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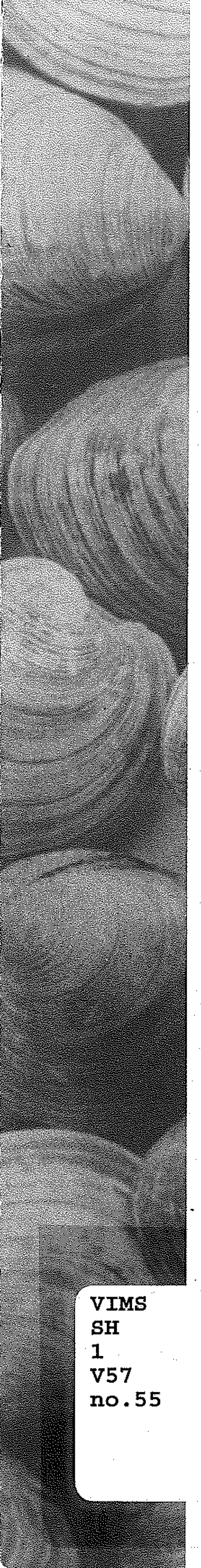

The Economic Impact of Marine Aquaculture on Virginia's Eastern Shore

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This document was published by
Virginia Sea Grant's Marine Advisory Program
School of Marine Science
Virginia Institute of Marine Science
College of William and Mary
Gloucester Point, Virginia 23062

Funding for this study was provided by the Virginia Institute of Marine Science, Shellfish Mariculture Initiative.

The first copy of this advisory is free to Virginia residents, and additional copies cost $2.00. The cost of the publication for out-of-state residents is $2.00.

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Editor and Designer: Susan C. Waters

Virginia Sea Grant Marine Resource Advisory No. 55
VSG-94-15

Executive Summary

Marine aquaculture on Virginia's Eastern Shore encompasses growing clams, oysters, other bivalves and shedding crabs. Of these, clam culture and crab shedding have the highest dockside value. In 1992, the dockside value of marine aquaculture on the Eastern Shore was approximately 6.5 million dollars with clams accounting for 4.5 million and soft crabs accounting for about 1.5 million. Soft crab production is highly variable because it is dependent upon the wild harvest supply of peeler crabs or premolt crabs. Average annual landings of peeler crabs on the Eastern Shore from 1985 to 1992 were 693,574 pounds, compared with 201,773 pounds in 1992. Most of the bivalves aquacultured on the Eastern Shore are from hatcheries. Based on the production forecasts of growers and hatchery managers, clam aquaculture will produce over 75 million clams by the year 2000. The projected dockside value of aquacultured clams in 2000 is 11.5 million dollars.

Employment from aquaculture activities was 134 Full Time Equivalents (FTEs) in 1992 and is expected to be 410 FTEs in 2000. However, the effects of aquaculture on the economy extend beyond dockside value and direct employment. Using the economic multiplier established for Virginia's seafood sector by the U. S. Department of Commerce, the estimated value of marine aquaculture to the Eastern Shore economy was 11.5 million dollars in 1992 and is projected to be 31.5 million dollars in 2000 (U.S. Department of Commerce 1993).

Introduction

Aquaculture is the fastest growing agricultural industry in the United States (DeVoe and Mount 1989, Gulf States Marine Fisheries Commission 1990). United States aquaculture production quadrupled in the 1980s; estimated production was 860 million pounds with a farm gate (dockside) value of 760 million dollars in 1990 (Joint Subcommittee on Aquaculture 1992). The Virginia Aquaculture Development Act, passed by the General Assembly in 1992, defines aquaculture as the propagation, rearing, enhancement and harvest of aquatic organisms in controlled or selected environments, conducted in marine, estuarine, brackish, or freshwater.

The development of a domestic aquaculture industry is important to the United States because of aquaculture's potential to offset the trade deficit created by imported fisheries products. In 1992 the total value of fisheries imports was 9.9 billion dollars and the United States trade deficit in seafood was 2.8 billion dollars (National Marine Fisheries Service 1993).

Within the broad definition of aquaculture is marine aquaculture, the culture of marine or estuarine organisms, or the culture of organisms in a marine environment. For coastal regions where traditional fisheries and related employment may be in decline, development of marine aquaculture provides employment opportunities that maintain links to traditional lifestyles. Marine aquaculture may also provide a basis for rejuvenating the local seafood industry.

Virginia's Eastern Shore represents an area with potential for marine aquaculture development primarily because of the abundance of coastal areas and few of the man-made influences of more developed coastal regions. The Eastern Shore is a narrow band of land, 75 miles long and rarely wider than 8 miles, bordered on the west by the Chesapeake Bay and on the east by the Atlantic Ocean (Figure 1). Designated as a United Nations Biosphere Preserve, the Eastern Shore's Atlantic coastline has one of

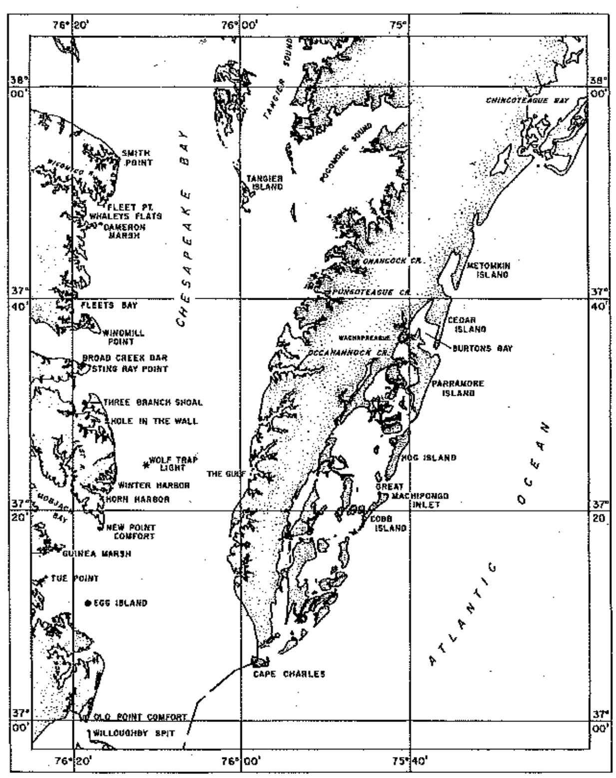


Figure 1. Eastern Shore of Virginia

the longest chains of barrier islands on the East Coast. The Eastern Shore is a rural area with about 45,000 people spread over 702 square miles. For many generations, residents of the Eastern Shore earned their livelihood from abundant and readily available natural resources.

Historical reports of the fishing industry on Virginia's Eastern Shore date back to colonial times. As early as 1621, there were inhabitants on the Eastern Shore whose duty was to catch fish for the colonies (Pleasants 1971). A strong fishery tradition has persisted through modern times. National Marine Fisheries Service (NMFS) data for 1972 listed 1,420 commercial fishermen, accounting for about 8.5% of Eastern Shore employment (Strand 1976). Strand estimated that seafood accounted for 25% of employment in 1972 ("seafood" includes not only harvesting but processing, wholesaling, and retailing as well). Like many rural and farm economies in the United States, the Eastern Shore did not fare well through the 1980s. The U.S. 1990 Census reported 1,902 people in the Eastern Shore Counties of Accomack and Northampton, employed in farming, forestry, and fishing occupations. This figure represents about 9.3% of the total employment for the two counties.

As of 1993, the Commonwealth of Virginia requires fishermen who sell their catch to have a Commercial Fisherman Registration License (CFRL) (§28.2-241 Code of Virginia 1990). The Virginia Marine Resources Commission (VMRC) issued 965 CFRLs to commercial watermen from Virginia's Eastern Shore in 1993. This is a reduction of 32% from the 1972 NMFS listing of commercial watermen. Using the ratio (8.25:25) established in earlier estimates of fishery and seafood employment on the Eastern Shore (Strand 1976), the estimate for 1993 seafood employment increases to 2,720, or 13.3% of employment. This difference is more than would be predicted by simply adding the estimated employment—between 753 and 1,306 jobs—in all value-added sectors: fresh and frozen fish processing; wholesale fish and seafood; and retail meat and seafood (U.S. Bureau of Census - *County Business Patterns* 1991). One explanation for the difference in estimates is a decrease in processing activity. Although several seafood processing businesses have closed, there are other factors which contribute to the difference in estimates. When a county has few businesses in a sector, *County Business Patterns* (CBP) provides only broad estimates of economic data to avoid revealing any business's proprietary information. Another limitation of CBP is that it does not include self-employed persons. Regardless of the estimate used, seafood supported employment is roughly half that reported for 1972.

In 1985, the community recognized it needed increased economic development to stabilize the declining population and to expand the eroding tax base of the Eastern Shore. These efforts are to be pursued, keeping in mind two needs: the preservation of the culture of Eastern Shore communities and the protection of natural resources (Accomack-Northampton Planning District Commission 1985). In 1992, citizens developed an implementation schedule for broad based sustainable development. They identified Northampton's most important assets as the gifts of nature and geography, fertile agricultural land, and clean productive coastal waters. Among the recommendations presented were modern sustainable seafood and agricultural industries, plus new product development and increased local processing. These assets and goals match those needed for the development of an aquaculture industry (Northampton Economic Forum 1992).

Status of the Industry

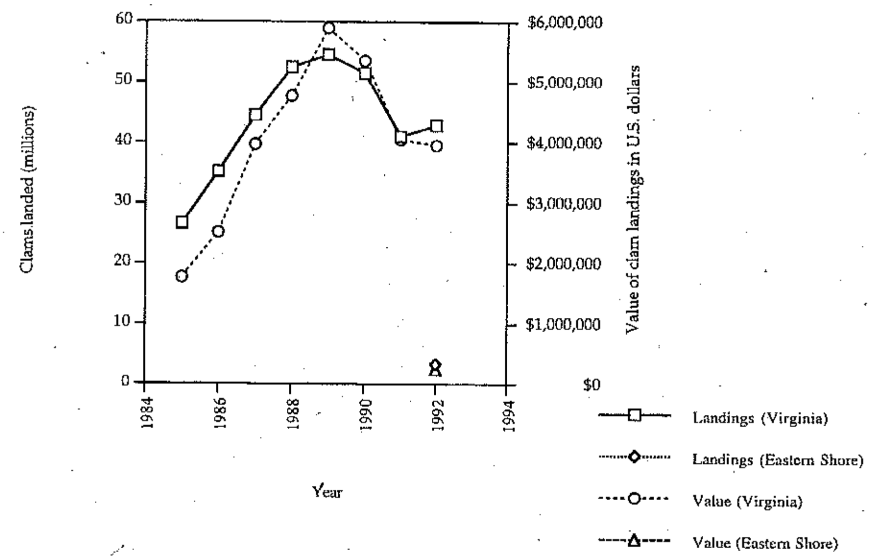
Marine aquaculture on the Eastern Shore encompasses many activities that produce and add value to seafood. Most marine aquaculture production comes from businesses growing hard clams, *Mercenaria mercenaria*. The Eastern Shore is home to the largest clam farm on the East Coast. Although Chesapeake Bay was once the world's largest producing region for oysters, *Crassostrea virginica*, recent oyster harvests are a small fraction of previous years. The 105,000 bushels harvested in Virginia in 1992 are less than 3% of 1959 harvests (VMRC 1959-1993). Oyster growers and researchers are working to develop new ways of growing oysters, including off-bottom culture. In addition to these traditional Virginia seafood items, growers are exploring the potential for culturing other bivalves as well. Included in the list of potential new products are bay scallops, *Argopecten irradians*.

Clams

Hard clams are an important seafood product from Virginia (Figure 2). The dockside value of the wild harvest clam fishery for 1992 was $4,025,129 of which $249,260 came from the Eastern Shore (VMRC 1993). The dockside value of clam aquaculture on the Eastern Shore in 1992 was in excess of 4.5 million dollars. The development of hatchery technology and grow-out strategies were the key to commercial viability of the clam culture industry.

Hatcheries provide increased control of the production process since operators can manipulate spawning times, genetics, and nutrition. Broodstock animals, frequently chosen for disease resistance or fast growth, are conditioned

Figure 2. Virginia Clam Fishery Landings and Dockside Value, The Wild Fishery



to spawn by maintaining favorable water temperatures and an abundant food supply (phytoplankton). After conditioning, rapidly increasing the water temperature induces spawning. The young clams are fed a diet of cultured algae and grow in the hatchery until transfer to the nursery. This technology is now standard and manuals exist for assisting growers (Adams et al. 1991, Kemp 1991, Manzi and Castagna 1989, and Castagna and Kraeuter 1981).

Another development leading to the commercial viability of clam culture is the ability to protect small seed clams from predators. Clams grow in land based flow-through nursery systems until they are large enough for planting in field nurseries. The seed clams are later harvested from the field nursery and planted for grow-out. Mesh in the form of netting or cages protects clams in the field from predators, such as blue crabs and rays. Approximately three years are needed for the clams to grow from embryo to market size (1" thick).

Clam Aquaculture 1992	
Production (number of clams)	**30,280,000**
Dockside Value ($)	**4,549,800**
Employment (FTEs)	**44.5**

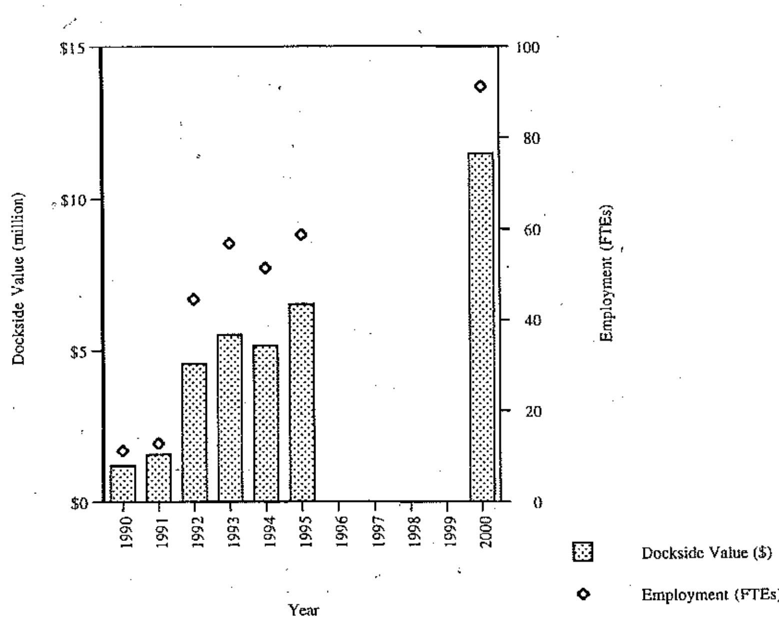
The clam culture industry is performing well and represents a model for the commercialization of marine aquaculture using other bivalve species. In addition to the largest vertically integrated clam culture firm on the East Coast, there are at least five other clam hatchery facilities currently in operation on the Eastern Shore. Most managers are planning to increase production and expand operations. All of these operations grow a portion of their crop to market size and several arrange cooperative agreements with other growers. Although each agreement is unique, the basic premise is that the hatchery provides seed, and the grower provides the labor for planting, tending and harvesting the clams. Revenue from the sale of the clams is shared between the hatchery and the grow-out partner.

By the year 2000, the dockside value of clam aquaculture is projected to be in excess of $10 million. Projected estimates of dockside value are based on growers' production forecasts and these estimates assume stable pricing. This assumption depends on future demand and supply equilibrium for hard clams and may not hold true, since aquacultured clams from the Eastern Shore compete in the marketplace with their wild-harvest counterparts and aquacultured clams from other areas. Clam prices traditionally peak in the winter due to reduced supplies from northeastern states (Brown and Folsom 1983). Conversely, increased supplies from aquaculture or a boom in wild harvest fisheries are likely to result in lower prices. Previous studies have examined the price and supply relationship of Virginia hard clams (Kvaternik et al. 1983). The relationship between supply and price is likely to differ from earlier estimates due to changes in distribution systems (transportation), marketing effort, and supply. Future research should focus on re-evaluating price and supply relationships for hard clams.

Estimated employment from aquaculture on the Eastern Shore increased from 11.25 Full Time Equivalents (FTEs) in 1990 to 56.8 in 1993. Based on the production forecasts, employment from clam farming will exceed 90 FTEs by the year 2000 (Figure 3). An FTE is a measure of employment that is roughly equal to a full time job and can equal a full-time salaried job or 2000 labor hours. Employment estimates, FTEs, are based on management, full time, seasonal, and part-time employee needs. Estimates include hatchery and nursery plus grow-out operations of the hatcheries, and growout partners.

Most of the projected increases in employment are expected to occur in the grow-out sector. Growers harvest clams manually using rakes because regulations restrict the use of mechanized harvesting devices for harvesting clams regardless of their origin, cultured or wild (§28.2-520 Code of Virginia). Since the manual skills are the same, many individuals participating in these cooperative efforts are commercial fishermen. A benefit of clam culture to commercial fishermen is that aquaculture revenues are relatively dependable compared with wild-harvest fisheries and consequently tend to stabilize income. Although labor appears a major benefactor of increased clam culture, it is also a potential constraint to increasing production. Despite an unemployment rate of roughly 7% and approximately 14,500 people not in the labor force (U.S. Bureau of the Census 1990), clam hatcheries report difficulty in obtaining suitable partners for grow-out.

Figure 3. Historic and Projected Dockside Value and Direct Employment from Clam Aquaculture on the Eastern Shore



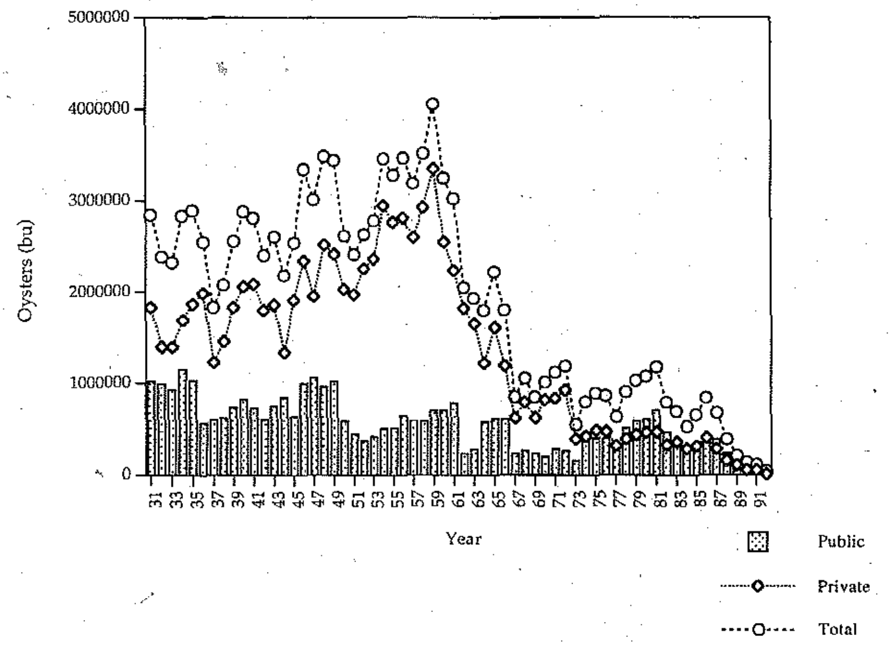
Another factor identified as a constraint to clam aquaculture development is availability of quality sites. This may contribute to the difficulty in finding suitable partners. Private leases to underwater lands are all "oyster" leases although they may be used for clams. There are 803 oyster leases with a total of 14,014 acres on the Eastern Shore; however, not all are suitable for clam culture and not all lease holders want to grow clams. Given appropriate water quality (salinity, dissolved oxygen, water flow and no contamination), suitability of a site is largely determined by how rapidly clams reach market size. Only a portion of the 14,014 acres will produce market size clams fast enough to repay a grower's investment in facilities, equipment and labor needed for production and harvest.

Oysters

Oyster culture in Virginia dates back to 1893 and the establishment of the "Baylor" grounds. The Baylor grounds, named for the surveyor, are those sections of Virginia waters where oysters occurred naturally in 1893. These grounds are for public oyster harvesting. All grounds not designated as public, or Baylor, are available for lease to private individuals. Since the only areas available for lease lacked commercial quantities of oysters, lease holders developed suitable bottoms for planting by transplanting shell and seed oysters from other areas. This was the beginning of private oyster culture in Virginia. Private grounds produced most of the Virginia oysters harvested from 1931 to 1973 (Figure 4). Private oyster planters still use these on-bottom methods for culture, although anecdotal evidence and landings suggest effort is decreasing.

As with agricultural crops, disease obviously has an impact on harvest. The widespread presence of oyster diseases Dermo, *Perkinsus marinus,* and MSX, *Haplosporidium nelsoni*, during the 1980s greatly effected oyster harvest from the Chesapeake Bay and continues to present a serious threat to the traditional fishery and any attempts to culture oysters. Although both diseases are serious threats to production, Dermo has caused the greatest losses in recent years. Dermo extends to all public oyster beds in Virginia and is responsible for as much as 90% of oyster mortality (Burresson and Andrews 1988). Dermo is most prevalent in the summer and previous exposure is more strongly related to mortality than existing infection intensity (Burresson 1990). Before 1980, Virginia oyster planters paid little attention to their grounds between planting of seed oysters and harvesting of market

Figure 4. Virginia Oyster Landings 1931-1992



oysters, two to three years later. Given this time requirement and the disease distribution, the likelihood of oyster mortality from Dermo is relatively high. Potential for exposure to MSX is much less certain; however, mortality generally occurs within one season. Mortality from MSX is generally between 30 and 50%, but levels as high as 80% have been recorded (Burresson 1994).

The threat of disease caused many Virginia oyster growers to reduce or curtail the planting of seed on private grounds and production fell to 28,847 bushels in 1992, a sixty year low (Figure 4). This represents a 93% decrease in bushels landed when compared to 1986. The dockside value of 1992 private Virginia oyster landings was $604,586 (VMRC 1993). Private landings of oysters from the Eastern Shore totaled 15,398 bushels in 1992 with an approximate dockside value of $357,430 (VMRC 1994). Data from earlier years are not available to document the decline of the oyster industry on the Eastern Shore. Conversations with watermen, however, indicate problems similar to those experienced by the rest of the Virginia fishery.

Off -Bottom Oyster Aquaculture 1992

Production (number of oysters)	**17,375**
Dockside Value ($)	**5,734**
Employment (FTEs)	**1.2**

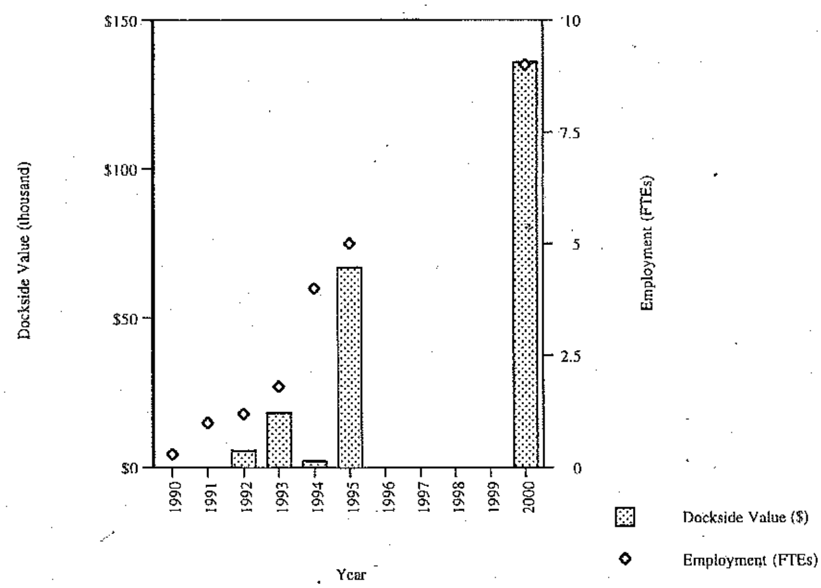
Not all growers have stopped trying to culture oysters. Some oyster growers are trying to augment the supply of oysters through off-bottom oyster aquaculture. In nature, oysters grow on the bottom. They are attached to other oysters in a reef or other hard surfaces. Research has shown, however, that oysters cultivated off-bottom grow faster than oysters planted on adjacent bottom (Paynter and DiMichele 1990). Using large seed and off-bottom culture techniques, oysters have been grown to market size oysters within 18 months. It is therefore possible, that with careful timing, oysters can be grown to market size without two Dermo exposures. If disease exposures occur, mortality is likely to be substantial. Since off-bottom aquaculture only changes the oysters' position in the water column, it does not impart any disease resistance.

Although off-bottom technology holds promise, it is still new and developing. Operations are small scale or demonstration projects with annual production levels below 50,000 animals. Rather than transplanting seed from other areas, off-bottom oyster culture generally relies on hatchery produced seed. Much of the seed currently available for grow-out is being supplied by the Virginia Institute of Marine Science (VIMS) as part of a cooperative research and development effort. Included within this effort is technical support for private bivalve hatcheries that produce oyster seed.

Growers plant seed oysters in floating mesh trays or in mesh bags secured to a rack. Growers transfer the oysters to containers with a larger mesh as soon as they are large enough to be retained by the mesh. Larger mesh openings also allow greater water flow and food availability, increasing oyster growth. Depending upon initial stocking density, oysters may be separated into more trays or bags as they grow and need more space.

Off-bottom culture tends to produce single oysters of consistent size and quality, features valued by the half-shell market. High quality fresh shellfish is the most desirable market form and commands the highest prices. Prices for mid-Atlantic cultured oysters on the half shell market averaged $0.28 per oyster for the 1993 production season (Virginia Department of Agriculture and Consumer Services 1993). This is roughly 3 times the dockside price paid to fishermen for wild harvest oysters. Average dockside price for 1992 wild caught oysters on the Eastern Shore was 23.14 dollars per bushel. Using 250 oysters per bushel as the standard, this translates to 9.5 cents per oyster.

Figure 5. Historic and Projected Dockside Value And Direct Employment from Off-bottom Oyster Culture on the Eastern Shore



Part of the difference in price is due to differences in the marketing channels for oysters grown off-bottom and those from oyster grounds. Nearly all oysters from off-bottom culture are destined for the half-shell market whereas many of the oysters harvested from oyster planters and public grounds go to shucking houses. Off-bottom oyster growers also tend to handle more of the packing and distribution functions (and their associated margins) than most fishermen. Off-bottom oyster aquaculture supports about 1.2 FTEs on the Virginia's Eastern Shore, excluding university and state sponsored research (Figure 5). Although off-bottom oyster culture is expected to increase in the future, it is difficult to predict when the proper blend of technology and management required for large scale development will be achieved.

Other Bivalve Aquaculture 1992	
Production (number of animals)	**21,000**
Dockside Value ($)	**4,000**
Employment (FTEs)	**1.0**

Other Bivalves

Marine aquaculture is beginning to diversify, extending to other bivalve species. Included in this list of new species are bay scallops (*Argopecten irradians*), ribbed mussel (*Guekensia demissa*), surf-clam (*Spisula solidissima*) and soft-shell clam (*Mya arenaria*).

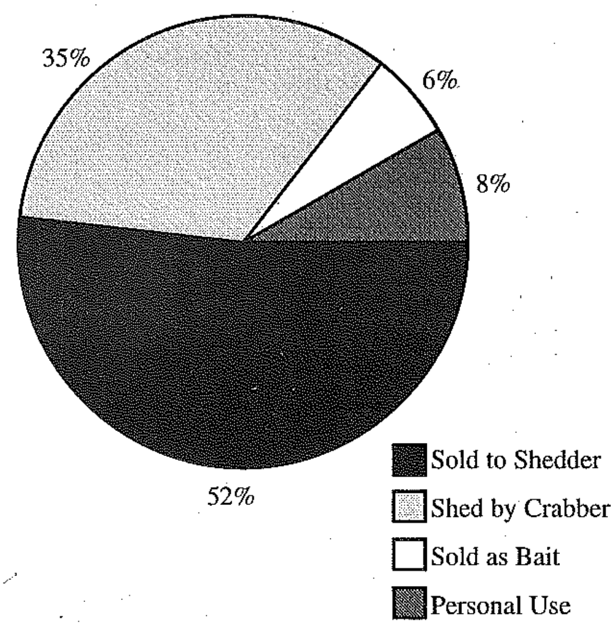
Work has already begun with bay scallops. The Virginia Institute of Marine Science is currently helping private growers with field planting to assess the practicality of bay scallop culture and the potential for hatchery operations. As with off-bottom oyster culture, most of the producers are experimenting and production systems are small scale. Some of these growers are also involved with culture of another bivalve species. Approximately 3 FTEs were dedicated to bay scallop culture in 1993.

Including bay scallops as an additional product line has two potential benefits: distributing risk and improving cash flow. Two crops mean that if a disaster strikes one, the other is still available. Bay scallops offer the advantage of fast growth, achieving market size (1.75") in 6 to 8 months, roughly 1/2 to 1/4 the time of oysters or clams. This means that the animals are marketed and revenues begin sooner. To achieve this cash flow, however, product must be sold. Since bay scallops are a new product, considerable effort will likely be required to build consumer awareness and develop a reliable client base.

Soft-Shell Crabs

Soft-shell crab production has been practiced on Virginia's Eastern Shore since the 1850s and is one of the oldest forms of aquaculture in the United States. A blue crab must shed its hard shell, or molt, before it can grow. Without a hard exoskeleton, the crab is vulnerable to most predators. This soft stage is short; several hours can elapse before the new shell begins to harden. The opportunity for predators, including man, to capture a crab in this stage is limited. To produce soft crabs, fishermen harvest crabs that are within a few days of molting (peeler crabs) then hold them in floating boxes (floats), flow-through tanks, or closed recirculating systems until they shed. Soft-crab producers, shedders, may catch their own peeler crabs or buy them from fishermen. Fifty-two percent of Virginia's peeler crab harvest is sold to shedders, and 35 percent is shed by the crabber and sold at retail or wholesale. Bait sales plus personal and family consumption account for the remainder of landings (Rhodes and Shabman 1994), (Figure 6).

Figure 6. Market Channels For Virginia Peeler Crabs



From Rhodes & Shabman 1994

Soft-shell crabs are a valuable and seasonal seafood item. The average ex-vessel price, \$1.73 per pound, for live soft-crabs is 3-4 times that of live hard crabs, \$0.41-0.61 (Rhodes and Shabman 1994, VMRC 1993). Advances in shedding technology and aggressive marketing have fueled the development of a valuable export market for soft crabs. The soft crab season lasts from April through October, with the major production peak occuring in early summer. Although catch varies each season, landings from the Eastern Shore average slightly less than 700,000 pounds, with an average ex-vessel value that is just over \$1,000,000 (VMRC 1985-1993), (Table 1). This is 39-86% of Virginia's reported annual soft-crab landings (Figure 7). It is believed that these reported landings substantially underestimate production and value. Some production is sold in Maryland and landings may be reported there instead of Virginia. Estimates from a producer survey place the 1992 Virginia peeler crab harvest at 1,919,446 pounds, compared with landing estimates of 518,770 pounds (Rhodes and Shabman 1994). Using these estimates, recorded landings are approximately 27% of the total harvest. If Eastern Shore landings were adjusted, using 33% to be conservative, then the 1992 harvests would be 611,433 pounds. Given an average price of \$2.40 per pound (VMRC unpublished data), the dockside value would increase to \$1,497,279 (Table 1).

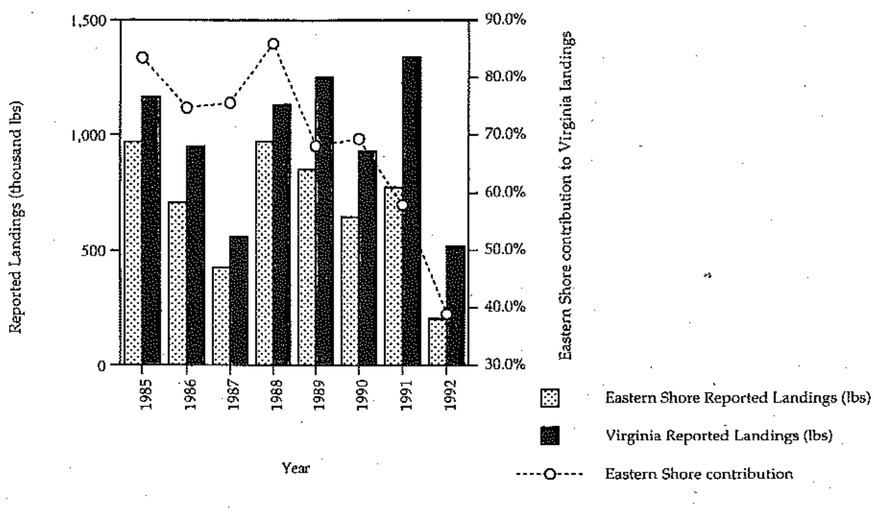
Table 1. Peeler and Soft-Crab Landings For Virginia's Eastern Shore

Year	Landings (lbs)	Value ($)	*Adjusted Landings (lbs)	Adjusted Value ($)
1985	970,025	1,035,170	2,939,470	3,136,879
1986	709,337	762,366	2,149,506	2,310,200
1987	424,424	586,312	1,286,133	1,776,703
1988	971,147	1,455,958	2,942,870	4,411,994
1989	852,806	1,783,249	2,584,261	5,403,785
1990	644,713	1,231,858	1,953,676	3,732,903
1991	774,370	1,077,252	2,346,576	3,264,400
1992	201,773	494,102	611,433	1,497,279

* Landing are adjusted using a factor of 0.33
Values are reported in current dollars (not adjusted for inflation).

Licensed commercial fishermen harvesting peelers on Virginia's Eastern Shore numbered 398 in 1992. These fishermen fished an average of 216 peeler pots for an average of 83 fishing days per season. (Rhodes and Shabman 1994). This translates into approximately 119 FTEs. Using catch per unit effort information calculated from the Rhodes and Shabman (1994) study and average peeler crab landings on the Eastern Shore from 1985-1992—employment for the Eastern Shore peeler crab fishery in 2000 is projected to be about 400 FTEs. It should be noted, this estimate is based on a single year of effort information and the mean of historical landings. Actual landings and effort may differ substantially, since it is quite difficult to make long range projections for wild harvest fisheries. Also, this estimate only accounts for effort from fishing crab pots. Effort from peeler pounds and scrapes is not known but is likely to be substantial.

Table 7. Peeler and Soft Crab Landings For Virginia and the Eastern Shore



Labor requirements and economic effects of shedding crabs are largely a function of the shedder's ability to obtain peeler crabs and the type of system used. Because the peeler crab fishery experiences annual and seasonal variations in landings, one shedder may be working nearly continuously during the peak of the season while some small operators would enter and exit depending upon supply and market conditions. Although there are exceptions, most crab shedders have alternate sources of income, generally from other fisheries but also from non-related occupations. Multiple products allow labor effort to shift between enterprises depending upon supply and market conditions. These conditions make it difficult to estimate labor associated with any individual venture such as crab shedding. In an economic evaluation of closed-recirculating crab shedding systems, 25,800 crabs required 1,720 labor hours (Roberts 1985). Using a conversion factor of 0.22 pounds per crab (Mike Oesterling 1994) and Eastern Shore harvest estimates, employment for crab shedding in 1992 accounted for approximately 87.6 FTE's (Figure 8).

Soft Shell Crab Aquaculture 1992

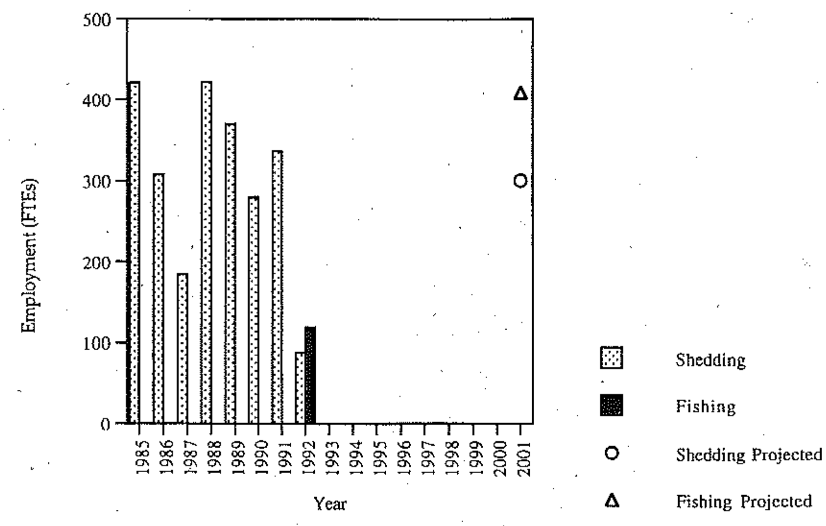
Production (lbs of crab)	**201,773**
Dockside Value ($)	**494,102**
Employment (FTEs)	
Fishery	**119.0**
Shedding	**87.6**

Discussion

Marine aquaculture is a valuable industry on Virginia's Eastern Shore with a combined dockside-value exceeding $6 million (Figure 9) and employment exceeding 130 FTEs in 1992 (Table 2). Many of the jobs created by aquaculture are similar to their fishery counterparts in that they require physical labor and skills that do not translate readily to other occupations. According to the U.S. 1990 Census, approximately 41% of the Eastern Shore's population over 25 years old had not graduated from high school. Providing employment opportunities to this group is one of the important benefits of the aquaculture industry. Although average real wages have grown slowly, on average less than 1% per year since 1973, the real wages of low skilled workers particularly young men with a high school education or less have actually declined (Economic Report of the President 1993).

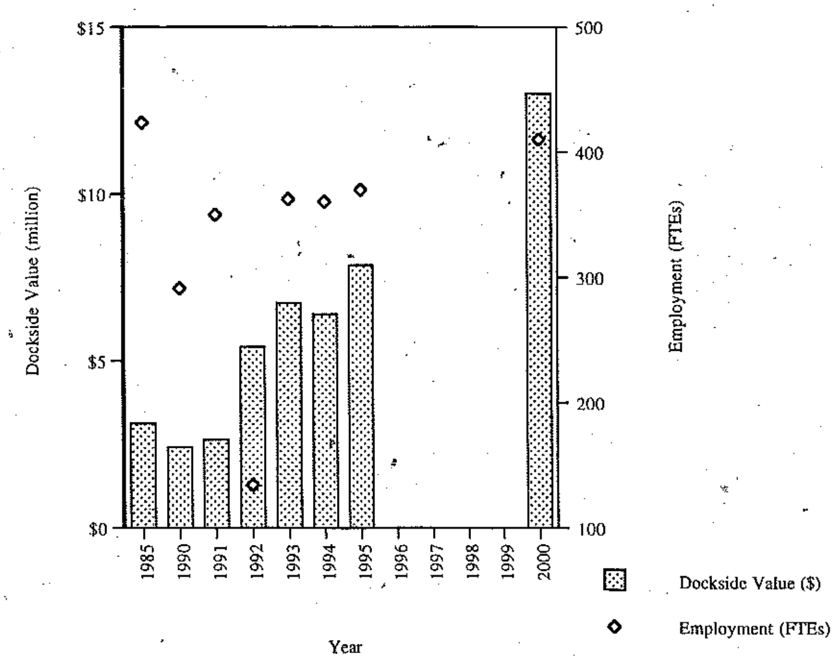
Beyond knowing the dockside revenue and direct employment that aquaculture businesses create, it is also important to recognize the additional effects that these businesses have on the local economy. It is widely known that a dollar spent in a community will have a ripple effect. The recipient of the dollar will spend at least some portion of it locally and the recipient of that portion will spend some, ad infinitum, until the last portion of the dollar is spent. In addition to the aquaculture business expenditures in the area, spending by employees (households) greatly affects the local economy. If all the local spending generated by a dollar was aggregated, the total would equal some multiple of the original dollar. One method used to estimate this effect on the regional economy is an input-output analysis.

Figure 8. Historic and Projected Employment from Soft Crab Production on the Eastern Shore



An input-output analysis examines the relationship between demand for a particular commodity and the regional economy. Change in income for a given industry is in response to a change in final demand of the target industry, in this case aquaculture. A change in demand for one industry product will have an effect on all the other industries which supply that industry. Direct effects are the initial purchases from those industries that sell products and services directly to the target industry. Examples include the sale of boats, harvesting gear, netting and pipe. Indirect effects result from the sale of goods and services to the industries that supply the target industry. Purchase of raw materials to build tanks is an example of an indirect effect. Employees of the target and supplier industries earn wages that are spent in the community. Economic activity generated from employee spending is known as induced effects. Adding all of these effects together yields total effect.

Figure 9. Historic and Projected Dockside Value Direct Employment from Marine Aquaculture on the Eastern Shore



Because of their ability to quantify interactions and the ripple-effect, input-output models are commonly used as part of coastal zone planning and management. To assure accuracy with input-output analysis there are some assumptions that must be satisfied: the technology is fixed (does not change), and there are no economies of scale in operations. Although aquaculture does bring with it new technologies, and hatcheries experience economies of scale, the grow-out phases have relatively constant returns to scale. Since much of the effort in aquaculture is directed at the grow-out phase, review of input-output analyses on the seafood industry can provide some insight into the potential economic effects of aquaculture.

Regional input-output analysis has been used in coastal zone economic impact assessments of commercial fishing and marine related activities for decades (U.S. Department of Commerce, 1992, Bundy 1990, Andrews and Rossi 1986, Briggs et al. 1982, Grigalunas and Ascari 1982, Rorholm et al. 1967). Grigalunas and Ascari (1982) and Rorholm et al. (1967) found that the income multipliers for seafood wholesaling, retailing and processing were

Table 2. Marine Aquaculture on the Eastern Shore: Summary for 1992

Sector	Production Units	Dockside Value ($)	FTEs	Community Value ($)	Community Jobs
Clams	3,028,000 ea	4,549,800	44.5		
Oysters - off bottom	17,375 ea	5,734	1.2		
Oysters -on bottom	21,000 ea	4,000	NA		
Other bivalves	15,398 bu	357,430	1.0		
Soft-Crabs	611,433 lbs	1,497,279	87.5		
Total	NA	6,414,243	134.2	12,251,204	185.4

Multipliers used to calculate Community Value and Community Jobs are from the USDC Regional input-output model for Virginia (RIMMS II).

substantially larger than the rest of the industries within the region (Table 3). Grigalunas and Ascari (1982) attributed these higher numbers to the fact that seafood has a high proportion of purchases within the region, especially from harvesting industries. Because of their need for labor, harvesting industries have a large proportion of payments to regional households as personal income. Briggs et al. (1982) also noted that the total income generated per dollar of seafood sales was higher than for virtually any other sector in the state.

Generally, the more self sufficient a region, the larger the income multipliers are. A self sufficient region will import fewer goods and services and thereby have less leakage of income from the area. Most of the production from aquaculture and commercial fishing is exported from the region and in some instances exported out of the country. This production leaves the region by way of brokers, distributors and shipping companies, and many of the supplies needed for aquaculture are purchased from suppliers outside the region. The need to go outside the local economy extends to most of the equipment used in aquaculture. Labor for operations and construction, however, is generally local. When considering aquaculture, the value of indirect income multipliers would tend to be reduced relative to fisheries by the need for imported inputs. However, input-output studies have been criticized for overestimating multipliers effects by treating inputs such as gasoline that was purchased from local suppliers as inputs that were produced locally (Andrews and Rossi 1986). Actual differences between wild fisheries and aquaculture industries may be quite small.

The ripple effect with respect to seafood and aquaculture may be best understood by viewing oyster planting on the Eastern Shore in terms of the Maryland oyster industry. In 1992, the Eastern Shore oyster growers harvested 15,398 bushels that had a dockside value of $357,430. The Maryland oyster industry required 12.47 million in expenses to produce 1.2 million bushels ($10.39/bushel) of oysters valued at $17.47 million in 1986 (Bundy 1990). Using this factor (not corrected for inflation), expenses for

Table 3. Multipliers for Seafood Harvesting Industries

Region	Author	Output	Income	Value Added	Jobs/ $Million
Maryland	Bundy 1990	1.36	1.59	1.7	
Virginia	USDC 1992	1.91	0.427		28.9
Ocean City	Rossi et al. 1985	1.96	1.3		
Maine	Briggs et al. 1982	3.22	1.02		
SNEMR	Grigalunas & Ascari 1982	3.37	1.83		27.8
Rhode Island	Callaghan & Comerford 1978	2.61	3.87		
SNEMR	Rorholm et al. 1965	2.96	1.76		
Cape Cod	King & Storey 1914	2.89			

private oyster planting on Virginia's Eastern Shore in 1992 were approximately $159,985. Maryland processors in turn spent $5.88 million to produce 0.356 million gallons ($16.5/gal) of shucked oysters worth $13.16 million (Bundy 1990). This translates to $170,762 worth of shucked oyster meats from the Eastern Shore production and processor expenses of $76,266. Many of the expenses associated with oyster production are wages for fishermen and processing plant labor. The total output and value added multipliers for the Maryland industry (Table 3) show that the oyster industry provides value added contributions to the state of Maryland nearly twice the amount that is spent for materials and supplies, and additional industry output almost 1 1/2 times the dockside value. Using regional multipliers for Virginia, the estimated total employment from private oyster planting on the Eastern Shore is 10.33 FTEs (U.S. Department of Commerce 1993). Given the employment generating ability of the oyster industry, it is understandable why declining oyster harvests are cause for concern and why it is important to find other industries to fill voids created by declining fisheries stocks.

If Virginia's regional multipliers are used for the entire aquaculture industry on the Eastern Shore, then the $6 million dockside value for aquaculture translates to an economic value to the community of approximately $11.5 million (U.S. Department of Commerce 1993). If aquaculturists' production forecasts are accurate and soft crab landings are near average (1982-1992), then the projected dockside value for aquaculture in 2000 becomes $16 million and the estimated total value of the industry is $31.5 million. The Virginia multiplier of 1.91 aggregates the seafood harvesting sector with agriculture and forestry and is one of the smallest multipliers available. If a multiplier that focuses more on marine harvesting is used, such as the unweighted average for harvesting sectors in Southern New England Marine Region 1982, then the estimates of value become approximately $19 million and $54 million for 1992 and 2000, respectively.

When the value of marine aquaculture is considered along with the fact that the industry is compatible with the lifestyles, values and development goals of residents, and the environment, then it is easy to understand why Virginia's Eastern Shore is a region with potential for increased aquaculture development.

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