could help alleviate a great deal of the destructive activities associated with such hunting and gathering techniques and concentrate production into smaller portions of the Lagoon.

This is not to say that mariculture is a panacea for the ills being encountered by the Lagoon and the industry. The ramifications of widespread application of these techniques will only be known with time and many social conflicts must be faced and resolved before the development of mariculture within the Lagoon will be accepted. However, it is another option, another weapon in an arsenal of management techniques available to us if we keep our minds open to new ideas and are willing to use these ideas to the betterment of the resource as well as ourselves.

Florida Sea Grant sponsored a workshop on the clamming industry in the Indian River Lagoon which was held in September of 1985 at the Florida Institute of Technology. This workshop focused on problems facing the Lagoon and the industry and on research currently addressing those problems. Additionally, the feasibility of applying mariculture techniques to clam production within the Lagoon was explored. This workshop brought together scientists, local and state regulatory agency personnel, members of the industry and the public to gain a more comprehensive understanding of the burgeoning industry. The following are summaries of the proceedings of that workshop.

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THE SETTING

HISTORY OF THE INDIAN RIVER LAGOON

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The ancient Ais Indians navigated the shallow grassflats of the large estuary isolated from the Atlantic Ocean. Teeming waters provided food and transportation routes. Villages were marked by tall mounds of discarded shells. The Ais controlled and were intimately knowledgeable of the secrets of existence in the long Lagoon draping along the east coast of Florida.

The Lagoon through the Spanish, English, and American colonial periods produced oranges, hides, feathers for ladies' hats, fish and produce including pineapples. Following the Indian Wars of 1845-1853, homesteaders eager for free land tilled the flood prone, poor soil along the Lagoon. Many turned to fishing. In the 1920's, the Drainage Acts of Florida established and encouraged the drainage of marshes and swamps. A highly speculative real estate market developed 95 drainage projects in wetlands. Mangrove forests were impounded by dikes to eliminate mosquito breeding grounds.

With drainage systems in place and the clouds of mosquitoes eliminated, large scale agriculture developed. By the 1960's, housing developments began to replace the less profitable agricultural lands.

The Ais people are now gone. Their homeland, the Great Lagoon, is no longer recognized or understood as a functioning ecosystem. Successively called the Ais Lagoon, the Indian Lagoon, and most recently the Indian River, the estuary has lost its identity as a productive system, dependent upon the delicate balance of salt and freshwater. No Ais chief directs the use of its resources or its management.

The Indian River extends along the east central Florida coastline from near Daytona Beach to Hobe Sound in the south. The shallow (three feet average depth) brackish water has salinities near that of seawater at the inlets and almost fresh at the mouth of freshwater streams. While nearly as long as Chesapeake Bay (150 miles vs. 180 miles) the Lagoon varies in width from less than a half mile at the Narrows near Vero Beach to 5 1/2 miles at the northern end near Titusville. The upper linear half of the Lagoon includes two-thirds of its area and volume. Contrary to its name, the Indian River in no way behaves or functions as a river flowing to the sea. Movement of water is directed primarily by wind and by tides near the inlets.

On a yearly average, the amount of rainfall on the Lagoon nearly equals evaporation. The major source of water is from land drainage via creeks and streams. The natural drainage area, a narrow band not more than ten miles wide historically, has been enlarged by extensive drainage systems; one such project adding more than one hundred square miles to the watershed.

The purpose of the drainage systems, when constructed in the 1920's, was to drain "useless marshes and swamps" for farming. In recent years, ranch lands have been converted to residential housing lots as industry and cities expanded on both the barrier islands and mainland. Water released from the land as runoff now carries herbicides, pesticides, fertilizer, industrial waste and

sewage effluent into the Lagoon.

The watershed of the Indian River and its shoreline is managed by six counties, forty cities, two regional planning districts, special taxing districts including drainage districts, mosquito control districts and inlet commissions. Each organization manages, regulates, or plans independently as if the lines drawn on maps were absolute boundaries drawn on the water.

The Indian River, a bar-built estuary, is an active biological system. The geographic location and confined protected waters provide a stable environment creating extraordinary diversity of life. Studies at the Florida Institute of Technology and the Harbor Branch Foundation show that the Indian River has a greater diversity of plants and animals than any estuary in the United States.

The shallow, warm, nutrient rich waters of the Indian River produce luxuriant flats of submerged aquatic vegetation, seagrasses, and algae. The grasses maintain an organic soup of decaying vegetation and a variety of food sources for an extraordinary variety and number of animals. The seagrasses also provide hatcheries and protected nursery grounds for oceanic animals. Nearly sixty percent of the fish caught commercially offshore spend critical portions of their life cycle in the Indian River Lagoon.

Commercial fishing, both offshore in the Atlantic and in the Lagoon, has made Brevard County a leader in State fisheries landings. This standing is due to the expansion of the clam and scallop fisheries. The Lagoon produces 80% of Florida's clam harvest. Clammers from New York, Rhode Island, and North Carolina have introduced basket rakes for clamming in shallow water and large basket rakes and tongs operated from boats in deeper water. Sophisticated depuration plants and relay techniques purify clams taken from polluted waters.

In the midst of great species diversity, an abundance of rare and endangered plants and animals are recognized in the Indian River region. The first national wildlife sanctuary was established on Pelican Island near Sebastian, Florida by President Theodore Roosevelt. Brown pelicans, roseate spoonbills, least terns, bald eagles, and ospreys all frequent the Lagoon.

The West Indian (or Florida) manatees are numerous in the Indian River Lagoon. Of the one thousand believed to exist, three hundred have been counted in Brevard County alone. The barrier island beaches along the Lagoon are prime nesting sites for young sea turtles. Populations of immature loggerheads and green turtles may spend early years in the Lagoon as a developmental habitat.

Today, the Indian River is home to an ever growing population of nearly 600,000 people. In the last six years, an awareness of and a concern for the future of the Lagoon's natural systems has grown as people find that the economy and quality of life within the region are based upon this aquatic treasure.

THE RESOURCE

BIOLOGICAL AND ENVIRONMENTAL FACTORS AFFECTING THE CLAMMING INDUSTRY

Conrad White
Brevard County Environmental Engineering Department

The Indian and Banana Rivers comprise east-central Florida's major brackish water systems. These waters lie east of the major coastal ridge and are separated from the Atlantic Ocean by an extensive system of barrier islands. The Indian River extends from Turnbull Creek in north Brevard County south to St Lucie Inlet; the Banana River begins as an extension of the Indian River referred to as Banana Creek within the Kennedy Space Center and terminates at the southern tip of Merritt Island. The length of the Indian River is approximately 150 miles (240 km); the width varies from 10 ft (3 m) to 5.5 mi (8.9 km). In actual fact, however, the lagoon systems that border the east coast of Florida extend from Volusia County to Martin County.

These lagoons are shallow, non-tidal, wind mixed, saline systems that have an average depth of 5 ft (1.5 m) and a depth range of 0 to 13 ft. (4 m); deeper areas occur in the Intracoastal Waterway channel and in those areas that have been dredged for fill material and/or marinas. The dominant type of bottom relief is gently sloping sand-shell-mud areas; in some areas coquina rock outcrops are present.

Historically, the lagoons had limited exchange with ocean waters. Small, shallow ephemeral openings in the barrier islands would occur periodically with turbulent fall and winter storms. For a long period, Ponce Inlet was the only opening in the northern Indian River; Sebastian Inlet was dredged in 1921, Ft Pierce Inlet was dredged in 1921, and the Canaveral Locks were completed in 1965. Because the lagoons are isolated from direct oceanic influence (except near man-made inlets) water temperature tends to mimic air temperature closely; the temperature range recorded by Brevard County over the past five years varied from 46 F to 90 F.

Salinity is the other major factor that determines the type of aquatic system that develops in the lagoons. Salinity can be influenced by a variety of factors, but the dominant one in the northern Indian and Banana Rivers is the rainfall-evaporation cycle (hydrogeological cycle). In this area freshwater discharges cause decreased salinities in zones near the major streams, which include the Eau Gallie River, Crane Creek, Turkey Creek, and Sebastian Creek and near urbanized areas with significant stormwater runoff. Stratification rarely occurs, however, except in the Sebastian Creek-Sebastian Inlet area, where the freshwater from the creek forms a lens on top of the higher salinity inlet water during high discharge events from the creek. Salinity ranges recorded for the northern portion of the Indian River were 14 parts per thousand (ppt) to 44 ppt, with a mean value of around 22-24 ppt (dependent on station location and proximity to inlet or stream).

The major biological communities of the lagoons are highly dependent on the temperature and salinity regimes found in given area. They are associated with the fringing wetlands and uplands and/or the submerged areas. The wetlands bordering the rivers are dominated by mangroves and to a lesser extent by chordgrass and other emergent vegetation. The submerged areas can be divided into vegetated and unvegetated zones while other relatively minor communities are associated with hard bottom and man-made structures. The communities that are important to this workshop are the submerged vegetated areas (seagrass and algae) and non-vegetated areas. The vegetated areas are dominated by the attached macrophytes manatee grass (Syringodium filiforme), shoal grass (Halodule wrightii) and turtle grass (Thalassia testudinum), by the attached algae Caulerpa prolifera, and by three genera of semi-attached "drift algae" (Gracilaria, Acanthophora and Hypnea). While it may appear that certain submerged zones are monotypic, most areas are a mixture of two or more species of grass and algae.

In terms of fauna, the Indian and Banana Rivers lie at the convergence between two large biogeographical zones referred to as the Carolinian and Caribbean. Those animals labeled as Carolinian tend to be species found in cooler waters, while those animals associated with the latter zone tend to be warm water species. A large percentage of fish and invertebrate species are found throughout both geographical areas. The importance of cool water/warm water species can be demonstrated from the fact that a number of species in this area tend to be existing at either the northern or southern terminus of their distribution relative to water temperature; outside disturbances that impact these sensitive species, such as a sudden elevation of water temperature above the ambient level can lead to a loss of that species from the area. Recovery of a sensitive species can be protracted; the recovery period for seagrasses can be particularly lengthy.

Four hundred (400) species of fish have been collected from the Indian River Lagoon. Many of these fish are highly dependent on seagrass and/or mangrove areas at some point during their life cycle for breeding, foraging for food, and for protection. Of the 95 species of fish that are frequently found within the lagoon waters, 90 were associated with seagrasses at some point in time; 48 were associated with mangrove communities at some point, 61 were found over or in sand bottom areas, 42 were found in association with lagoon hard bottom habitats, 51 near canals, 45 near freshwater tributaries and 20 were found within mosquito control impoundments. These figures serve to illustrate the importance of seagrasses to the overall quality of the lagoon ecosystem.

In terms of RELATIVE importance to the lagoon, the 10 top ranked fish collected from the northern Indian River were:

1. bay anchovy

2. silver perch
3. sea catfish
4. pinfish
5. striped burrfish
6. southern puffer
7. spot
8. gulf pipefish
9. code goby
10. Atlantic stingray

The lagoon also supports an extensive invertebrate fauna on which the fish are indirectly or directly dependent for food. Extensive invertebrate species lists have been compiled by the County and other institutions. These lists help point out how important the seagrass and mangrove habitats are to the stability and productivity of the lagoon. As with the fish the grass and mangrove areas serve the invertebrates as places for breeding, foraging for food, points of attachment for sessel species such as a number of polychaete worms, amphipod crustaceans and bivalve molluscs, and as zones of refuge from predators. The ten most common invertebrates found in the northern Indian River are:

1.	Brachidontes exustus	small clam
2.	Parasterope pollex	very small crustacean
3.	Cymoduce faxoni	small beach flea type crustacean
4.	Limnodriloides winchelmanni	very small oligochaete worm
5.	Ophiophragmus filograneus	small long-legged starfish
6.	Axiothella mucosa	small fringed polychaete worm
7.	Cymadusa compta	small beach flea type crustacean
8.	Leptochelia rapax	small long-bodied crustacean
9.	Phasicolion sp.	small worm-like animal
10.	Erichsonella attenuata	small long-bodied crustacean

The invertebrate fauna also includes commercially valuable species such as shrimp, blue crabs, stone crabs, and of course the hard clam, Mercenaria mercenaria.

Without good water quality, however, the biological community of the lagoon begins a rapid decline. The need for excellent water quality in the lagoons is more acute than with some other brackish systems because of their physical configurations. True estuaries receive significant inputs of freshwater from the major tributaries that empty into them and at the same time have major outlets to the oceans; although pollutants can degrade these systems, there is a flushing mechanism present that can dilute some of the pollutant's effects. The Indian River is land-locked and anything discharged into the system either ends up in the sediments or is taken up into the biological food web. Once a compound is present in the food web, there is the possibility that it may be passed to humans. Brevard County's Environmental Services Division is concerned with the apparent decline over the past 10 years of "water quality" in large areas of the Indian and Banana Rivers.

The Environmental Engineering Department's biological laboratory

has monitored surface water quality in the County from 1967 to the present. The primary focus of the laboratory is toward water quality monitoring via collection of water samples, long-term invertebrate monitoring, establishment of a bivalve sentinel program for trace metals and monitoring of seagrass areas. The programs can be separated into: 1.) long term projects of greater than two years' duration, 2.) short term projects of less than or equal to two years, and 3.) interface projects of varying time intervals. Other functional categories the laboratory provides for are euphemistically referred to as 4.) "Alarms" and "Panics", and 5.) other, or better known as "other duties as assigned".

The laboratory programs can also be divided into site and non-site specific projects. The major water quality monitoring program of the lab is non-specific and includes 33 permanent stations located in the Indian, Banana and St. Johns Rivers and Mosquito Lagoon. Each station is sampled monthly to determine physical, chemical and biological values. The site specific projects include 18 stations within the class II waters, 6 stations in the Tortoise Island subdivision, 4 stations in the Sykes Creek impoundment, 2 stations inside Port Canaveral, 8 stations in the Kiwanis Island basin on Merritt Island, and 2 stations inside the Sands Canal (Lake Washington). In addition to the long term monitoring water quality projects, the lab samples 6 sites for benthic invertebrates. These stations have been sampled since 1976 and contribute greatly to determining the relative health of the particular water body.

The lab also has a number of short term programs targeted toward maintenance and management of the lagoon and adjacent waters. These include a sentinel program to determine trace metals in the hard clam, a study of water quality decline within Port Canaveral, a survey of the water quality within the Merritt Island barge canal, and a $35,000 grant from the federal coastal zone management program to map the outlines of the seagrasses in the lagoon from Turnbull Creek to Sebastian Inlet. The various interface projects in which the laboratory provides scientific expertise are planning and zoning ordinances, artificial reef sites, dredge and fill investigations, and fish kill investigations.

Analysis of the data collected by the laboratory to date shows that water quality is highly variable within the county. In general, those areas isolated from intensive development, or away from direct agricultural runoff exhibit good water quality. Those areas in close proximity to urbanized zones and/or are subjected to significant agricultural runoff showed degraded conditions. The degradation can be attributed to the discharge of water high in macronutrients (nitrogen and phosphorus) which causes excess phytoplankton productivity, and which in turn can lead to warm weather dissolved oxygen instability. In addition, discharges from both wastewater plants and stormwater systems have led to localized increases in turbidity; the turbidity increases have in turn decreased light penetration in the photic zone. The implication of the decreased water clarity is that the

amount of light needed for seagrass growth and reproduction has been reduced in some areas to the point where significant seagrass loss has occurred over the past 15 years. The amount of seagrass loss exceeds 30% in large sections of Florida, and in Brevard County losses are expected to approach 50% within a short time.

Areas within Brevard County that have "good" water quality and appear to have a balanced biological community are:

1. Mosquito Lagoon
2. The Indian River between Turnbull Creek south to the railroad bridge north of Titusville
3. The Indian River on the east side of the ICW from SR 402 south to the SR 528 Causeway.
4. The Indian River from Malabar Point south to Sebastian Inlet
5. The Banana River from the NASA Causeway south to SR 528

Those areas that exhibit "fair" water quality in Brevard County are:

1. The Indian River other than what was listed as having good water quality.
2. The Banana River between SR 528 and the Pineda Causeway
3. Newfound Harbor south of the Merritt Island airport to the connection with the Banana River
4. Sebastian Creek

Those areas that show <u>enriched</u> conditions are:

1. Sykes Creek and the northern half of Newfound Harbor
2. The Banana River south of the Pineda Causeway
3. Turkey Creek

Those areas that are <u>degraded</u> or EUTROPHIC are:

1. Crane Creek
2. Eau Gallie River
3. Numerous residential canal systems throughout the County

It should be pointed out that the above classifications are not all-inclusive and that there are areas within most of the segments that are better, or worse than what was indicated. In many areas of the lagoon, strides are being taken toward eliminating the pollutants that have caused the decline of water quality; many of the wastewater plant discharges into the lagoon are being taken out. The greatest threat to the lagoon water quality now appears to be the loss of shoreline habitats to intense residential and commercial development via the legal permitting processes, coupled with weak enforcement of existing rules and regulations by both State and Federal agencies that govern stormwater and industrial discharges and dredge and fill activities.

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A single hard clam may release from one to over 20 million eggs per spawn. If the average clam lives in the river long enough to spawn several times, it may produce over 100 million eggs, of which only one must survive to adulthood to maintain the population. If two survive, the population would double; if 10 of one hundred million survive, a bonanza would result. Thus very small differences in survival make very large differences in the fishery.

The two major factors normally affecting survival are (1) availability of food (single cell algae or phytoplankton), particularly during the 1-2 week larval stage and (2) predation. As with all organisms that produce large numbers of young, predation is most severe in the youngest stages (larvae and newly-set seed) and declines rapidly as the animals reach commercial size, excluding the affects of man.

Both food availability and predation may be beneficially affected by rainfall. Land drainage, particularly from fertilized agricultural areas, brings nutrients to the river and stimulates growth of the unicellular algal food of the clams. Freshwater drainage and the resulting reduced salinity may also kill or exclude predators, as is the case in oyster culture, where nursery areas are commonly located in the upper, brackish sections of estuaries for that reason.

It is therefore suggested that the recent success of the Indian River clam fishery may have resulted from the unusually heavy rainfall during 1982, particularly during the spring and fall spawning seasons, and the above-normal rainfall during the succeeding two years (1983 and 1984), in contrast to the prolonged period of several years of below-normal rainfall prior to 1982. Below-normal rainfall during the spring spawning season of 1985, if followed by similar conditions during the fall of this year, may herald a return to poor recruitment success.

The above conclusions are theories only, based upon correlations and indirect evidence. A modest, continuing recruitment monitoring program, correlated with meteorlogical data, would confirm or deny the hypothesis, provide useful predictive information to the industry for planning purposes, and could lead to water management practices that might prove beneficial to the fishery.

ECONOMICS OF CLAMS

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In 1982 "Clams" recorded in world landings totaled 1,303,775 tons. This contrasts with 1973 totals which were recorded at 822,400 tons or only 63 percent of the 1982 total. 1) In 1982 over half of this catch was taken from the Northwest Pacific (primarily Japan) almost half of the remainder was harvested from the Northwest Atlantic (particularly the United States). The United States East Coast Clam Fishery is dominated by four species wich accounted for a record production in 1984, see Table 1.

Thus in spite of management and environmental problems the United States Clam Fisheries are operating at record levels.

The primary species are summarized briefly below.

1) FAO, 1979 (Vol. 48) Yearbook of Fishery Statistics
" 1982 (Vol. 54) " " " "

Table 1.

U.S. Landings of Clams - 1984 2)

	Pounds of Meats	Value in Millions	Value Increase* Percent
Surf Clams	70,200,000	$ 34.3	38
Ocean Quahog	38,800,000	11.8	10
Hard Clams	14,100,000	49.8	18
Soft Clams	7,900,000	19.8	13
Other	900,000	.8	-
	132,900,000**	116.5	+21

* Over Previous Year
** Previous High 1974 - 121,800,000 pounds

2) Source - Fisheries of the United States 1984 - (1985)
U.S. Dept. Comm. Natl. Marine Fisheries Service

Surf Clams

The surf clam Spisula solidissima, has been an important fishery in the Mid-Atlantic area since World War II (mid 1940's). The fishery grew steadily through the early 1970's when some signs of overfishing became apparent. Management restrictions and expansion of the fishery to offshore areas has helped to keep production high. Although the surf clam is found from eastern Canada to the Carolinas most of the significant production is limited to the area from Georges Bank (off Massachusetts) to Cape Hatteras, N.C. The surf clam is canned and sold as strips for frying. Landings are reported in weight of meats. Surf clams harvested from wild stocks probably have reached peak production levels and indeed some decline is likely.

Ocean Quahog

The ocean quahog Artica islandica is, like the surf clam, taken from ocean waters. The ocean quahog lacked significant fishing effort until the decline of the surf clam was perceived by industry in the early 1970's. Increased fishing for the "OQ's" has accounted for record levels of production in the 1980's; this trend is expected to continue. The resource is widely distributed from Virginia northwards. Deterrents to expansion include conservative market interest due to strong flavor and slow growth rates. Large adult ocean quahogs have been reported to be very old (up to 100 years); this could represent resource problems at some point. The ocean quahog is primarily a northern variety not normally expected in commercial quantities south of the Carolinas.

Soft Clam

The soft clam Mya arenaria is the traditional clam of the New England area which is used as a fried clam and in chowders. Due to heavy fishing pressure and environmental problems, including pollution, predation and "red tide", the supply in New England has been "down"; in recent decades this has been offset to some extent by production from the chesapeake Bay area. The Chesapeake production was accomplished by development of harvesting equipment capable of bringing quantities of clams up from 10-20 feet below the surface of the bay. This was (and is) accomplished with "escalator" dredges. The soft clam fishery of the Chesapeake represents a fishery developed through a combination of unsatisfied markets and innovative harvest technology.

Hard Clam

The hard clam Mecenaria mercenaria is the most valuable of the four primary east coast species. It is harvested in most coastal states from Maine to Florida. Some biologists believe a second species (or variety?) occurs in the southern part of this animal's range; this aspect needs more study and clarification. Much of the high value of the hard clam is attributable to its demand as a raw or "half shell" food item. The production of hard clams has been under stress in New England and in the middle Atlantic; however, this has been offset and supplemented by increased production in the south, particularly in Florida; (see other material in this publication).

Florida has enjoyed production of hard clams before. A fishery existed in the Ten Thousand Island area of the Florida Bay from the late part of the 19th century until after World War II. Most of the production (up to 200,000 bushels (year) was taken by mechanical dredges and was subsequently canned, one of two or more canneries existed at Marco, FLorida. 3)

Early man in Florida also took advantage of the intermittent abundance of the hard clam. Indian middens (refuse heaps) around the periphery of the Indian River area, and elsewhere reveal that hard clams were a major component of the aboriginal diet. Evidence seen at a "dig" underway at "Honeymoon Hill" on Merrit Island suggests that clams and other molluscs alternated with oysters as a primary food source. This suggests that variable environmental conditions probably occurred, thus making it more or less favorable for individual species.

Conclusion

Clams are a major shellfish product on the U.S. East Coast of North America. Changes in environment and resource condition coupled with market demands allow for adjustment in production opportunities from different sectors of the range of the products. In some cases management and/or culture can be effected to enhance the access to these valuable and attractive resources.

3) Tiller, Richard E., John B. Glude, and Louis D. Stringer, 1952, Hard Clam Fishery of the East Coast; March Fisheries Revue Vol. 14 No. 10.

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Total U.S. hard clam production in 1984 was reported to be 14.5 million pounds and valued at $49.8 million dockside. The landings of hard clams (the colloquial term "hard clam" can actually apply to three genera of commercial importance - Mercenaria, Protothaca, and Saxidomus) represented only eleven percent of the total domestic clam production, the majority of which was surf clam landings (70.2 million pounds was valued at $34.3 million). However, hard clams, which are utilized primarily in whole form (i.e., half-shell, steamed, etc.) trade rather than in a minced or strip form, were the most valuable species on a per pound of meat basis. The dockside value of hard clam landings represented 43 percent of the total dockside value of all species of clams landed in the U.S. in 1984 (Table 1). The hard clam industry has historically be centered in the New England and Mid-Atlantic regions, with the majority of the landings being reported by Maine, New Jersey, Massachussetts, Rhode Island, New York, and Virginia.

Florida has only recently become a significant producer of the hard clam Mercenaria mercenaria. Landings in 1984 of hard clams in Florida were reported to be 1,851,069 pounds on a meat weight basis, with a dockside value of $6,552,200. Florida generated approximately 13 percent of the total domestic landings and dockside value of hard clams in 1984. More dramatically, this represents a 13-fold increase over landings and value reported for 1983 (Table 2). Hard clams were ranked as the eighth most important commercial species in the state in terms of dockside value (Table 3). In addition, of the ten most important commercial species in Florida in 1984, hard clams had the highest un-weighted exvessel price per pound. The price per pound of meat has continued to increase since 1971 (Table 2). Few species in Florida have exhibited a comparable increase in production and value in the commercial industry, with the notable exceptions of calico scallops and swordfish.

The majority of the Florida production for a given year occurs on the east coast, primarily in the restrictive confines of the Indian River lagoon system. Brevard County, which borders the Indian River lagoon, accounted for 92 percent of reported landings and dockside value in 1984 (Tables 4). Prior to 1984, however, Brevard County landings of hard clams averaged less than 100,000 pounds of meats (Table 5). The neighboring Indian River, St. Lucie, and Volusia counties reported minimal production in 1984, with approximately 5 percent of the state's landings reported by Gulf County on the west coast. The number of producers at a given time has varied considerably since 1983, with estimates ranging from 400 to 1,000. These values most likely include a number of part-time operators. In addition, many producers have apparently migrated down from the northeastern regions of production. Accurate estimates of the current number of producers is difficult to obtain due to the degree of seasonal entry and exit which had not previously existed in the fishery. The recent initiation of a "trip ticket" reporting system and a clammers liscense will undoubtedly provide for more accurate future estimates of effort and production.

There are approximately 20 major dealers of hard clams in Florida, with an additional 5 dealers which market depurated clams. Most of the hard clams produced in Florida are marketed outside of the state, although a percentage are sold to local wholesalers and restaurants. Florida hard clams are marketed as

shell stock, primarily for the lucrative restaurant trade.

The growth in the hard clam fishery is obviously of importance to the local economy, particularly as more producers reside permanently in the region and as more of the product is sold outside of the region. This ensures the incomes and expenditures generated through dockside sales and value added from processing and/or depuration is retained within the local economy. A major obstacle to a more accurate assessment of the status of the hard clam industry in Florida is the lack of data at the producer and dealer level. This problem is compounded by the fishery having only existed as a major commercial industry for 1 1/2 years, with an uncertain future to continue as such. Recent efforts to more accurately document effort and production should be complemented by attempts to describe various marketing aspects of the industry, such as ...

(1) describing product distribution and market channels by size class and product form,

(2) documenting production and price by size class at the producer and wholesale level,

(3) collecting cost and return data at the producer and wholesale level,

(4) describing the seasonal impact on local price from production changes in the northeast region, and

(5) evaluating the relative economic importance of depurated versus non-depurated clam production.

Increased knowledge of these various economic aspects of the industry will help ensure a viable industry will be maintained through efficient management and regulatory policies.

Table 1: Total U.S. Clam Landings and Dockside Value, 1984

Species	Pounds (meat weight)	Dockside Value	Average $/lb.	% of Total lbs	% of Total $
	(X 1,000)				
Hard	14,749 lbs	$ 49,849	$ 3.38	11	43
Ocean Quahog	38,812	11,829	.30	29	10
Soft	7,919	19,842	2.51	6	17
Surf	70,243	34,334	.49	53	29
Other Species	1,198	637	.53	1	1
Total	132,921 lbs	$ 116,491		100	100

Source: Fisheries of the United States, 1984, NMFS, NOAA, U.S. Dept. of Commerce.

Table 2: Annual Reported Florida Hard Clam Production and Dockside Value, 1970-1984

Year	Pounds (meat weight)	Dockside Value	Average $/lb
1984	1,851,069 lbs	$ 6,552,200	$ 3.54
1983	142,566	473,108	3.32
1982	145,329	458,562	3.16
1981	117,249	313,458	2.67
1980	61,892	154,856	2.50
1979	71,714	163,756	2.28
1978	126,282	221,183	1.75
1977	147,927	205,172	1.39
1976	60,837	77,338	1.27
1975	73,233	90,394	1.23
1974	94,130	94,258	1.00
1973	139,103	101,257	.73
1972	63,468	39,979	.63
1971	99,264	49,632	.50
1970	60,804	33,171	.55

Source: Published and unpublished Florida Department of Natural Resources and National Marine Fisheries Service (NMFS) state and county commercial fisheries data.

Table 3: Reported Landings and Dockside Value of Most Important Commercial Species in Florida, 1984

Species	Pounds	Dockside Value	Average $/lb
Shrimp	35,750,883 lbs	$ 59,305,342	$ 1.66
Calico Scallops	42,741,500	23,212,895	.54
Grouper/Scamp	10,062,680	13,931,748	1.38
Spiny Lobster	5,481,556	13,772,013	2.51
Swordfish	3,218,977	9,001,468	2.80
Oysters	6,720,855	7,495,422	1.12
Stone Crab	3,857,258	7,177,264	1.86
Hard Clams	1,851,069	6,552,200	3.54
Red Snapper	2,733,691	5,864,317	2.15
Black Mullet	19,509,958	5,006,043	.26
Blue Crab	18,040,525	4,731,233	.26
King Mackerel	3,441,128	2,790,494	.81
All Species (including above)	209,517,000 lbs	$178,395,247	

Source: Unpublished NMFS state commercial fisheries data.

Table 4: Reported Hard Clam Landings and Dockside Value in Florida by County, 1984

County	Pounds (meat weight)	Dockside Value
Brevard	1,708,378 lbs (92%)	$ 6,130,783
Gulf	85,994	184,189
Indian River	39,901	177,826
Lee and St. Lucie	117	452
Volusia	16,679	58,950
Total	1,851,069 lbs	$ 6,552,200

Source: Unpublished NMFS county commercial fisheries data.

Table 5: Hard Clam Landings and Dockside Value for Brevard County, 1975-1984.

Year	Pounds (meat weight)	Dockside Value
1984	1,708,378 lbs	$ 6,130,783
1983	108,332	374,604
1982	136,498	432,542
1981	61,348	171,542
1980	50,816	129,650
1979	37,269	88,650
1978	112,442	203,261
1977	135,198	184,536
1976	50,547	61,144
1975	67,018	85,841

Source: Unpublished NMFS county commercial fisheries data.

KNOWING HOW MUCH IS THERE

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Site Location

Four transects at each of three sections on the Indian River Lagoon were sampled between April and July 1985. One section (at Grant) represented a conditionally approved area with a history of heavy clam harvesting; another section (at Palm Bay) was in closed (restricted) waters and had some relaying associated with it; the third section in closed waters with little harvesting activity was located between Channel Markers 99 and 100 south of the Pineda Causeway. Bivalves from three of the four transects at each of the lagoon sampling sections have been sorted, identified, measured (along the longest length of the shell), and enumerated.

Methods

Each of the twelve transects were sampled at stations of 200 m (655 ft.) intervals. A 1/4 m^2 open-ended drum with a 4 inch wide fluorescent strip and a bevelled edge was pushed to a depth of 4 inches into the sediment. Bottom substrate along with shellfish were collected with an airlift (suction) dredge (see figure) with the assistance of SCUBA equipped divers. The suction dredge operates by a Briggs and Stratton engine which draws water through the intake and into the pump, expelling it with great thrust. The outflow passes through a long hose leading to a suction control valve which regulates the amount of water transmitted and, indirectly, the force of water movement. The water then passes through a suction head with a reduction nozzle where the flow of the water is accelerated and the pressure below the nozzle falls creating suction into the suction hose. Consequently, a sample is airlifted through the hose and collected into a 2 mm mesh bag. This dredge along with the aid of SCUBA is believed to be one of the more accurate and quantitative methods of benthic sampling. In addition, the researcher is able to observe the bottom morphology and vegetation.

Core samples for particle size fractionation were also taken at each station. Sorting of the shellfish was done in the lab by sieving through a 2.8 mm screen sieve (U.S. Standard No.7) and collecting the shellfish from the shell fragments and debris.

Preliminary Results

The enclosed table presents the average number of individuals for each size class of clam and other bivalve shellfish found at each site. The smallest size class for clams, "seeds" (<1"), are the most abundant group of clams at Grant. An avewrage of 8 clams per 1/4 m^2 (average of 31 stations on three transects) indicates the Grant area has received a successful set of clam larvae and should continue to yield substantial quantities of harvestable clams as long as no significant die-off occurs. By contrast, the numbers of "seed" clams at the Palm Bay and Merritt Island locations are considerably less than those found at Grant. Whether these differences are due to varying salinities, substrates, depth, food supply, or competition among the sites is uncertain. The substrate at Grant was sandy and the water depth shallower than at the other two sites. Merritt Island had a bottom that was composed primarily of shell fragments and silt. Also, notice the large numbers of Mulinia lateralis at the Palm Bay and Merritt Island

locations. The similar sizes of Mulinia and "seed" clams suggest that competition for food and attachment sites may be part of the explanation why "seed" clams are more abundant at the Grant site than at the Palm Bay and Merritt Island sites.

For size ranges of clams greater than one inch in length, there are no obvious differences between sampling locations. Moreover, the number of individuals at Grant decrease dramatically from the small "seed" clams. There are two possible explanations for the decrease at Grant of clams greater than one inch:

1. Harvesting in the conditionally approved waters near Grant has reduced the numbers of larger clams to levels similar to those areas of the lagoon where the populations are lower.

2. Unsuccessful sets of larvae for a two-year period or mortality of juveniles reduced the numbers of the larger clams as the survivors grew to marketable sizes. Note that the number of "beans", an illegal size of clam for harvesting, is present in very low numbers at Grant.

Conclusions

Successful recruitment of juvenile clams in the Grant area should sustain the supply of harvestable clams for the next two years providing mortality is kept to a minimum. However, the low recruitment at Palm Bay and Merritt Island locations suggest that those areas will not provide large numbers of harvestable clams. The populations of harvestable clams at Grant is considerably lower than the juveniles, and is comparable to the harvestable clam populations at the other sites.

The sampling methodology (SCUBA assisted suction dredge) provides a quantitative picture of the shellfish populations, and should prove to be a valuable tool in future recruitment, growth, and inventory studies on this valuable resource in the Indian River Lagoon.

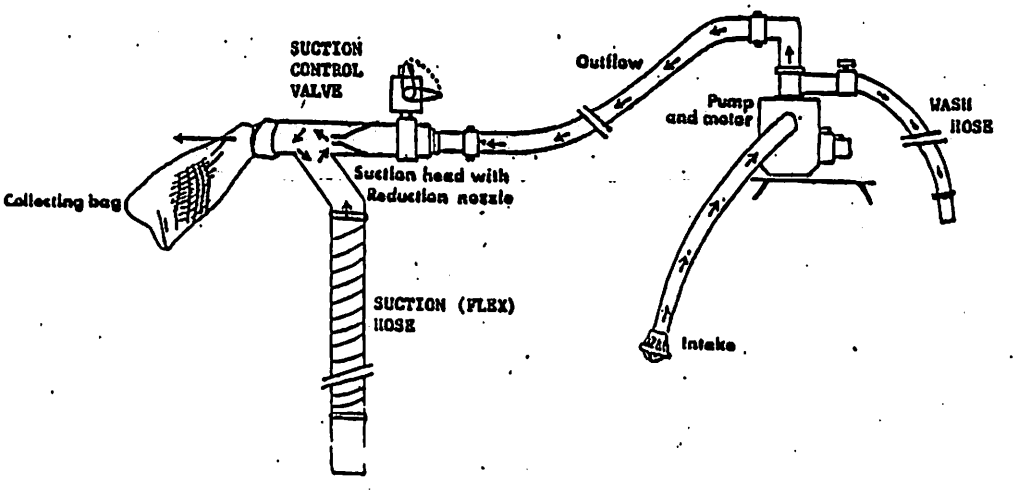

Figure 3. Airlift suction dredge.

Mean number of individuals per ¼ m^2 in each size range (shell length in inches) in transects, A, B, C, of each of three sections of the Indian River Lagoon.

	GRANT			PALM BAY			MERRITT ISLAND		
Transect	A	B	C	A	B	C	A	B	C
Number of stations	(11)	(11)	(9)	(11)	(10)	(9)	(9)	(9)	(8)
Mercenaria mercenaria[1]									
Seeds < 1"	9	8	7	1	0.5	0.7	0.0	0.1	0.0
Beans 1" - 1½"	0.2	0.2	0.0	0.0	0.3	0.0	0.2	0.0	0.0
Buttons 1½" - 2"	0.3	0.4	0.6	0.7	0.1	0.1	0.1	0.2	0.0
Little necks 2" - 2½"	0.6	0.5	0.6	0.9	0.2	0.2	0.4	0.3	0.4
Top necks 2½" - 3"	0.6	0.6	0.4	0.6	0.8	0.1	0.3	0.0	0.0
Cherry stones 3" - 4"	0.0	0.1	0.2	0.2	0.3	0.0	0.1	0.0	0.1
Chowders > 4"	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1
Mulinia lateralis									
0.1" - 0.4"	45	34	43	509	818	684	328	1,007	924
0.4" - 0.8"	9.0	10	6	1	8	19	0.3	0.2	0.1
Anomalocardia auberiana									
0.1" - 0.4"	0	0.5	0	0	0	0.7	0.3	0.2	0.4
0.4" - 0.8"	0	0.1	0	0	0	0.2	0	0	0
Amygdalum papyrium									
0.1" - 0.4"	0	0	0	0	0	0.2	3	1	5
0.4" - 0.8"	0	0	0	0	0	0.2	3	3	1

IMPROVING PRODUCTION

CLAM MARICULTURE

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The hard clam, Mercenaria mercenaria is considered an excellent candidate species for aquaculture for the following four reasons:

First, the hard clam has a good market demand. A review of the National Marine Fisheries Service market reports indicates a strong and steady demand for clams (especially for smaller sizes). There have been few unexplained fluctuations in demand or price.

Second, M. mercenaria is a hardy, relatively fast growing species with few reported diseases.

Third, the technology for growing this species is available and a number of successful clam farms are already in operation. Demonstrations of this technology are available at a number of research centers in the southeast.

The fourth and, perhaps, the most important aspect of clam farming is the maximum price is offered at the minimum saleable size. In other words, the little neck clam is worth more than the cherrystone or chowder sizes. Besides, the obvious cash flow advantage in this, there is also an advantage in growing the product only through the rapid juvenile growth phase and not after the growth rate slows down as they reach larger sizes.

Farming of clams is usually divided into three phases. Phase one is the hatchery stage in which adult clams are induced to spawn, the eggs collected, graded and fertilized. The fertilized eggs are then cared for while they develop into free-swimming clam larvae. The larvae achieve metamorphosis and set as small clams after about 10 days.

During the second or nursery phase, the newly set clams are held in raceways or upwellers, which exclude predators, and are washed free of silt until they are large enough to plant on natural bottoms with a reasonably good chance to survive to market size. Clams set at about a quarter of a millimeter in size, or about the size of a small sand grain. They can be eaten at this size by a whole array of predators such as grass shrimp, minnows, etc. When the clams are this small, their siphon is not completely developed and they are vulnerable to smothering. A nursery system eliminates these problems and allows the seed clams to grow under careful maintenance.

Once the clam seed reaches 8 to 10 millimeters (about half the size of a dime) they are ready for the final field grow out phase. A successful field grow out plot must have proper salinity (20 o/oo or higher), temperature and food to sustain fast growth. The clams must be protected in prepared beds which prevent larger predators from destroying them and also prevent the clams from moving away from the protected bed. Clams are usually planted in the prepared beds at densities of 100 to 300 per square foot, dependent on the conditions found in the area. Stone or shell aggregate for bottom substrate and plastic nets or pens for covers are used for protection.

The field grow out phase requires the lowest investment and has the best cash flow and profit potential. This phase is recommended for starting clam growers. Proper sized seed can be purchased from commercial hatcheries.

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The Harbor Branch Foundation, located in Ft. Pierce, Florida maintains an on-going research program in mollusc cultivation. The facility includes a 2,000 sq. ft. greenhouse covered with translucent polyethylene film to provide illumination for phytoplankton cultures, and chemical laboratories for algae stock cultures and water quality analysis.

The facility was designed for pilot-scale production of bivalve molluscs to meet the increasing demand for shellfish products. During the fall of 1984, the Harbor Branch Foundation, in collaboration with Indian River Mariculture, Inc. investigated the feasability of providing through hatchery production juvenile hard clams, Mercenaria mercenaria, for subsequent planting in the Indian River.

Adult hard clams collected from the Indian River near Grant, Florida were transported to the laboratory and induced to spawn by thermal shock (alternately raising and lowering the water temperature) and by adding an infusion of stripped gametes to the culture water. The fertilized eggs developed into straight-hinged veligers within 24 hours.

Clam larvae were cultured in 500 liter cone-bottom fiberglass tanks following standard techniques for bivalve culture (see Castagna, 1981). Phytoplankton, unicellular algae which serves as food for larval as well as adult filter-feeding bivalves, were cultured in 400 liter clear fiberglass tanks. Unialgal stock cultures were maintained in a temperature and photoperiod controlled incubation room in test tubes. As culture cell densities increased, they were transferred to increasingly larger volumes of enriched seawater until the 400 liter tanks were inoculated. Clam cultures were fed approximately 10,000 cells/ml daily commencing 48 hours after fertilization. Food levels were increased to 50,000 cells/ml as the larvae grow and clear the algae from the culture water.

Larvae were stocked initially at 10 - 15 clams/ml in 5 micron, UV irradiated seawater. The culture water was exhanged daily, the larvae being collected on fine screens as the tanks were drained. During water exchanges, small larvae were culled from the cultures, and the larval densities lowered as the clams became larger. Within 10 - 12 days the clams were competent to metamorphose (the pediveliger stage); at this stage larval densities had been reduced to 1 - 3 larvae/ml.

Pediveligers that were retained on a 110 micron mesh screen were placed in screened fiberglass cylinders, termed downwellers, and suspended in the culture tanks. A gentle flow of water air-lifted from the culture tank created a downward current forcing the larvae into contact with the screen on the bottom of the cylinder.

Once all of the clams had set in the downwelling cylinder, they were transferred to a larger culture tank (8' diameter) which holds several cylinders. Cultured phytoplankton were added to the nursery tank, and the the flow of water through the cylinder was reversed, that is water and food were pumped upward through the cylinders. As many as 1/2 million juvenile clams were held in each upwelling cylinder. This technique, termed passive upwelling nursery sytems, is becoming widespread in the culture of bivalves.

The juvenile clams were harvested from outdoor raceways when they reached 5 to 10 mm in shell length. They were then transported to Indian River Mariculture for growout in sand-filled trays with protective plastic mesh covers to deter predation. Clams grow rapidly in growout systems, reaching marketable size in about 16 to 18 months.

Preliminary results indicate that hatchery production of hard clams to provide mariculture farms in the Indian River is feasable. Several million clam seed were cultured at the Harbor Branch facility in 1984. This program has the capability to expand production of clam seed should the demand for cultured hard clams for mariculture purposes increase.

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(Available from Sea Grant, $3.00)

CONTROLLING PRODUCTION

MANAGEMENT OF THE INDUSTRY

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Management of hard clam resources in Florida has a short and recent history when compared to more traditional clam producing states. Although clam landings in Florida have been recorded for more than 100 years, little resource management has been directed specifically toward the clamming industry. Hard clam harvesting has been managed and regulated as an adjunct to policy developed for oyster resources. Existing policies dealt more directly with regulating the clamming industry rather than managing clam resources. However, the goal is the same, preserve, enhance, and perpetuate shellfish resources.

Recently the need for new regulations arose and a new mechanism for establishing fishing regulations was adopted. Hard clam regulatory responsibility in Florida is now shared by the MFC and the DNR. As of July 1, 1983, a 7 member Marine Fisheries Commission (MFC), appointed by the Governor has rule making authority in the following areas; gear specifications, prohibited gear, bag limits, species that may not be sold, protected species, closed areas, quality control codes, seasons, and special considerations relating to egg-bearing females and oyster and clam relaying.

Florida DNR continues to be the regulatory authority to enforce the MFC's rules. DNR's Division of Marine Resources, and more specifically the Bureau of Marine Resource Regulation and Development, work with the MFC, FDA, NSSP and ISSC to regulate the shellfish industry and maintain shellfish product quality assurance. The Division's Shellfish Environmental Assessment Section (SEAS) and the Shellfish Sanitation Section (SSS) are instrumental in administering shellfish quidelines and achieving shellfish management goals. The enforcement authority for Florida's fishery regulations is the DNR's Marine Patrol (FMP).

The SEAS section is responsible for designating shellfish harvesting areas according to established federal guidelines. Shellfish growing areas in Florida are classified as Approved, Conditionally Approved, and Prohibited on the basis of bacteriological and sanitary surveys. Unclassified areas are closed to shellfish harvesting pending SEAS surveys. Harvesting shellfish is permitted only in Approved or Conditionally Approved areas. Shellfish harvesting areas may be designated as Approved when the Interstate Shellfish Sanitation Conference (ISSC) standard for fecal coliform densities are met during the most

unfavorable pollutional conditions, and designated as Prohibited when the ISSC standard is exceeded. Conditionally Approved areas must meet ISSC standard at all times while areas are Approved as a source of shellfish for direct marketing. Public health is protected in Conditionally Approved areas by closing those areas to shellfish harvesting when the ISSC standard is exceeded. Harvesting is also permitted in certain unclassified areas when harvested shellfish are relayed and depurated.

The SEAS section has developed an atlas which defines shellfish harvesting areas. Brevard County has 162 square miles of growing waters of which 80 square miles are Conditionally Approved and 80 square miles are Unclassified. The Conditionally Approved harvesting area, designated as Body F, is approximately 16.2 square miles and was the location of the highest concentration of clams in 1984 and 1985.

The Seafood Sanitation Section (SSS) is responsible for monitoring a comprehensive quality control program which regulates the production and processing of shellfish. However, few clams are processed within the state since the primary product is shipped as shellstock. The Seafood Sanitation Section also shares responsibility with the SEAS Section. They determine bacteriological water quality and also monitor process water and meat quality from depuration and relaying operations. Meat samples and water samples are forwarded to the SSS Laboratory, or they are sent to independent laboratories for bacteriological testing before relaying clams can be approved for harvest from shellfish leases or depuration plants.

Several requirements must be met in order for clams to be commerically harvested and sold. Any person or business harvesting or selling saltwater products to a wholesale or retail dealer must have a valid saltwater products license. Also, any harvester selling saltwater products for human consumption must sell only to a licensed wholesale dealer. Primary producers must also conform to specific quality control regulations.

Persons or businesses buying and reselling saltwater products must have a saltwater products license or obtain a wholesale dealers licence. Wholesale and retail dealers must also be in compliance with the Seafood Quality Control Code and the Comprehensive Shellfish and Blue Crab Control Code. These Codes give regulatory authority to the Department of Natural Resources to control seafood quality aboard fishing vessels, in offloading facilities, during production, handling, processing, storing, and distribution.

Issued with a wholesale dealers license is a wholesale dealer permit number which must accompany all wholesale transactions. Tags showing the permit number and certificate number must also accompany products when sold through licesned dealers. These tags are used to establish the source and distributional channels of shellfish.

In addition, all wholesale dealers are required to maintain records of all purchases and sales, and these records are open to inspection by the DNR. Records are collected through a newly established reporting format established by the Marine Fisheries Information System (MFIS) at the DNR Marine Research Laboratory. Wholesale fishery transactions and supplemental information supplied on 'Trip Tickets' should supply fishery scientists with necessary information for making stock assessments and implementing fisheries management policies to maximize yields and economic benefits.

The Department of Natural Resources also has regulatory authority in managing shellfish resources through special permits; including shellfish processing, mechanical harvesting, relaying, depuration, shellfish leases, and aquaculture leases. Table 1 represents a summary of management policy and regulatory authority controlling hard clam resource management. These policies are promulgated in the Florida Statutes (F.S.) and the Florida Administrative Code (F.A.C.).

Rules have been adopted to protect clam resources from over harvesting and depletion. These rules established a minimum harvesting size of 7/8 inch thickness (across the hinge), protect the environment by restricting harvesting hard clams in grassbeds, protect environmentally sensitive areas by regulating the use of mechanical harvesting gear, and insure public health. Rules also restrict the time and manner of taking and transporting hard clams. The effect of these newly adopted rules will be to assure an abundant supply of hard clams in the future, while protecting seagrasses and other parts of the estuarine environment. Because some rules only became effective January 1, 1985, it is impossible to determine their impact on clam resources. However, it is apparent that this action was not swift enough in coming to sufficiently curtail harvests of buttons in 1984. The year class, or set which would make up the most valuable part of the 1985 harvest, the little necks, make up only a small percentage less than 5% of the present clam population.

In order to increase shellfish production an extensive leasing program has been developed. Approximately 2275 acres of state bottoms have been leased through 194 lease contracts; 99 of these leases are located in Brevard County, totaling 850 acres. Bottoms are presently leased at $5.00 per acre. Over the years Florida's policy on leasing has fluctuated between strongly encouraging leasing to suspending new leasing activity. In earlier years shellfish leases were most commonly used to cultivate oysters, but more recently, clam production and relaying to shellfish leases have increased, particularly in Brevard County. Leased bottoms are designated by corner posts, but access is not restricted except for harvesting shellfish.

Under Florida Law a lessee must demonstrate that the lease is being developed to improve productivity to levels suitable for commercial harvesting. Suitable development for shellfish

leases generally meant providing suitable substrate, or cultch to promote oyster attachment and growth. Suitable development of a lease for clam production is much more difficult to define, and other criteria to demonstrate development may need to be applied.

The Governor has requested leasing contracts be carefully scrutinized; attempts are being made to have all public lands which are leased by the private sector become self-supporting. Lease contracts and prices, including docks, marinas, and shellfish leases; would be sufficient to reimburse the state for all costs incurred in the course of administration and enforcement. The Department's position has been to restrict leasing activity until the specific guidelines are enacted. The Department is also presently investigating alternative shellfish leasing concepts pertinent to use requirements, compensation, and fee structures.

Numerous changes have been proposed to improve leasing concepts. These include 1) revising aquaculture leasing rules defined in FAC 160-21, 2) restricting the size of shellfish leases, 3) changing lease prices, and 4) developing methods of payment based on production levels. New policies are also being developed which will pertain specifically to aquaculture leases and the restricted use of state bottoms and overlying waters.

The clamming industry in Florida, particularly Brevard County exploded during 1984 after successful sets in 1982 and 1983. Table 2 represents a conservative estimate of the fishery's landings and values. To appreciate the magnitude of increase, these figures can be compared with state wide landings and values of approximately 125,000 lbs and 400,000 dollars in the preceeding two years (Table 3).

New policies have also been enacted to support and encourage relaying and depuration activity. Florida's shellfish management policies are directed toward promoting shellfish production, as well as, protecting and perpetuating the resource. One method of increasing production is through relaying clams to depuration facilities. Depuration has proven to be an effective method for utilizing a previously rehabilitated resource and insuring product quality. The DNR has supported the conscientious harvesting of clams, from specific areas closed to public harvesting, for the purpose of depuration. Individuals or companies which hold shellfish leases can apply for permits to relay clams.

Harvesting, transport, and relocation are closely monitored and supervised by law enforcement officers and the DNR. Clams can be harvested from leases 15 days after relaying has been officially terminated, if meat samples meet bacteriological standards (230 standard).

Depuration is typically accomplished in tanks using recirculated UV treated water, water quality paraters are controlled, and bacteriological concentrations are closely monitored. Table 4 demonstrates the rapid increase in relaying and depuration activity in recent years.

Table 1

Management Policy	
Clams	Ch. 370.16, F.S.
Harvesting	Ch. 16B-28, F.A.C.
Mechanical Harvesting	Ch. 370.16, F.S.
Vessel Requirements	Ch. 16B-28, F.A.C.
Shellfish Lease	Ch. 370.16, F.S. and Ch. 16B-28, F.A.C.
Aquaculture Lease	Ch. 16Q-21, F.A.C.
Relay Permits	Ch. 16B-28, F.A.C.
Depuration Permits	Ch. 16B-28, F.A.C.
Quality Control	Ch. 16N-27, F.A.C.
Enforcement	Ch. 370.16, F.S. and Ch. 16N-27, F.A.C.
Reporting Landings and Sales	Ch. 370.06, F.S.

Table 2

Hard Clam Harvests And Values (1984)

	Bushels Harvested	Number/ Bushel	Number (millions)	Percent Harvest	Value ($0.00)	Total Value (million $)
Buttons	54,548	1200	65.46	25	0.02	1.30
Little Necks	130,914	700	91.64	60	0.06	5.50
Cherry Stones	26,183	300	7.85	12	0.05	.40
Chowders	6,545	100	0.65	3	0.01	.06
Total			165.61			7.26

Values Extrapolated From Florida Landings And Industry Surveys

Table 3.

Hard Clam Landing And Values								
Year	Total		Brevard County		Volusia County		Gulf County	
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
1979	71,714	163,756						
1980	61,892	154,856	50,816	129,650	4,149	9,715	262	489
1981	117,249	313,458	61,348	171,404	31,275	94,609	13,735	21,217
1982	145,324	458,562	136,498	432,542	7,971	24,429	790	1,433
1983	142,566	473,108	108,332	374,604	19,234	59,168	14,033	36,475
1984	1,548059	4,836,684	1,433,295	4,498,611	14,513	45,851	71,634	154,476

From Florida Landings, NMFS.

Table 4.

Hard Clam Landing And Values								
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1984	1,548059	4,836,684	1,433,295	4,498,611	14,513	45,851	71,634	154,476

From Florida Landings, NMFS.

Patty Carbonara
Aquatic Preserves Manager
Florida Department of Natural Resources

The Indian River - Malabar to Vero Beach Aquatic Preserve may be the setting for a new industry soon: mariculture. As those in the shellfish business realize that clams can not reproduce fast enough to keep up with the increasing demands and the aquaculture industry improves the technology to cultivate clams, people are beginning to look towards clam mariculture as a way to keep production up.

Clam mariculture projects on state-owned submerged lands will require a lease. Until, recently, aquaculture leases in this area and around Florida have not been in big demand. In anticipation of more requests for leases, the Department of Natural Resources is looking into their leasing policies again. The Department of Natural Resource's Divison of State Lands has put a temporary hold on leasing new areas while rewriting portions of the rule concerning aquaculture leases. They will resume processing aquaculture lease applications when the rule has been revised.

If the lease applied for is in an aquatic preserve, it will also be reviewed by the staff of that preserve. The aquatic preserve personnel will try to determine if that particular lease and its mariculture plan are compatible with the goals of aquatic preserves. Staff will be looking at the lease location, the types of impacts the project will have on the lagoon's resources and will try to work with the applicant in developing environmentally-sound plans. If there is not enough data to make a thorough evaluation, a small-scale test of the proposal might be possible first.

Mariculture can be a valuable asset to the shellfish industry but not if it is done at the expense of the lagoon. A healthy habitat is needed for the propagation of shellfish. The Indian River Lagoon is in good condition and with careful planning we can keep it that way.

Captain R.A. Patterson
Florida Marine Patrol

Prior to the development of the Brevard/Indian River clam industry, there were few regulations dealing with the harvesting and processing of clams. Rapid growth and large influx of harvesters brought about many problems.

Through cooperation with people in the industry, additional regulations have been instituted and others are in the process of being updated. Considering that clamming is basically a new industry to Florida, growth has been orderly. Additional studies on the resource and the effect on the marine environment needs to be initiated.

Present Regulations

MFC Rule 46-17	Size and Harvesting restrictions
Special Act:75-336	Sport bag limit
F.S. 370.16	Shellfish regulations
F.S. 370.06	Saltwater Products License
1985 HB-89	Brevard/Indian River Clam License
Adm. Rule 16B28	Shellfish Code and Relaying requirements
Adm. Rule 16N27	Quality Control (Boat Requirement)

Enforcement Problems

Rapid growth of industry
Large influx of clammers
Size of harvest areas
Control of relay operations
Control of depuration processes
Lack of sufficient regulations
Lack of manpower - (Activity increase 1983-84. 200%)
" " 1984-85. 87%)
Illegal operations (harvest/sale)
Courts and fine structure
Community impact

INDUSTRY'S VIEW

Tom Jones
President, Indian River Clammers'Cooperative Association
Brevard County

The following is a brief description of concerns and recommendations of the Indian River Clammers' Cooperative Association which represents approximately forty clammers now working in the Indian River Lagoon.

1. The current 7/8", across the hinge, size limit is too small and should be increased to one inch. All clams smaller than 1" should be returned to the Lagoon for later harvesting. This will protect the industry by protecting the resource from overharvesting. To aid enforcement and clammers culling for small clams, the tolerance level for harvested undersized clams should be raised from the present level of 3% to a 5% level.

Equipment presently in use is designed for the 7/8" size limit (7/8" between teeth or bars) so that minimal culling by clammers is required. Raising the tolerance limit to 5% will allow for the increased possibility of undersized clams being harvested between the 7/8" and 1" size ranges due to human error introduced in the culling process and save clammers from purchasing expensive new equipment.

2. The Indian River Lagoon is too small for the intense fishing and recreational activities presently occurring within it. Submerged lease areas decrease the size of areas available to the public. Old leases which are not being used for production purposes (i.e., relaying or mariculture) should be reissued to persons wishing to participate in productive activities or else revert back to the people of Florida.

3. The southern clam has a shorter shelf life than does the northern clam. Due to this fact, it would be preferable to open new harvesting areas within the Lagoon during the winter months (perhaps on December 1st) when the shelf life of the southern clam more nearly approaches that of the northern clam.

4. The practice of relaying clams from unapproved or conditionally approved areas to either leased areas in approved waters or to depuration plants has positive and negative impacts upon the industry. Some of the positive aspects include the creation of a steady market flow by allowing harvest from unapproved areas or during times when conditional areas are closed. Unfortunately, this also has the effect of creating increased harvesting pressure on the resource and allows buyers to more easily set prices lower than fair market value since only buyers with leases or depuration plants can buy these clams.

5. Money from the newly created "clam diggers license" should go to purchasing and properly placing seed clams rather than to research which may be of questionable benefit to the resource. If research is to be conducted, it should be of a practical, applied nature and be directed at increasing production. The Florida Marine Patrol or other suitable government agencies should also be able to use this money to help combat pollution problems facing the Lagoon.

6. [This section presented by Mr. Charlie Hotcavig- Indian River clammer.]

Pollution is the clammers' biggest enemy. Many people involved in the clamming industry in other areas of the country have been forced out of these areas by harvesting area closures necessitated by severe pollution problems. At this time, approximately 80% of clam harvesting areas in the state of New York are closed due to pollution. Individuals have the ultimate responsibility for the health of the Lagoon. However, the state of Florida must aid the people of Florida in this effort by taking the lead in the fight against pollution of the Indian River Lagoon.

CONCLUSIONS

Mike Endnoff
Aquaculture Development Representative
Florida Department of Agriculture & Consumer Services

The Brevard County Clam Industry Workshop, held September 7, 1985, brought together a concerned group of people, representing varied interests to talk about the use, protection and management of a resource of importance to all. The workshop was a success in that attendees came away with a better understanding of one another's interests and the overall picture of the Indian River Lagoonal System. What follows is a summary of some of the information presented at the workshop, my impressions and some recommended actions for the future.

Participants heard that over 90% of the clams reported harvested in Florida came from Brevard County waters. The 1984 statistics showed 1.7 million pounds of clam meats valued at $6.1 million or a dockside value of $3.54 per lb. of meat. Since Florida harvests 13% of the nation's total, clamming is clearly an economically important industry to Brevard County.

Participants learned that the Indian River is more of a lagoon than an estuary since there is relatively little water exchange between the lagoon and the Atlantic Ocean. In fact, the term river is a misnomer which adds to the problems of the lagoon since it implies anything, such as pollutants, added into the river will merely be carried away. So creating a better public awareness of the value, function, and fragility of the Indian River Lagoonal System should be a high priority of all attendees. We learned that the lagoon is one of the most diverse estuaries in the United States with approximately 400 species alone of fish collected from the lagoon. The marine grasses, mangroves, and other marsh plants are very important to the health of the lagoon and the overall system directly impacts the commercial harvests in and outside the lagoon.

The Indian River Lagoon is now an aquatic preserve which is an attempt to provide more protection to the area. The lagoon has an aquatic preserve manager and a management plan. The plan is the process by which such a concerned group as the clam workshop, can work within to eliminate the pollution sources into the lagoon and protect the clam resource. An aquatic preserve could accommodate aquatic farming enterprises such as clam culture if they are designed in an environmentally compatible manner and do not overly restrict the other users or purposes of the preserve. A demonstration project was suggested as one possible method to evaluate the compatibility and impact of a culture operation on the Indian River Aquatic Preserve.

The audience learned that a great deal of research has been undertaken in the lagoon,. DNR has contributed through the shellfish assessment program, aquatic preserve program, and scientists at the Marine Research Lab in St. Petersburg. The University of Florida, Florida Institute of Technology, and Harbor Branch Foundation have all undertaken research in the lagoon. FIT and Harbor Branch have been actively sampling the lagoon to determine clam, abundance and develop methodology to predict yearly recruitment to the clam fishery. Recent research suggests that the large 1984 clam harvest may have resulted from heavy rainfall during the spring and fall spawning seasons in 1982 and the above normal rainfall the succeeding two years, in contrast to previous theories of prolonged low rainfall and decreased clam abundance. Developing the appropriate methodology to predict clam populations on a yearly basis should be a high research and management priority. A second observation is that researchers have shown considerable interest in the Indian River Lagoonal System. Workshop participants should work towards insuring that these resource persons continue to undertake active research programs in the lagoon and provide these researchers with direction which reflects the needs and concerns of the various user groups.

Regulatory issues were discussed and questions answered. One issue which needs to be clarified is the names for the various sizes of clams harvested. One speaker suggested sizes should be as follows:

Seed clams	less than 1.0 inch
Beans	1.0 - 1.5 inches
Buttons	1.5 - 2.0 inches
Little necks	2.0 - 2.5 inches
Top necks	2.5 - 3.0 inches
Cherry stones	3.0 - 4.0 inches
Chowders	greater than 4.0 inches

Little necks, top necks and cherry stones were considered the sizes commercially important. Therefore, one industry need is to standardize the clam sizes wherever the hard clam can be grown. This will assist both in managing the resource and marketing the product. The lease moratorium was briefly discussed. DNR staff stated that even though clams were recognized in the shellfish lease law (Chapter 370.16 F.S.), that law, when written (1961), was aimed at oysters since very few clams were harvested at that time. Staff stated the law was in the process of being revised along with the aquaculture lease law (Chapter 253 FS). Staff also felt the shellfish lease law to be too vague on DNR recinding idle leases and if challenged, probably would not stand up in court (i.e. another part of the shellfish lease law states the leases are granted in perpetuity). Regulators did state very clearly that industry members must make their needs known and work with government agencies, legislators, other users, etc. to obtain their goals and wisely utilize the resource. The Marine Patrol ran through the current regulations, fielded questions, and expressed a willingness to continue to work with workshop participants.

Industry concerns were presented by four speakers. Dealers would like to see the industry work together to improve the quality of the product and maintain high standards. Marketing is presently no problem as demand exceeds supply. However, improved methods (which IFAS researchers are addressing) of handling and storing the product are needed, especially

storage temperatures. The exeuctive director of an industry association talked about the economic importance of the industry to Brevard County and the state. He stated very clearly how all groups need to work together, state their problems and needs clearly, and engage in the political system to foster change. The only reason no assistance has ever been given to the clam industry (i.e. in contrast to the oyster industry) is because none has ever been requested.

Clammers presented eight industry concerns:

1. The size of clams needs to be standardized. Clams harvested should be the size worth the most money and not undersized. Undersized clams should be culled back into the water to be harvested the following season when they are worth more money.

2. The size of rakes currently have teeth spaced 7/8 inches apart to coincide with the minimum allowable sized clam harvestable. If the minimum clam size increases to 1.0 inch, the rakes should be allowed to remain at the current 7/8 inch spacing.

3. The Marine Patrol presently allows a 3% tolerance of undersized clams per bag of clams harvested. If the minimum harvestable size is increased to 1.0 inch, then the tolerance should be increased to 5%.

4. The lease moratorium should be lifted and an equitable system of leasing instituted. There are many leases not presently being utilized and this is not fair, especially since the law says these leases should revert back to the State.

5. The industry needs to have more approved shellfish areas opened. Presently, the process requires too much time. The state should be doing all it can to maximize the number and acres approved for shellfish harvesting.

6. Relaying was viewed as a necessary evil when approved areas were closed or not producing. Relaying from unclassified waters should be allowed.

7. The new license fees are high when compared to other commercial fishing industries (i.e. saltwater products license) and represents the money the clammer gives to the state to protect the resource. Clammers should have a more representative voice in how the funds are allocated and to what types of programs that benefit the needs of the industry.

8. There should be a better effort to stop and abate pollution in the Indian River Lagoon. The Marine Patrol could take a much more active role. Many clammers have moved south as the resource has become polluted along the eastern seaboard. There is no place further south to go if the Indian River becomes polluted.

The majority of the afternoon was devoted to presentations dealing with clam aquaculture in Virginia and in the Indian River Lagoon. Virginia researchers have found the hard clam to be an excellent candidate species, with a good market, a relatively short culture period for the highest priced market size, a hardy species once the organism is cultured past early life

stages, and culture technology is readily available. There are a minimum of 24 clam farms in operation and most are already earning a profit. While aquatic farming of clams will never replace the wild catch, it should be viewed as a supplement to the wild catch which could stabilize supply and improve markets.

Clams can be induced to spawn through manipulation of temperature and photoperiod or through injection of hormones such as seratonin. They should be reared in a hatchery or well protected area until they are a minimum of 9-10 mm in length (7/16 inch). Planting at this size along with some protection will yield 70-80% survival. A simple hatchery and nursery can be established for as little as $7000. A number of commercial hatcheries are in operation and a person with an aquatic farm or lease can send clams from their waters to these northern hatcheries to be spawned and juvenile clams shipped back to the farmer. Prices range from $7 per thousand 6mm clams after August to $14-17 per thousand 9-10 mm clams. A number of growout techniques can be employed. A manual written for the culturist without a scientific background was presented. The reference is:

Manual for Growing the Hard Clam Mercenaria
Michael Castagna and John Kraeuter
Special Report in Applied Marine Science and Ocean Engineering
Virginia Institute of Marine Science, No. 249, Spring 1981
Gloucester, Point Virginia 23062 $3.00

Researchers in Virginia have established a cost to the farmer of 3.4 cents per clam from spawning to loading a market sized clam on a truck.

In Florida, there is one commercial farm which has worked closely with Harbor Branch Foundation developing appropriate clam culture technology for the Indian River Lagoon. Harbor Branch has established a research hatchery and is now routinely spawning clams. Genetic selection has yielded a clam with a reddish shell and easily distinguished from a wild caught clam. Researchers have been planting a 4-6 mm clams in 4 x 8 foot covered trays on leased bottoms. Approximately 50% of these clams will survive to market size and yield 5 bags per tray. Growout requires 16-18 months with seed clams planted in the spring and harvested the following year in the fall. The speaker invited all interested clammers to come to Harbor Branch and view their facilities.

The workshop and its participants could become the focal point in developing an industry composed of wild harvesting, relaying and culturing clams, and in harmony with environmental concerns and other users of the Indian River Lagoon. The workshop only scratched the surface of the work which must be carried on by participants to foster change and insure the continuance of the resource. The major points identified at the workshop were:

1. The Indian River Lagoon is a valuable resource. It is extremely productive, biologically diverse and economically important to both commercial and recreational fisheries within and outside the lagoon. The wetland (marsh) and aquatic plants (grasses) are directly tied into that productivity, diversity, and commercial economy, and as a result, must be protected and well managed. The aesthetics of the area must be maintained as they are the primary reason for growth in Brevard County. The Aquatic

Preserve designation was made in an attempt to protect and manage the resource and could be used as a vehicle to achieve commercial needs as well.

2. The Clam resource has problems. The resource is poorly understood in terms of yearly abundance and recruitment and with what factors (i.e. rainfall, salinity)it is correlated. Population growth and other sources of pollution are continuing to further threaten the resource and not enough is being done to abate or control these sources. The clam industry must share the resource with other users including other commercial and recreational fishing, navigation, other recreation, agriculture, and public uses such as causeways and power lines. In addition, there are unresolved regulatory problems with relaying, depuration, leases and harvestable sizes of clams and enforcement of present laws is inadequate.

3. The technology to culture clams commercially on leases exists, such aquatic enterprises can be profitable, and clam aquaculture would add a new dimension to the industry. The efficiency of agriculture over a hunting and gathering technique has been an established fact for over 100 years for nearly all food consumed. Aquaculture can stabilize and enhance markets through year round production and availability of a quality product. Such a program in the Indian River Lagoon could be accomplished in an equitalbe manner without eliminating the small independent businessman and at the same time reduce enforcement problems.

Clearly, the participants who gathered at the workshop to discuss problems and needs of the clam resource and the cooperative spirit of communication generated at the meeting should be continued. I believe all the necessary ingredients exist to develop a productive clam industry which will be a strong economic incentive to protect and manage the resource in an environmentally sound manner. Therefore, I am suggesting the following recommendations for consideration as a course of further action.

1. Create an organization of all existing user groups, resource persons, and private concerns to actively pursue development of a plan of action to foster needed changes and implement objectives. The organization can be in the form of a committee, a new incorporated organization, or a branch of an existing group such as the clammers association, the Marine Resources Council of East Central Florida, or through the Aquatic Preserve Management team. The organization should develop clearly defined goals and plan strategic objectives to obtain those goals. The organization should also have broad based representation to insure they are managing their own future destiny with respect to the Indian River Lagoon. Representation should include:

a) Industry. A member and a non-member of the clammers' association, a relayer, a depurator, a dealer, a member of the Organized Fishermen of Florida, a member of the Southeastern Fisheries Association, a commercial fisherman directly dependent on the lagoon, a commercial fisherman indirectly dependent on the nursery function of the lagoon, a clammer at large, a clam farmer, and a recreational clammer.

b) Conservation and environmental groups such as the Marine Resources Council.

c) Researchers such as Harbor Branch, Florida Institute of

Technology, University of Florida and others.

d) Resource persons such as IFAS and Sea Grant extension and other government agencies, especially regulatory. DNR, for example, could have members representing shellfish assessment, Marine Research Lab, State lands, and aquatic preserves.

e) Others including the aquatic preserve manager, chamber of commerce, local government, and public at large.

One possible organization could be based on Alaska's Regional Aquaculture Association's designed to protect and manage the resource, but requiring legislation. A brief synopsis of the Alaska program is attached.

2. Continue to encourage research in the Indian River Lagoon, especially as it relates to the clam industry. This would include continuing monitoring and ecological studies; basic clam biology, recruitment predicting, handling, storage, shipping, pros and cons of relaying and depuration, and quality control; culture techniques including environmental compatibility of aquatic farming enterprises; and demonstration projects.

3) Develop an educational program. Informing area residents, industry members, and other users about the importance of the lagoon, the benefits of a clam industry which includes aquatic farms, and the long term value of protecting and managing the resource should be a high priority. This program should minimally include how the lagoon functions, the economic importance of users including the clam industry, pollutional threats to the resource, and what steps concerned citizens can take to insure maintenance of the resource. News releases, media events, and brochures describing all the various users and functions of the lagoon are important tools which numerous government resource persons can assist with in developing. The long term solution is to develop a comprehensive program within the Brevard County School District so that hopefully, our children will grow up knowing how to respect the resource and not make similar mistakes.

4) Develop a dynamic plan of action and systematically implement those identified actions. This is a key recommendation and may be accomplished through an existing planning process or developed as an independent plan from the organization described in recommendation (1). The process should contain specific elements to manage and enhance the clam resource. The elements to address should include:

a) Pollution. The sources of pollution, the pollution issues affecting the shellfish industry, and the approaches currently being taken to reduce pollution in growing areas.

b) Leases. The issue of creating private property rights in a publically held natural resource should be resolved one way or the other. The DNR should begin by plotting existing leases on a map of the Indian River Lagoon. Industry would then know where the leases were located, who the owners are, and possibly work a deal to sub-lease or purchase a lease. Regulators and users could also use the map to assess where additional leases should or should not be located. Next, DNR should recind inactive leases. If the statute is not clear, then testing in court would clarify

the statute by developing case law. The moratorium should be lifted and new parcels leased. One possible solution to the lease dilemma would be to use the organization in recommendation (1) to work out a new lease plan with government regulators satisfactory to both sides. The DNR could then go to the Legislature with the organization's support to amend existing statute (s). The paper entitled "Building the Perfect Lease" could be the basis for fostering a workable solution.

c) Aquatic Preserve. The goals and objectives of the organizations dynamic plan of action should be integrated into the aquatic preserve management planning process.

d) Demonstration. A public or joint public-private demonstration project on clam aquaculture should be undertaken. Appropriate technology will be determined, costs and return data generated, and environmental compatibility evaluated. Most importantly, skpetical industry members will have the opportunity to see how such an aquatic farming enterprise is established and operates.

e) Political Strategy. This is an important element which was addressed by two speakers. Collect the facts, determine needs and priorities, and engage in the political system to properly inform the local Legislative delegation. As both speakers stated, you have to ask for something in order to get it.

I believe these recommendations could assist the start of a new future for the shellfish industry in the Indian River Lagoon. The key is to organize and cooperate. Interested industry persons should not give up if they can't get all their members to agree. The Industry must adapt to modern times and not expect to survive with past methods or technology. Those who do not participate at first, will participate as changes occur and objectives achieved. These are the facts of life and are no more evident then in the competitive nature of our free enterprise system. And the dynamic plan of attack can be so designed as to never eliminate the small or individual businessman which presently makes up the majority of this industry. The keys are communication, cooperation, and compromise.

ME:jn