STATUS OF CLAM CULTURE IN THE UNITED STATES

February 19, 2000

—Workshop Proceedings—

Virginia Institute of Marine Science
College of William and Mary

in cooperation with
Virginia Shellfish Growers Association
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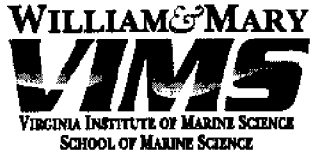

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INTRODUCTION

According to the first-ever Census of Aquaculture conducted by the U.S. Department of Agriculture, gross sales of cultured molluscan shellfish (including seed stock sales) in 1998 exceeded $89,128,000. Clams (primarily *Mercenaria mercenaria* and *Tapes philippanirum*) accounted for over $53,428,000, close to 60% of the total aquacultured shellfish production. Based upon the gross value of the reported cultured production, the top 5 producer states were: Washington ($12,148,000); Virginia ($11,049,000); Florida ($9,541,000); New Jersey ($1,574,000); and, Massachusetts ($1,337,000). Other states that had cultured clam production, but could not be separately reported in the USDA Census of Aquaculture, include Maine, Connecticut, New York, North Carolina, South Carolina, Alaska, and California.

Within the past decade, the culture of clams has grown dramatically around the United States. Basic approaches to clam culture are very similar nationwide, but because of regional differences, the specifics of culture techniques vary. Additionally, different regions of the country are experiencing unique problems related to industry growth. In an effort to promote a better understanding of the current status of the clam culture industry and to identify potential areas of mutual benefit, representatives of the major clam culture producing states came together to exchange information and perspectives. On February 19, 2000, almost 100 people convened at the Virginia Eastern Shore town of Exmore to participate in this unique opportunity to openly discuss issues and concerns of the clam culture industry. This report contains abstracts or summaries of the presentations given at that meeting. Following the abstracts is a summary of concerns or initiatives identified within the clam culture industry.

The meeting was sponsored by the Virginia Institute of Marine Science of the College of William and Mary, in cooperation with the Virginia Sea Grant Marine Advisory Program and the Virginia Shellfish Growers Association.

CLAM AQUACULTURE IN VIRGINIA

Dr. Mike Peirson
Cherrystone Aqua-Farms

Virginia was ranked tenth in total aquaculture production in the recently released 1998 U.S. Census of Aquaculture. Clams accounted for $11,049,00 in sales with 25 farms producing a total of 70,636,000 clams. There were about 300,000,000 clams insured in Virginia with the new crop insurance program this year (multiple planting years). There are probably eight active hatcheries in Virginia with seven of them on the Eastern Shore, with possibly 50 mostly small growers planting seed. By 2001, Virginia growers should produce over 100,000,000 market clams.

Of the growers without hatcheries, many buy ready-to-plant seed of at least 10-mm shell length, while other buy smaller, cheaper seed which they grow to planting size in raceways, upwellers, spat bags, or nursery bottom beds.

Cherrystone Aqua-Farms, with hatcheries in Cheriton (bayside) and Willis Wharf (seaside), plants 100,000,000 seed per year using their own employees and co-op growers. Cherrystone operates 122 upwelling tanks each containing ten 18" upwelling cylinders. These tanks produce 3-mm-mesh seed for spat bags and 4-mm-mesh seed for sand trays. Spat bags are stocked at about 20,000 seed per bag and are deployed for six weeks. The resulting 4-, 5-, and 6-mm-mesh seed are planted in sand trays at 10,000 per tray and are harvested after eight weeks during the planting season or after over-wintering for late planted seed. The 8.5-mm or 12-mm-mesh seed are bottom planted at 50,000 per 14' by 50' bed from April 1 until December 1. Beds are covered with 1/4" mesh held down by long, tubular gravel-filled bags. Average growout time is 24 months, but some beds are harvested after only 14 months. Clams are harvested by 18" wide hand rakes.

Some problems and potential problems include QPX, which has been found along the entire length of the seaside, but has not been documented to cause any mortalities. Seed importation without documentation is another potential problem. A major current problem is in the tightening of the provisions in the Army Corps of Engineers Nationwide Permit #4 which allows aquaculture production as long as it does not interfere with submerged aquatic vegetation (SAV). Determining what is an SAV bed is up to the local COE person and is becoming a problem for clam aquaculturists. Cherrystone Aqua-Farms believes that clam aquaculture actually encourages SAV growth and we have a series of aerial photographs that we believe supports this view.

A REPORT ON THE STATUS OF QUAHOG FARMING IN MASSACHUSETTS

Rick Karney, Martha's Vineyard Shellfish Group, and
Dale Leavitt, Southeastern Massachusetts Aquaculture Center

Quahog (hard clam - *Mercenaria mercenaria*) farming in Massachusetts is alive and well! Hard clam farming in Massachusetts can be divided into two categories, public and private aquaculture. Public, or community, aquaculture focuses on the need for restocking and restoration of current or formerly productive shellfish fishing areas. Usually undertaken by the town's shellfish constables within the region, municipal culture raises clams to a size where they can be released into the wild with a reduced risk of mortality from predation. At the appropriate size threshold, the clams are seeded into productive fishing areas to support the wild harvesters, both commercial and recreational, in the town. On the other hand, private aquaculture encompasses the traditional licensing of tracts of marine intertidal and subtidal areas for private use to grow quahogs and a variety of other commercial shellfish species. Associated with the public restoration programs and the private bottom shellfish grow-out "grants" are the shellfish hatchery and nursery industries within the region as well.

Current Production

Massachusetts quahog production has been steadily expanding over the past ten years as the number of towns, farmers and the amount of licensed bottom has increased. Production of farmed quahogs, assuming that two-thirds of total cultured shellfish production in Massachusetts can be attributed to quahogs, is approximately $3 million (total cultured shellfish production at $4.5 million - NRAC Status & Outlook Report, 1996). Since 1996, the number of private aquaculture permits for shellfish culture has increased from about 250 to over 300 individuals while the amount of privately licensed bottom has increased from 600 acres to greater than 1,000 acres. The vast majority of this culture area is located on intertidal and subtidal flats within the two counties of southeastern Massachusetts, encompassing Cape Cod and the Island of Martha's Vineyard.

There are presently about twelve private shellfish aquaculture sites actively growing shellfish on Martha's Vineyard. Most of these growers are fishermen who were retrained as aquaculturists under a National Marine Fisheries Service funded project in 1995-1997. Single oysters for the half-shell market are the preferred crop as they have greater market value than quahogs. Also, the nature of lease sites available to the Island growers are better suited to the cage culture of oysters rather than bottom culture of clams. A number of growers have been successful culturing small and inexpensive seed (0.75-1mm) to more valuable 15-20mm field plant size quahogs in one season in floating sandbox and tidal-powered upweller nurseries. The field plant size seed has been sold to municipalities for public stock enhancement programs and to other growers off-island for grow-out to market size.

Wild commercial harvest of quahogs, on the other hand, has remained fairly stable, if not declining a slight amount, at about $5 million for the entire Commonwealth for the past ten

years. Of this $5 million, Cape Cod accounts for approximately $2.70 million while Martha's Vineyard provides an additional $0.55 million, together accounting for approximately 65% of the total state harvest. Quahog production from the recreational fishery is a more difficult number to gather. Recreational harvesters do not have to report their catch other than an estimate when renewing their licenses. Suffice it to say that the recreational quahog fishery is a very important component to the "way of life" on Cape Cod and as such has a large influence on the intangible attraction of living and visiting the region.

With respect to providing clams for wild harvest, the shellfish departments within the towns of Cape Cod and Martha's Vineyard are dedicated to public aquaculture of hard clams and other shellfish species. In 1999, the fifteen towns of Cape Cod collectively purchased twenty million juvenile quahog seed from commercial hatcheries as a component to their municipal restocking programs. On Martha's Vineyard, the Martha's Vineyard Shellfish Group - a consortium of Island towns dedicated to producing shellfish seed in a hatchery, provided eleven million quahog seed to the six towns in the program. These juvenile clams were destined for release into the wild fishery after nursery culture within the each town's municipal shellfish nursery program.

Current Culture Practices

Massachusetts is the home of two shellfish hatcheries that produce a wide variety of seed shellfish, including American oysters, quahogs, bay scallops, soft shell clams, and surf clams. One hatchery is a commercial (for profit) enterprise, Aquaculture Research Corporation in Dennis, MA. ARC has been at the forefront of shellfish hatchery technology and production for greater than thirty years. The second is a collaborative hatchery supported by six towns on Martha's Vineyard. The Martha's Vineyard Shellfish Group has been operating a shellfish hatchery on the island for twenty-two years with the goal of supplying the public shellfish propagation programs on the island with quahogs, oysters, and bay scallops. Both hatcheries have proven to be successful undertakings where their production levels have supplied the local and regional industry with shellfish seed on a regular and consistent basis since their start.

The nursery stage of quahog farming has traditionally been using a bottom tray system on Cape Cod and a raft-based tray system on Martha's Vineyard. In both cases, the growers would purchase small seed (1-3mm) and plant it into small (2-32 ft^2 surface area) shallow (4-8 inches deep) trays in June. The seed would be harvested in October at 15mm and planted under netting for the final grow-out stage by the private farmers. The towns prefer to grow the seed to 25mm, by over-wintering, and then plant the seed directly into the wild.

More recently, there has been an effort to develop upwelling nurseries in Massachusetts and this has met with considerable success. Using an upweller allows the public and private grower to purchase their seed at a smaller size with lower cost and grow the seed in a protected environment until they are ready for the field nursery during the late summer or for direct grow-out planting in the fall. The vast majority of the growers use bottom planting with a fine-mesh net covering the beds, to keep the surface predators off the crop, as their final grow-out technology.

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Current Problems and Possible Solutions

A list of current problems confronting the shellfish aquaculture industry in Massachusetts can be summarized in three statements. The first problem is one that was identified by the aquaculture industry through a survey conducted in 1999 by the MA Department of Food and Agriculture. All aquatic farmers in Massachusetts identified an overall lack of understanding of their industry by the general public as their primary concern. Public education has been identified as a number one priority area for future efforts to support the industry. Education covers a range of programs - from demonstration projects and technological workshops for the industry to public relations and introductory education for the general public. It is believed by the aquaculture industry in Massachusetts that this effort will produce the greatest change in the attitude in relation to the development of an aquaculture industry in the Commonwealth. It will also provide the best cost-benefit compared with the level of investment by federal, state and local agencies and private individuals to promote positive changes for the industry.

The second concern is the growing level of conflicts with other users of the coastal zone. Other users range from wild shellfish harvesters, who are concerned with losing fishing bottom by privatization of the resource areas, to upland owners, who are concerned that farming activity on the flats will disrupt the view from their multi-million dollar "trophy" home. Much of this conflict can be disarmed through a public education process that explains the reasons for and the potential of aquaculture as an environmentally friendly economic motor for the region.

The third issue facing the hard clam grower in Massachusetts is the potential for disease. As is true for the oyster, the occurrence of QPX (Quahog Parasite Unknown) in Provincetown and other sites in Massachusetts has driven home the concept of disease and disease management to the quahog farming industry. There is growing support within the industry and throughout the Commonwealth for developing an organized shellfish health monitoring program and for increasing disease research by local scientists to assist the industry in dealing with this issue in the future.

In order to address all of the concerns with respect to aquaculture, both real and imagined, that have been vocalized in Massachusetts over the past few years, the industry has embarked on the development of a manual of Best Management Practices (BMPs). BMPs are a voluntary set of operating procedures that promote the development of an industry that uses technologies that are low impact yet support good production. The primary issues of concern to be addressed by BMPs have been identified through a public discussion process and the recommended best management practice is being developed by an industry working group. The final document will be one that is accepted by a wide array of groups, including the existing shellfish farming industry, the regulatory agencies controlling shellfish farming and the non-governmental agencies who are watchdogs for the environment and property owners rights.

Anticipated Problems

A list of future problems that are destined to confront the Massachusetts shellfish farming industry includes:

1. The genetics of farmed animals relative to wild animals: Because the commercial shellfish hatcheries have developed a specific genetic phenotype that results in distinctive shell markings ("notata" clams), hatchery reared quahogs are easily identified. This is resulting in a growing awareness of the contribution of hatchery reared shellfish to wild populations. The contributions of notata clams comes both from municipal restocking programs using hatchery reared clams and from the larval production of cultured clams that are spawning in the growing beds prior to harvest. Regardless of the source, the question will inevitably be asked as to what is the impact of hatchery-selected strains of shellfish on wild shellfish population genetic diversity.

2. There will be an increasing level of space use conflicts between shellfish farmers and other users of the coastal zone. What is currently happening in Massachusetts will continue to escalate as the coastal zone becomes more populated and more heavily used for recreational purposes. One solution to this problem is for commercial aquaculture to move onshore or off-shore in order to move away from areas of use conflicts.

3. The final anticipated problem relates to seed supply. Massachusetts had a severe shellfish seed shortage two years ago (1997-98) due to the failure of one of the primary commercial hatcheries supplying the Commonwealth. Although a number of new hatcheries have been started in response to this situation, the stability of the seed supply is still in question as the industry grows and seed demands increase. A means must be found to allow the seed suppliers to produce the necessary amounts of shellfish seed and efforts should be made to keep these businesses in operation.

Future Technological Development

The final discussion point is a listing of the future technologies that are needed to support the developing shellfish culture industry. These new technologies must focus on:

1. Alternate shellfish nursery technology: The key to successful production is a good supply of healthy growing seed shellfish at the right time of the year. By developing better nursery technologies, our ability to meet this need is greatly enhanced.

2. Alternate species development: The shellfish culture industry in Massachusetts currently relies on two species of bivalve, the American oyster and the quahog. There is a critical need to expand the species list to allow the growers to diversify their crop and thereby develop assurances that the loss of any one crop may not ultimately result in the destruction of the whole commercial crop on the farm. More species are needed to provide opportunities to diversify the crop.

3. Genetic selection: Improving the performance of commercially cultured strains of clams and oysters through genetic selection and manipulation will provide great benefits to the industry. Classical genetic selection and the application of ploidy manipulation both have the potential for significant improvements to the growth and survival of cultured bivalves.

As we stated in the beginning, clam culture is alive and well in Massachusetts! Although the industry has been growing at a rate of 10% per year for the past five to ten years, there is still a large potential for continued development of the industry in the future provided that the proper incentives and support remain available to the developing industry.

MANILA CLAM CULTURE IN WASHINGTON STATE

Eric R. Hall
Taylor Shellfish Company

This presentation was put together to give the Virginia Shellfish Growers Association some insight on clam culture activities in Washington state.

The Manila clam *(Tapes philippanirum)* was first introduced in the state of Washington by accident. In the 1920s, Pacific oysters *(Crassostrea gigas)* from Japan were introduced into Washington State. The Manila clam along with the Japanese drill and the Japanese flat worm were introduced unknowingly.

The Manila clam spread rapidly throughout Puget Sound and Hood Canal. During the 1960s, Manila clams were being harvested and sold commercially. Upon the introduction of hatcheries and the ability to transport and set larvae remotely, the cultivation of this species began.

The Manila clam industry has grown significantly since introduction in the 1920s. The production of this species has grown to an excess of five million pounds annually. With advanced hatchery technology and micro-management of clam beds, production will continue to grow in the future.

There are many issues that face the industry today, from various populations of salmon being added to the Endangered Species Act to the tribal lawsuit against the state of Washington.

The future of the Manila clam industry will depend on the diligent efforts of the industry to become responsible stewards of the estuarine environment and the ability to work together with local tribes and state agencies to attain a favorable resolution for all parties involved in the tribal lawsuit.

STATUS OF HARD CLAM CULTURE IN NEW YORK STATE

Gregg Rivara
Cornell Cooperative Extension of Suffolk County

Although New York State has a long history of innovations in hard clam culture, the business of private clam culture in the state has not kept up with some other states to the north and south. This summary will delve into the history, current status, problems, and future of clam mariculture in New York.

The first instance of clam culture in New York was the transplant of seed clams from Massachusetts in 1901. This project was deemed a success as a four to one return was realized. The first artificial propagation of clams in New York was in 1926 by William Wells in an Oyster Bay State Hatchery. It wasn't until the early 1930s that Joseph Glancy took fertilized eggs to 25mm at the Bluepoints Company in West Sayville. By the mid-fifties the state was planting thousands of hatchery-reared seed to enhance natural production.

By the early sixties two established shellfish firms, F.M. Flower and Sons of Oyster Bay and the Bluepoints Company of West Sayville had established commercial hatcheries. In 1968 the Shelter Island Oyster Company was using the *notata* variant to genetically mark their clams. Municipalities have been involved with clam culture since the mid-seventies. Islip Town was the first to build a public hatchery in 1986, which grows primarily clams. By 1991 two more municipal shellfish hatcheries were in operation.

The current status of commercial hard clam culture in New York centers on two venerable companies formed in the 1880s and a number of smaller firms formed in the last two decades. Four out of six commercial hatcheries in the state produced 89 million seed clams in 1999; in 1998 cultured clam production of 25,240 bushels accounted for 12% of the state's total clam production. Note that oyster production of 31,364 bushels the same year accounted for 42% of total state oyster landings. Of the approximately 23,000 acres available for shellfish cultivation, only about 2,000 acres are currently in use for clams.

While not using hatchery-reared clams, the relay program in New York is considered shellfish culture by the state (the same permits are required). Currently, the great majority of clams are sourced from Raritan Bay off Staten Island and are relayed to four sites on eastern Long Island (Suffolk County). Since the program began in 1964 when 11,000 bushels were relayed by hydraulic dredge the relay program has evolved. In 1999, 81 hand rakers moved 82,176 bushels during the relay season (April to October). This represents 40% of the state's total clam production worth about $5 million dockside.

Municipal clam culture began in the 1850's with the planting of wild clam seed into town waters. The three municipal hatcheries serving four towns produced 44 million clam seed in 1999. Twelve out of 13 towns in Nassau and Suffolk Counties have shellfish seeding programs that rely on hatchery-reared clam seed. These programs, while popular with politicians and most shellfish harvesters are not usually scientifically evaluated in terms of survival, recruitment and economics.

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The problems that face clam culture in New York are many. New York lacks the intertidal or shallow subtidal expanses that other states enjoy. Most privately-controlled underwater lands are ten to twenty feet deep at low tide; five acre temporary assignments permitted by the state preclude the use of the natural bottom. Clam growth from egg to market size in New York waters is three to five years but can be slower in much of the deeper, private grounds available. Another problem is baymen opposition to the relay program, which is based on so many clams produced in such a short time affecting the market price and the semi-closed nature of who participates in the program.

The future of clam mariculture in New York State includes the current operators and the addition of a handful of new entrants, mostly small-scale. The revamping of state and town lease laws expected in the coming years will make more land available for clam culture. Commercial fishermen will continue to get into the business, but will most likely focus on other species, such as oysters and bay scallops. Town enhancement programs will get more into rigorous evaluations of their planting programs and use these results to increase recruitment to the hard clam fishery.

HARD CLAM, *MERCENARIA MERCENARIA*, CULTURE IN NEW JERSEY

Gef Flimlin
Ocean City Extension Center

Hard clam, *Mercenaria mercenaria*, aquaculture in New Jersey began in the mid-1970s with several baymen who wanted to take their future into their own hands. Clamming in the coastal bays was showing signs of waning and raising clams seemed a good idea. Following some instruction, and hands-on work with Mike Castagna and John Kraeuter at the VIMS Wachapreague Laboratory, a hatchery was set up in Atlantic City and clam production was underway. The State of New Jersey leased non-productive bay bottom to the aspiring aquaculturists and within a couple years the basics of field production was cemented with predator control screens of 1/4" plastic mesh being the prime method of reducing crop loss from crabs and rays.

The industry grew in the 1980s with the addition of some hatcheries. Most were run by baymen to produce seed for their own use and a couple larger commercial scale hatcheries came on the scene. One large commercial hatchery lasted a few years and then faded away, while two more have taken hold and remained for 10 to 15 years. There are still 5 baymen-run hatcheries and one baymen-owned land-based nursery system. These are spread over the three county area of Lower Ocean, Atlantic, and Upper Cape May Counties.

Field grow-out is focused in Atlantic County, and mostly in one bay call Dry Bay. There are about 40 to 50 growers with the majority holding leases in Dry Bay. The industry has not been experiencing much growth for several reasons. Leases have been hard to come by and the industry is trying to work with the State to open up alternative areas for expansion. This expansion is needed for both physical reasons of needing more space, and the biological reason that an epizootic event might wipe out most of the production, if most of the production is limited to Dry Bay. There are also social and bureaucratic constraints of opening other areas since there is significant recreational boating and fishing pressure in the coastal bays, and marine enforcement can inhibit the opening of other areas if they feel that they can't patrol the area sufficiently.

Hatchery production has been haphazard in the past five years with unexplained mortalities taking its toll in several hatcheries. The presence of Brown Tide in four of the past 6 years has slowed production in some hatcheries and in some field plots. The market is fairly steady but the price has not improved for the grower. Competition in the marketplace has not come from within state, but from out of state, and some growers are investigating other marketing options.

Industry support from the State is limited to the leasing of the ground where the clams are grown and not much more. There is no State involvement in the aquaculture techniques and methods. Rutgers, the State University, provides support from the Haskin Shellfish Research Laboratory and Rutgers Cooperative Extension. There are two industry organizations to which growers can belong, the NJ Aquaculture Association and the NJ Shellfisheries Association.

NORTH CAROLINA CLAM CULTURE INDUSTRY SYNOPSIS

Skip Kemp
North Carolina Sea Grant Marine Extension Program

Category	Description	Amount
Leases (DMF)*	Number (1998)	284
	Acres (1998)	2,135 ac.
Hatcheries	Seasonal spawns, cultured algae (small-scale)	3 active 4 inactive
Plantings (DMF)	Seed (reported by leascholders)	7.37 Mill
Plantings (DMF)	Relay (9.2 K bu @ 400 clams/bushel)	3.67 Mill
Seed Purchased	To nursery or direct plant (phone survey)	22-30 Mill
Seed Sold	From nurseries (phone survey)	10-12 Mill
Nursery type:	Upwellers (12-14 inch diameter)	600
	Raceways (4 ft. x 10-16 ft.)	200
	Bags (4 ft. x 4 ft.)	100
Nursery Survival	avg from 1 mm seed in upweller	78%
Nursery Survival	avg from 4-6 mm seed in raceway	88%
Nursery Survival	avg from 4-6 mm seed in bags	72%
Grow-out	Bottom Beds (14'x20', 14x28, 14x50, 14x25, 16x20, 10x20, 14x80, 20x28)	mesh (1/4", 3/8", 1/2")
	Bottom Bags (4'x4', 4-1/2 X 4-1/2)	mesh (9-mm)
Planting densities	Bottom Bed average	52/sq.ft.
	Bag average	66/sq.ft.
Grow-out Survival	Bottom Beds average	60 %
	Bottom Beds range est.	50-90 %
	Bottom Bags range	0-95 %
Time to harvest	variable, depends on site	50% @ 1-1/2 yrs.
	Percent of survivors	35-80 % @ 2 yrs.
		avg. 70% @ 3 yrs.
		100 % @ 4 yrs.

Problems:Theft, predation, storms, sediment shift, fouling, market competition, obtaining leases in good areas

Harvests (DMF)	Number (reported by leaseholders)	4.84 Mill
Harvests (survey)	Number (includes forecast and estimates)	6.2-8.2 Mill

**DMF = Division of Marine Fisheries*

THE REALITIES OF CLAM CULTURE IN NORTH CAROLINA: A PARTICIPANT'S PERSPECTIVE

William F. Cox
Cox Clam Farms

My business, which will soon be called Cox Clam Farms, Inc., is located on Core Sound just south of Drum Inlet near Atlantic, NC. I started my garden in 1994 by planting 500,000 10-mm purchased seed planted 100 per square foot. Survival was quite good for the first year producing a clam bed with many more clams than could grow at that density. In the second year, over crowding coupled with severe net fouling and hot shallow water, most of the clams died before making it to market size.

Without enough clams surviving to market size to recoup my seed cost, I realized that I had to make some changes fast. Reducing seed cost and improving survival became major objectives. I built a small nursery consisting of 12 raceways and two tanks of 10 upwellers. I purchased 1-mm seed at $3.00 per thousand and had good survival, better than 80%. I grew, this first year, enough 10-mm seed to pay for the cost of the nursery plus a nice profit, if I could have sold them at what I paid for my seed in 1994. The lesson learned: **keep your seed cost to a minimum and maximize survival.**

The garden survival rate needed considerable improvement. I have learned that the planting density needs to be tailored to the survival rate attainable in a given location. This may be difficult and cannot be done without trial and error. I determined that a density of 60 to 70 clams per square foot was right for me. Net fouling can cause slow growth and low survival if allowed to get too severe. Changing the nets during the second year works best for me when I have a fouling problem that does not correct itself during the summer. Keeping the bed secure from predators such as blue crabs, conchs and moon snails can not be over stated. In general, the better the care the better the survival rate. I have also found that removal of the protecting net (screen) late in the second year helps growth without too much worry from crabs and conchs. If you are likely to have skates and sting rays, however, you must keep them covered.

I have found that harvesting techniques can affect survival if the harvesting equipment moves too much sand and covers clams down stream. I have found that hand rakes or a mechanical rake that does not pump water is less likely to cause problems with adjacent beds.

As our industry grows we must develop better marketing channels. I have found that local clam or seafood dealers can not handle the volume that a fair size clam grower can produce. Markets closer to the table should be investigated and pursued. Although I have not attained what I want in a good marketing program, I believe that contract marketing will work well for our business. Finding a customer at or near the retail level that can handle the volume growers in a given area can produce on a contract price will work well for the growers and their customers.

HARD CLAM SEED SURVIVAL AND GROWTH BASED UPON INITIAL SEED SIZE AND PLANTING METHOD IN NORTH CAROLINA

Jonathan Grabowski
University of North Carolina, Institute of Marine Science

Seed clams were grown using two different methods for one year (10/98 to 10/99) on lease 9102, in Carteret County , North Carolina: 1) Three initial seed sizes (average length mm. = 10.9, 13.0, and 14.8), were grown in 4' X 4' soft bags tented with a 12" long PVC stake, AND 2) Two initial seed sizes (12.8mm. and 14.9mm.) were grown in 4' X 4 bottom beds covered with 1/4" polypropylene mesh. All treatments were stocked with 700 seed clams.

Clam survival in tented bags was enhanced with increased initial planting size. Small seed (10.9mm) had an average survival rate of 76.7% and large seed (14.8 mm) had an average survival rate of 93.1%. Survival was greater in soft, tented bags than mesh covered bottom beds when similar initial seed sizes were used. The average survival in soft, tented bags was 90.1% when medium (13.0mm) and large (14.8mm.) initial seed sizes were pooled. Survival in the mesh covered bottom beds for similar initial sizes (12.8 mm. and 14.9mm.) was 71.7% when these treatments were combined.

Growth rates in the various treatments were quantified by averaging the final clam length and determining the proportion of clams within each of the following three graded sizes (<5/8', 5/8" to 7/8", and > 7/8"). Higher growth rates were obtained with the mesh covered bottom beds when compared to soft, tented bags. Growth rates were slightly greater within each planting method when initial seed increased.

This project documents a method to increase survival using tented soft bags for the first year of growout as compared to mesh covered bottom beds; however, there is a growth penalty associated with this increased survival. The project also supports a minimum initial seed size that should be attained from a nursery system before planting in tented bags or bottom beds.

STATUS OF CLAM AQUACULTURE IN SOUTH CAROLINA

Knox Grant
SeaPerfect, Atlantic Farms, Inc.

Total sales of farmed clams (market clams and seed) are about $3 million annually. There are ten individuals licensed to farm in the state, four of which are inactive. Two of the active farmers produce seed for more northern customers using sand trays, tidal upwellers or pond culture. Three more growers are relatively small producers. Atlantic Farms, Inc. produces about 75% of the states clam revenues. In addition to the company's efforts, it has about 10 Family Farmers who farm under its permit. They produce about 2.5 million market clams annually and are trying to increase production. Atlantic Farms has 47 employees, a hatchery and a nursery in Charleston County, as well as nurseries in Sebastian and Cedar Key in Florida. It produces about 300 million 1-mm clam seed annually for its use and sale to customers in VA, NC, SC, GA, and FL. It also produces about 10 million market clams annually.

The company's corporate objectives are to increase seed sales and develop a better growout method. It is also investigating the culture of other species. The main problems we see as an industry are over-regulation and restrictions on interstate commerce in clams and clam seed.

HARD CLAM, *MERCENARIA MERCENARIA*, AQUACULTURE IN FLORIDA: AN INDUSTRY ON THE RISE

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In a state which ranks third in the United States in aquaculture production values, the culture of hard clams, *Mercenaria mercenaria*, represents the fastest growing segment of Florida aquaculture. Development of the industry was facilitated through the efforts of federally-funded job retraining programs which promoted shellfish aquaculture as an alternative employment opportunity for fishery dependent communities. Further, the availability of 10-year term, aquaculture leases and year-round growing conditions have contributed to the rapid expansion of this industry. From the placement of the first program graduates onto leases in 1993, the industry now supports over 430 growout operations on 1600 acres of state-owned submerged lands. Small-scale businesses have achieved acceptable levels of profitability with annual net returns estimated at $30-35,000 for farms (2-4 acres) planted at a million seed per year. Statewide sales, farm gate value, have risen from $0.4 million in 1987 to $12.7 million in 1997. Production rose to an estimated 99 million clams in 1997. Doubling of production once predicted for 1999 was not realized due to seed and crop losses associated with El Nino-related freshwater events.

Recent efforts have moved from focusing on training programs and growout production to developing infrastructure to support this emergent industry. Emphasis has been placed on seed production with several private-sector hatcheries and over 60 land-based nurseries now in operation. A number of small businesses manufacturing growing and processing equipment also exist in the state. Another focus, due to the rapid recruitment of fishermen into aquaculture, is marketing and distribution. Both industry and state government have reacted to the surge in production through a comprehensive program to create new markets. Technical research on shelf life and handling protocols is ongoing with the intent of recommending practical standards to improve product quality. Local governments have been spurred to address water quality issues with the intent of protecting and preserving their shellfish resource-based economies. Hard clam aquaculture has provided a means of economic revitalization for rural coastal communities in Florida. The challenge this growth industry faces in the future will be to achieve a level of sustainability.

SUMMARY

There is no doubt that the clam culture industry in the United States continues to expand. While there are some minor differences in production technology, the basic principle of predator protection over bottom planting holds true for all regions. Expansion, however, has not been smooth, with each region or individual state experiencing both common and unique problems.

A central theme for all regions was the area of user conflicts. These conflicts took several forms. In the New England region, this was exemplified by the sentiment of high-valued upland owners not wishing to have their "scenic vista" impacted by commercial shellfish aquaculture activities. This was viewed as continuing to worsen in all regions as more coastal land is developed. Many times these conflicts stem from a misunderstanding of the clam culture industry. It is essential that those in the clam culture industry strive to portray themselves as good environmental stewards and emphasize that their activities are potentially very beneficial to overall water quality. Clam culture must be identified as a "green" industry that is compatible with high standards of water quality. Additionally, clam culturists may have to look to more remote areas offshore for expansion if they are excluded from nearshore areas. On the West Coast, user conflicts take on an entirely different meaning. Besides the aesthetics controversy, Pacific Coast growers are faced with native American tribal claims of ownership. These conflicts, unfortunately, will be decided in a court of law.

As mentioned above, in keeping with the user conflict issue, is a need for the clam culture industry to develop a code of conduct or best management practices to maintain an image of environmental stewardship. These types of programs would serve as good public relations tools that could be used to educate the general public about the positive environmental aspects of clam farming. Public perception of the clam farming industry can be enhanced by proper care and disposal of used planting materials (nets, etc.), respect for property and access rights, and, basically, acting as good neighbors in high-visibility areas.

Another conflict that has impacted clam culture, especially in the mid-Atlantic region, is the issue of submerged aquatic vegetation (SAV) restoration efforts. This has been particularly acute in Virginia, and more recently in New Jersey, but has the potential to impact all clam growing grounds because of federal statutes. In particular, the Army Corps of Engineers Nationwide Permit #4, which applies to aquaculture activities, currently prohibits planting in areas where SAV is known to have existed. Clam culturists do not want to plant in existing SAV beds and contend that their planting activities actually encourage the re-establishment of SAV beds surrounding their growing grounds. This presents the appearance of having planted in the middle of a SAV bed, leading to a perception that clam growers are destroying the beds by their planting activities. Research is needed that documents the beneficial environmental nature of clam culture.

As grow-out operations have expanded, the availability of high quality planting seed has become problematic. The numbers of commercial shellfish seed producers have not grown

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at the same rate as grow-out operators. This has forced many growers to seek seed from outside their home state, leading to another suite of problems involving disease-free certification and varying state regulations regarding the importation of shellfish seed. The supply of high quality seed, ideally suited for local conditions, will ultimately be a concern of all grow-out operators who do not operate their own hatchery.

The lack of regulatory oversight of seed importation could become critical if the clam disease, QPX (quahog parasite unknown), expands its distribution or increases in prevalence and virulence. Documented mortalities from QPX have occurred in Massachusetts and the disease organism has been identified in Virginia clams, but not implemented in any mortalities in Virginia. Since the disease has been implicated in cultured clam mortalities only in the past few years, not a great deal of information is known regarding it life history, mode of infection, or how it spreads. These topics are all current research projects.

While no one in the clam culture industry wants to be "regulated," regulatory agencies are a fact of life. Problems arise when more than one agency becomes involved in the process. Maintaining all the necessary paperwork to satisfy shellfish sanitation agencies, interstate shipping mandates, and resource managers can become burdensome, especially when there are inconsistencies from agency to agency or state to state. In many states, sales of cultured clams are restricted because of inflexible resource management rules or regulations that were originally intended for wild stocks conservation. It must be recognized that culture clams are a privately-held product that should be exempted from laws meant to conserve a public resource.

Some regulation can be good, especially when it applies to the theft of either seed or market-sized animals. As the demand for seed has increased and it has become more difficult for grow-out operators to obtain, there has been an increase in the occurrence of seed theft, many times directly from an onshore upweller nursery system. On the water regulatory agents are already spread thin. With grow-out operations located in isolated coastal areas, the amount of time that they can devote to "patrol" of clam culture operations is exceptionally small. Clam culturists must be vigilant in the protection of their own product and must push for harsh punishment of convicted offenders as a deterrent to continued thefts.

As clam culture has grown, the amount of information available regarding the biology and the business of culture has grown. However, that does not mean that everything is known and that continued investigations are not necessary. There are still many topics that need to be addressed: unexplained hatchery mortalities, better understanding of growing ground dynamics, market refinement especially for smaller producers, genetic issues for seed selection, alternative growing technology, to name a few. The clam culture industry must take the initiative to establish relationships with academic institutions, research agencies, and other governmental bodies to lobby for assistance in furthering the development and expansion of clam aquaculture in the United States. Only through cooperative programs, with the free exchange of information, will all regions of the country prosper from a well-established clam culture industry.

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