

Aquaculture

Section 309 Enhancement Objective

Adoption of procedures and policies to evaluate and facilitate the siting of public and private aquaculture facilities in the coastal zone, which will enable States to formulate, administer, and implement strategic plans for marine aquaculture

Resource Characterization

Purpose: To determine the extent to which problems and opportunities exist with regard to the enhancement objective.

1. Generally characterize the private and public aquaculture facilities currently operating in your state or territory.

Type of existing aquaculture facility	Describe recent trends	Describe associated impacts or use conflicts
Private Hatcheries	<p>Increase in the number of hatcheries. There are 9 operational hatcheries in Virginia currently, of which at least 3 are new since 2005, and the larger hatcheries represent an investment of approximately \$500,000 to start. There has been an overall increase in the number of oyster hatcheries, as well as the number of hatcheries expanding into “grow-out” operations. Clam hatcheries experienced a very successful year in 2009.</p> <p>The acquisition of shellfish seed continues to be an important issue for the industry. In the past, there was a substantial lack of seed supply with the growth of the aquaculture industry. Currently, Virginia hatcheries cannot produce enough seed for all of the oysters or clam growers, so seed is imported to meet demand. There are importation regulations with VMRC about how seed can be imported due to concerns of diseases that could be imported including the parasites MSX and Dermo, and other concerns exist</p>	<p>This has been a positive trend as it has stabilized oyster production capacity. Additionally, there has been an increase in the availability of clam seed, which fueled an increase in production with a possible recent overplanting in clams.</p> <p>See the sections below under oyster aquaculture and clam shellfish aquaculture for additional impacts and use conflicts.</p>

	<p>about importing clam seed. As growers are required to get a permit for any seed that is imported into the state for oysters and clams, there was an overall decrease in importation of seed in 2009 as more oyster and clam seed is being produced instate at hatcheries.</p> <p>According to a VIMS/ Sea Grant report, “the oyster industry in Virginia has continued to expand its hatchery capabilities, reportedly producing 26.7 million seed oysters for sale or planting during 2007. Virginia's oyster hatcheries saw a more than eighteen-fold increase in the number of seed and larvae sold between 2007 and 2008. 84% of the seed planted by Virginia growers was purchased from a hatchery. The growers surveyed in early 2008 projected an additional 14% increase in oyster seed production during that year to an estimated 30.5 million. With the initiation of large-scale ‘spat-on-shell’ oyster planting in Virginia (see below for more information) during 2008, the entire hatchery-volume picture changed, as existing firms became active in purchasing not just clutchless seed, but large quantities of eyed larvae for spat-on-shell development.” The survey also found that hatcheries were predicting an additional four-fold increase in sales in 2009.³⁰</p>	
Public Hatcheries	Two public research hatcheries are owned by the Virginia Institute of Marine Science (VIMS), both capable of raising multiple species. For example, both hatcheries did extensive research on the Asian oyster, but that	The research being conducted at the public hatcheries will likely continue to be utilized by aquaculturists and private hatcheries.

³⁰ *Virginia Shellfish Aquaculture Situation and Outlook Report Results of 2008; Virginia Shellfish Aquaculture Crop Reporting Survey* by Tom Murray of Virginia of Sea Grant Marine Extension Program and Mike Oesterling of Virginia Institute of Marine Science from June 2009.

	<p>species is now no longer being considered as a viable option in Virginia. The VIMS hatchery on the Eastern shore of Virginia is now looking into scallop restoration options. The VIMS hatchery at Gloucester Point (main campus) houses the largest oyster selective breeding program in the country, and has had a significant role in the growth of oyster aquaculture over the last decade.</p> <p>While scallop restoration and hatchery efforts are still small in scale, there is a potential for them to grow in coming years, particularly for restoration efforts.</p> <p>Meanwhile, the advantages of domesticated strains of oysters for aquaculture have proven themselves, and such improvement is continuing incrementally.</p>	
<p>Finfish aquaculture</p>	<p>There are a few facilities currently attempting finfish aquaculture, with a focus on baitfish, including summer flounder and particularly spot. In some facilities, spot are caught with nets in the water and then held until they are sold for bait (which can yield a high return). Some of these facilities are not capable of hatching spot, but they are holding facilities for wild-caught spot. These closed system facilities, which are located on land near coastal areas, would like to have the potential to spawn and rear the spot. However, at least one facility has been spawning, rearing, and selling privately-produced spot for commercial sales for the past couple years, yet overall production numbers remain low. Some aquaculturists are working to grow finfish for food, but it has not yet become a large industry.</p>	<p>The principal use conflict that arises with shore-based finfish aquaculture is around the water quality of their effluent. Since the fish must be fed, the water they discharge from their systems is presumably higher in nitrogen, phosphorus (and possibly carbon) than their intake waters. They are required to have a discharge permit from the Dept. of Environmental Quality, so presumably if they don't violate their permit, this is not a significant problem.</p>

	<p>Some aquaculturists have examined the possibility of growing black-sea bass as well as cobia in farms at Saltville and on the Eastern Shore.</p> <p>There are also two research hatcheries for fish, one at VIMS and one at the Virginia Agricultural Seafood Research and Extension Center in Hampton.</p>	
Crayfish aquaculture	<p>There are two modestly-sized facilities that do pond aquaculture of crayfish. These are not marine facilities.</p>	<p>Closed system aquaculture done entirely on uplands is generally not considered to pose a use conflict. However if the facility is pulling in ambient seawater and discharging that water with an increased nutrient and chemical load due to feeding and medicating the crayfish, pollution impacts could occur.</p>
Spat-on-shell oyster growing	<p>According to a VIMS/ Sea Grant report, spat-on-shell oyster growing, also called remote setting, is a method of oyster cultivation in which oyster larvae are added to tanks containing aged oyster shells in a controlled environment on land, rather than in open Chesapeake Bay waters. After the larvae attach, or set, on the oyster shells and metamorphose into seed or spat oysters, the resulting spat-on-shell planted within a week in the Bay where the spat will grow naturally until ready for harvest.³¹ This method of oyster cultivation has increased since the previous assessment.</p>	<p>Spat-on-shell growing takes place more frequently on the western shore of the Chesapeake Bay. The primary advantage of spat-on-shell cultivation is that it requires less labor and fewer materials than single-oyster cultivation, thereby making it a more economically feasible option for producing oysters. Because spat-on-shell cultivation produces oysters grown in clumps (similar to wild-caught oysters), the primary product is oysters for shucking rather than single oysters for half-shell consumption. For this reason, remote setting is not meant to take the place of single-oyster culture (which produces consistent, high-quality, half-shell oysters) but to complement it with a means of large-scale production of local oysters for use by Virginia's oyster processors. The industry forecast for continued growth of eyed larvae for spat-on-shell is clear. Growers estimate that eyed-larvae purchases for culture will increase nearly four-fold during 2009 to an estimated 1.66 billion eyed</p>

³¹ Information from a June 2009 report, the *Virginia Shellfish Aquaculture Situation and Outlook Report Results of 2008 Virginia Shellfish Aquaculture Crop Reporting Survey* by Tom Murray of Virginia Sea Grant Marine Extension Program and Mike Oesterling of Virginia Institute of Marine Science.

		<p>larvae.² Ultimately, the market for eyed larvae could easily reach an order of magnitude higher.</p> <p>The lack of infrastructure in spat-on-shell cultivation may result in fewer use conflicts than cultivation of single oysters, which require cages and may be submerged or on the surface of the water, but use more of the water column than spat-on-shell in which growing only takes place on bottomland. Remote setting is currently occurring in areas where oyster aquaculture has traditionally taken place; if it expands considerably, potential use conflicts could result around the shoreline handling and shallow-water nursery facility stage in spat-on-shell cultivation.</p>
<p>Oyster shellfish aquaculture</p>	<p>There has been a significant increase in oyster hatcheries and oyster aquaculture activities in the past three years, and the majority of production is concentrated in the Chesapeake Bay. Oysters reach market size in 18 months, before diseases impact the oysters at two years of age. The oyster aquaculture industry is expected to continue to expand significantly. Oysters generally sell for 2 to 3 times the price of clams.</p> <p>While there is a well-established clam industry in Virginia, operating both on the Bayside and Seaside of the Eastern Shore, grossing approximately \$50 million dockside, (compared to approximately \$27 million in 2003 according to the Virginia Agricultural Statistics Service) the industry has shifted to start growing a significant number of oysters, both through spat-on-shell and single oyster growing (which are grown initially as larvae in a</p>	<p>Oyster aquaculture may have more of a visual impact than clams due to the surface equipment and water column utilization used for oyster growing, and there may be more impact on boaters. There have been use conflicts over the number of floats used in oyster growing, preserving viewsheds, and other issues. Alternately, it has been reported that some private landowners are requesting leases from VMRC in a defensive mode to exclude large-scale aquaculture activities and preserve their view. (See the section below under <i>Priority Needs and Gaps</i> for suggestions on VMRC addressing the leasing of subaqueous lands more effectively.)</p> <p>There has been funding, referred to as the “crab disaster funds,” available for crabbers to receive training and to transition to become oyster growers in the past year (for additional information, see the section below under <i>Program Guidance</i>). The private industry has</p>

	<p>hatchery, and then grown out in cages or floats, and are geared to the half-shell market) techniques.</p>	<p>speculated how this program will affect the supply and demand of oysters, and whether it will cause a drop in the price of oysters due to an increase in supply as the overall number of growers increase.</p>
<p>Clam shellfish aquaculture (and shellfish aquaculture overall)</p>	<p>Expansion of the industry and resulting management issues is a trend. Although there was some contraction of the industry in 2001-2002, the industry has grown significantly since that time.</p> <p>According to a 2009 VIMS/ Sea Grant report, there was a “small decline in clam plantings and sales but continued growth in oyster aquaculture. More than 185 million farmed clams--worth \$27.3 million--were sold by Virginia growers in 2008--down 13 percent from an estimated 2007 sale of 212 million clams. About 9.8 million farmed oysters went to market in 2008--up from 4.8 million in 2007, and surpassing the industry prediction of 7.3 million.”³²</p> <p>The shellfish industry is working more actively to be seen as a good neighbor, and to be recognized as a “green industry” for the environmental benefits of growing shellfish such as algae removal, fine sediment filtering and habitat formation (in the case of oysters).</p> <p>Some major traditional wild harvest seafood businesses are now getting involved in aquaculture. Currently the demand outpaces supply, and the primary market is out-of-state. However, there have been concerns</p>	<p>The majority of the clam industry is located along the Eastern Shore of Virginia, both bayside and seaside. Several areas--particularly for clam aquaculture--are being planted too densely which could be an issue of too many clams per square foot, too many nets on one growers farm, or too many farmers within a region of a creek or tributary. There have been some reports of concerns that creeks have become unnavigable as there are too many clam nets in them.</p> <p>As there is an increase in hatchery capacity and revenue, there is an increase in the overall number of clams that are being planted. There isn’t monitoring of the total number of nets being used in clam growing or the total number of shellfish being grown (although this is shifting with new VMRC reporting regulations; see below under <i>Regulations</i> for more information). Small tidal creeks are prime clam aquaculture locations, and many of these creeks are being overcrowded with clam growing equipment. However, clamming may become more self-regulating (either by industry or by the growth capacity of the clams) as clam growth and production is actually going down due to the large volume of clams being planted and issues with disease and food availability. There may be too many clam growers as well,</p>

³² *Virginia Shellfish Aquaculture Situation and Outlook Report Results of 2008; Virginia Shellfish Aquaculture Crop Reporting Survey* by Tom Murray of Virginia Sea Grant Marine Extension Program and Mike Oesterling of Virginia Institute of Marine Science from June 2009.

	<p>about the market getting saturated with too many growers (although some say this may be true for half shell, but the market for spat-on-shell for shucking is virtually unlimited).</p> <p>Wild harvesting continues to decline, and farmed harvest continues to increase and fill the gap. Oyster and clam aquaculture may have less overall impact than wild harvesting.</p>	<p>with some reporting that the market is saturated with too many clams and the price is thus negatively affected.</p> <p>On the seaside of the Eastern Shore, there is competition for leased space. The grounds have changed over time so the quantity of the bottomland has decreased as a whole, and the quality of some of the grounds have changed so that certain areas are no longer usable (see the section below on <i>Research</i> for information on the Baylor Grounds).</p> <p>Some areas have seen an increase in complaints about the visual impacts and user conflicts regarding aquaculture facilities, particularly on the Eastern Shore, which is experiencing significant residential growth. Homeowner complaints and concerns will likely increase with the increase in oyster farming as the equipment that is needed is frequently more visible than for clam aquaculture is (however clam aquaculture equipment, including PVC demarcation poles and clam netting which is sometimes exposed at very low tides, is often visible as well). There have been some homeowners and a Homeowners Association protesting the application of a lease for new clamming operations in small creeks in recent years. Conversely, there has been a move to recognize the importance of traditional maritime activities and working waterfronts. Some report that as most aquaculture facilities are advertised, conflicts are generally addressed before a facility is put in. This will continue to be an issue in the future.</p> <p>There has been an associated impact on commercial aquaculture from land agriculture, particularly polluted water</p>
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		runoff from agricultural (chiefly tomatoes) fields. Shellfish are extremely sensitive to copper which is sometimes used as a fungicide by tomato growers.
Bay Scallop cultivation	<p>Bay scallops are starting to be cultivated for restoration purposes on the Seaside of the Eastern Shore.</p> <p>Bay scallops require attachment to eelgrass at early growth stages and thus cannot survive without it. Because the CZM funded Seaside Heritage Program has successfully restored eelgrass on the Seaside, it may be possible to once again support a population of bay scallops. American Recovery Act funds through NOAA are being used to explore this possibility.</p>	The impact of reintroducing the bay scallop would be positive both ecologically and economically. A viable population that could eventually be sustainably harvested will provide jobs and income as well as an economic reason to support protection and expansion of eelgrass beds. However eelgrass and scallop habitats cannot co-exist with clam farms and so would present a use conflict to be resolved.
Algae production	All shellfish hatcheries are growing their own algae, but a significant portion of it is dying and there are problems with long-term cultivars. This has been an important issue since mid-2008. (See the section below under <i>Research</i> , particularly on ocean acidification, for additional information on this topic.)	Additional research is needed on reasons for algal death and ways to maintain steady production of algae.
Oyster gardening	There is an increase in the overall number of people doing oyster gardening, or growing oysters recreationally, throughout Virginia's coastal areas. VIMS estimates about 2,000 people in the state are currently growing between 1,000 to 5,000 oysters each, for environmental purposes (water quality improvement and restoration) and personal consumption. The Tidewater Oyster Gardeners Association estimates that there were approximately 1000 oyster gardeners in 2005.	As additional research and information on oyster gardening is available, more people are growing oysters for both recreation and restoration purposes.

Management Characterization

Purpose: To determine the effectiveness of management efforts to address those problems described in the above section for the enhancement objective.

1. For each of the management categories below, indicate if the approach is employed by the state or territory and if significant changes have occurred since the last assessment:

Management categories	Employed by state/territory (Y or N)	Significant changes since last assessment (Y or N)
Aquaculture regulations	Y	Y
Aquaculture policies	Y	Y
Aquaculture program guidance	Y	Y
Research, assessment, monitoring	Y	Y
Mapping	Y	Y
Aquaculture education & outreach	Y	Y
Other (please specify)		

2. For management categories with significant changes since the last assessment provide the information below. If this information is provided under another enhancement area or section of the document, please provide a reference rather than duplicate the information.

- a) Characterize significant changes since the last assessment;
- b) Specify if it was a 309 or other CZM driven change (specify funding source) or if it was driven by non-CZM efforts; and
- c) Characterize the outcomes and effectiveness of the changes.

Aquaculture regulations

The U.S. Food and Drug Administration (FDA) has suggested a new regulation that, beginning in 2011, raw oysters originating in the Gulf of Mexico during warm-weather months must be treated before they can be sold to consumers. In addition, the FDA considered new regulations that as of 2011, unprocessed oysters (and possibly clams) may not be sold during warm months due to concerns over deaths from the vibrio-bacteria that occurs during warm months. The proposed regulation has currently been withdrawn. However future federal regulations could be imposed regarding shellfish handling and marketing.

In part as a result of CZM program efforts, on October 7, 2009, Governor Tim Kaine announced a new regulation to protect important shellfish habitat areas and the sustainability of Virginia's

aquaculture industry by providing additional protection for these waters on the Eastern Shore. The DEQ regulation is intended to ensure that the best wastewater disposal methods are evaluated, resulting in the least environmental impact. The proposal is intended to reduce condemnations on the Eastern Shore so more waters may be protected for clam and oyster production, including aquaculture. According to the Governor's website, growth and changing land uses on the Eastern Shore have increased the frequency and amount of wastewater discharged from businesses and localities into seaside waters.³³ However, shellfish growers have stated that seaside regulations should be expanded to the western side of the Chesapeake Bay so that they would apply to all of Virginia's waters, as good water quality is a necessity for shellfish operations.

Since the previous assessment, there are now permits required for shellfish growers at the state level. Oyster and clam growers are now required to obtain permits and report their harvest data, including locations they are farming under new regulations adopted by Virginia Marine Resources Commission (VMRC) as of November 2007. There has been more participation every year from growers in reporting, although VMRC currently doesn't have a dedicated staff person to enforce the mandatory reporting program. In addition, oyster gardeners (recreational growers) are required to obtain a permit for growing, although it is a free permit from the Habitat division of VMRC. This recreational growing permit was instituted in 1998, and is not a new permitting requirement since the previous assessment.

A new regulation was developed by the Fisheries division at VMRC in 2007 which is a more streamlined and quicker process for getting general permits for cage (container) aquaculture (Reg.# 4VAC20-1130-10 (2007)). Prior to this, subaqueous permits were required, which was a longer permitting application process that went through the Habitat division at VMRC

VMRC drafted a legislative amendment, *Water Column Leases for Aquaculture Purposes*, which authorized VMRC to "lease the water column above certain state-owned bottomlands for aquacultural purposes." On April 15, 2004, the Virginia General Assembly approved the amendment to Chapter 16, Title 28.2 of the state code. However, this "3-D regulation" was never funded, and the amendment "sunsetting" and is no longer applicable. The use conflicts were partially resolved as regulations for cages moved to the Habitat division of VMRC, as referenced above, and this regulation replaces the "3-D regulation." However, the use conflict of using the whole water column from the bottom-up remains.

Aquaculture policies

The U.S. Environmental Protection Agency (EPA) is currently directing the Chesapeake Bay states and the District of Columbia to develop and implement a "pollution diet" for the Chesapeake Bay and its tidal waters known as a Total Daily Maximum Load (TMDL), with expected completion in December of 2010. The EPA may allow states to consider aquaculture as a means to reduce pollution and meet TMDL goals. For additional information, see the website: <http://www.epa.gov/chesapeakebaytmdl/>

³³ <http://www.governor.virginia.gov/MediaRelations/MediaLibrary/galleries.cfm>

Several coastal counties are updating their Comprehensive Plans, and aquaculture is figuring prominently in the Plan revisions in several locations. Northampton County, located on the Eastern Shore, recently developed a new zoning code as part of their comprehensive plan revision with shellfish aquaculture being recognized as a by-right use, although some wetlands or minor special use permits may still be required in specific conditions. Aquaculture is being recognized as a significant issue that needs to be addressed in local policies and planning. The Mathews County Aquaculture Working Waterfront Steering Committee, which was funded by the CZM program, has developed eight innovative recommendations which are currently being considered by the Mathews County Board of Supervisors. These recommendations involve policy changes for expanding and supporting aquaculture on the land and in the water. In Gloucester County, the York River Use Conflict study, which was funded by the CZM program, addressed aquaculture and use conflict issues. The recommendations of the Use Conflict study were adopted by the Board of Supervisors as new public policy to protect, preserve and accommodate aquaculture and working waterfronts in the York River. The Mathews County Aquaculture Working Waterfront Steering Committee used many of these recommendations in their work.

There may be a conflict in the future between how local governments wish to use offshore submerged land and existing offshore uses. As space becomes more crowded and there is greater competition to gain access to subaqueous lands, there may be conflicts between state agencies and local governments regarding jurisdiction of the lands. Multi-jurisdictional marine planning will likely increase as some localities have zoning ordinances that identify and reference water zoning, and other localities are exploring and using a variety of police power tools for marine planning and zoning (including Urbanna and King and Queen Counties). As a whole, permitting and taxation issues will grow in significance in the future around shellfish aquaculture operations.

The nexus between water quality and upland land use is recognized as becoming increasingly important. If a coastal community decides that working waterfronts are of primary importance, then land use policies and activities may need to change to increase water quality. For example, there may need for a requirement that no livestock are allowed in creeks near the coast, as well as increased enforcement of regulations around failing septic systems. Local governments may need to protect water quality more under health, safety, and welfare provisions. Alternately, local jurisdictions may develop “public relocation areas” where a locality may lease subaqueous lands from VMRC and manage it as an in-water business park where, for example an aquaculture facility could temporarily utilize it as a holding facility for shellfish (particularly if a water use violation occurs in the area an aquaculturist cultivates shellfish in, or if an area becomes contaminated, these public relocation areas could be used without the aquaculture facility shutting down entirely).

Aquaculture program guidance

Some shellfish growers report that clam nets are still released into the open ocean, and that some growers pick up the discarded nets of other growers to properly dispose of them. This is of concern as they pose a threat to wildlife and boaters, as well as to the “responsible neighbor” approach that many growers are working to maintain with adjacent landowners by properly

discarding used clam nets. There has been extensive research, funded by CZM and others, into the issue of derelict clam nets. This research has had positive impacts, including gaining data about the location of derelict nets and presenting the data to various groups of people and growers. Although most groups have increased their awareness of the problems with nets, it remains a problem (for more information on this and suggestions for next steps, see the *Priority needs and gaps* section, as well as the *Coastal Debris* Assessment section).

A 2008 report, *Best Management Practices for the Virginia Shellfish Culture Industry*, was developed in September of 2008, with CZM funding through its Seaside Heritage Program, and it has the potential to have a significant positive impact within the industry. More time will be needed to determine the guide's long-term effectiveness in providing program guidance and concrete on-the-ground results, but it has been very effective as an educational tool to date. For example, according to a 2006 report prepared by the Virginia Eastern Shorekeeper, there was a 41% reduction in the amount of clam net found on the barrier island beaches of the Eastern Shore of Virginia over the period of time from spring 2004 to autumn 2006.³⁴ The guide is voluntary for industry to utilize, but it was endorsed by Governor Kaine's appointed aquaculture advisory board, the Farm Bureau, and Virginia Dept. of Agriculture and Consumer Services (VDACS), and it has received strong buy-in from growers. One advantage for growers to utilize the BMPs is that they can market themselves as a "clean operation" or a "green operation". The guide may be viewed on the website: www.vims.edu/adv/aqua.

The Environmental Quality Incentives Program (EQIP), a program of the Natural Resource Conservation Service, is a voluntary conservation program for farmers and ranchers that promote agricultural production and environmental quality as compatible goals. EQIP offers financial and technical help to assist eligible participants install or implement structural and management practices on eligible agricultural land, including incentives for reducing nitrogen in water through BMPs. More information may be found on the website: <http://www.nrcs.usda.gov/PROGRAMS/EQIP/>

A manual was published in 2009 for spat-on-shell aquaculture, *A Practical Manual for Remote Setting in Virginia*, which is available at the website: <http://web.vims.edu/adv/aqua/index.html>. There is also a training program (as mentioned above under the *Resource Characterization* section) for individuals transitioning from crabbing to oyster growing, which utilizes the "crab disaster funding" that has been available since 2006. A new cage aquaculture manual is currently being developed as part of this program, which will be available in the spring of 2010. Approximately 10 people a year have been trained in spat-on-shell and cage aquaculture growing techniques; this year expanded to 100 people participating in the training program as there was a funding increase in 2009. This funding will be available for two more years, at \$500,000 each year, and significant participation is expected for the remaining two years of the training program.

Research, assessment, monitoring

Significant aquaculture research has been conducted since the previous assessment on topics such as spat-on-shell growing methods, carrying capacity, restoration, the health of shellfish,

³⁴ <http://www.deq.state.va.us/coastal/documents/task11-07-04a.pdf>

disease resistance breeding, business modeling development, industry expansion and monitoring by the Virginia Institute of Marine Science (VIMS), Virginia Sea Grant Marine Extension Program, the Virginia Tech Seafood Aquaculture Lab in Hampton and other agencies and organizations. There have been expanded efforts to restore shellfish for ecological restoration to the Chesapeake Bay since the previous assessment as well.

In the previous assessment, it was noted that the Virginia Agricultural Statistics Service (VASS) completed a 2003 survey on commercial aquaculture, collecting information on amounts harvested, gross profits, and projected growth for the next year. Since that time, the survey moved to the USDA National Agricultural Statistics Service, which was conducting a statewide aquaculture survey starting in the spring of 2009. The purpose of the survey was to reference the 2008 production year and measure changes in size and scope of the industry since the last state aquaculture survey was conducted in 2003. The survey is intended to be conducted once every five years and the information is supposed to help with legislative, regulatory and marketing decisions at the state level. In September of 2009, according to the Virginia Aquaculture Association website,³⁵ the Virginia Aquaculture Survey was stopped due to budget cuts. There was an update on the extent of the budget cuts at the November 2009 Virginia Aquaculture Conference in Williamsburg, Virginia, and it doesn't appear that the study will continue in the near future.

The June 2009 *Virginia Shellfish Aquaculture Situation and Outlook Report Results of 2008; Virginia Shellfish Aquaculture Crop Reporting Survey*, by Tom Murray of Virginia Sea Grant Marine Extension Program and Mike Oesterling of Virginia Institute of Marine Science, yielded significant information into sales and recent trends within the aquaculture industry (see the Resource Characterization report above). Below are charts from the report regarding the number of shellfish planted and sold in Virginia from 2005-2008.

³⁵ <http://www.virginiaaquaculture.org/News.html>

Figure 1: Number of Hard Clams Planted in Virginia (2005-2008)

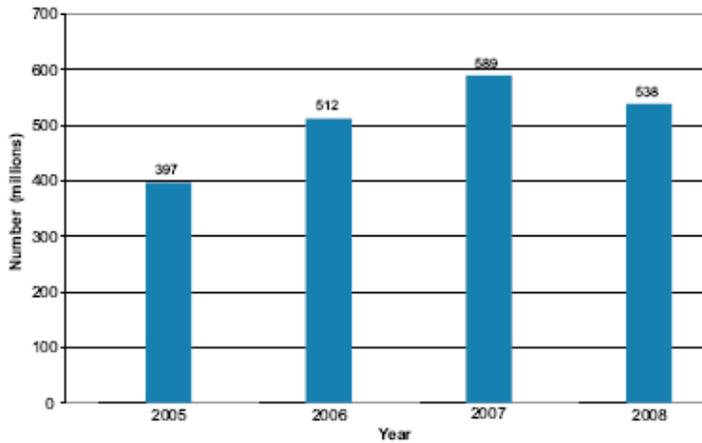


Figure 2: Number of Hard Clams Sold in Virginia (2005-2008)

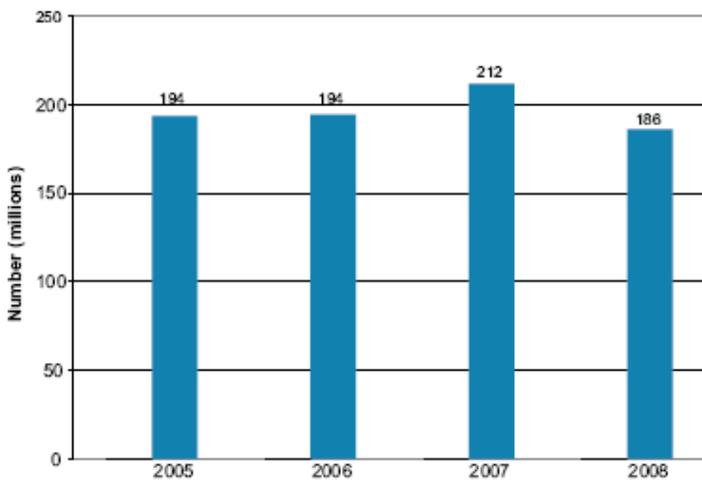


Figure 4: Clam Prices Reported by Virginia Growers (2005-2008)

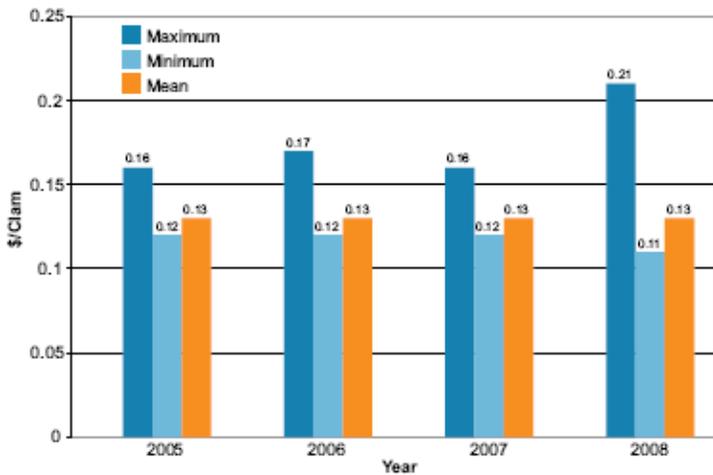


Figure 6: Number of Oysters Planted by Virginia Aquaculturists (2005-2008)

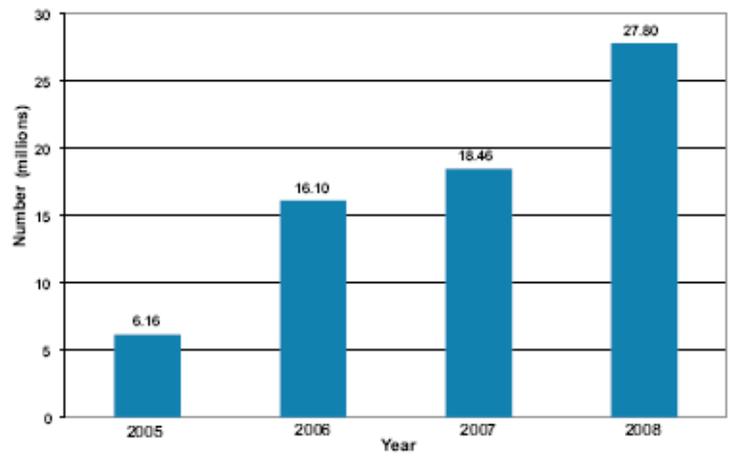


Figure 7: Number of Aquacultured Market Oysters Sold by Virginia Growers (2005-2008)

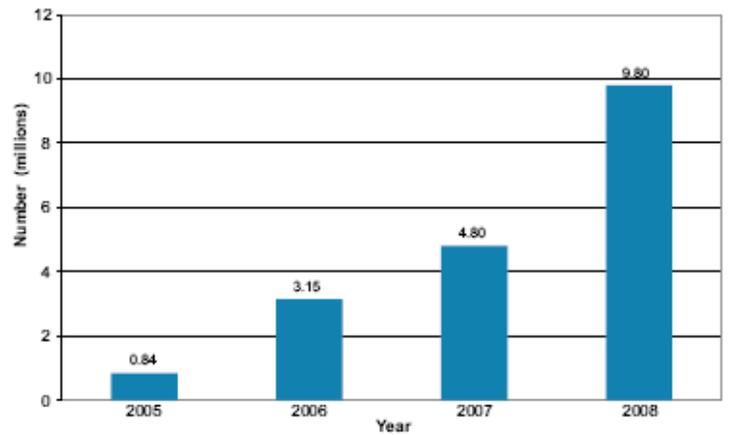
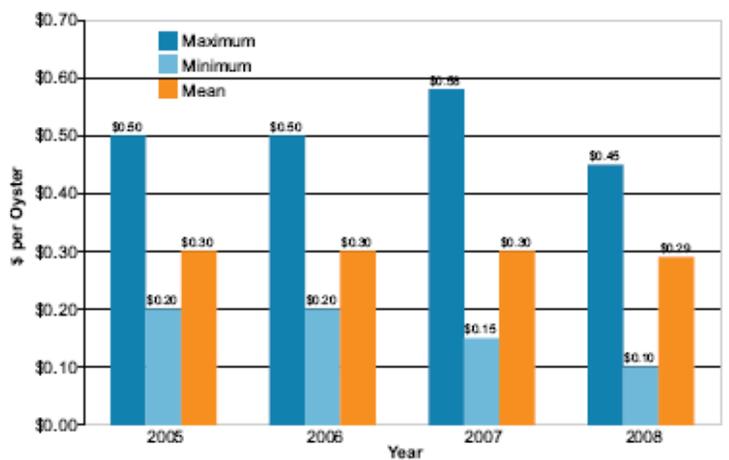


Figure 8: Reported Market Prices for Virginia Aquacultures Oysters (2005-2008)



Other new research includes:

- The Virginia Joint Legislative Audit and Review Commission (JLARC) called for a study of aquaculture beginning in 2009 under the topic area “Economic Potential of Virginia’s Seafood Industry.”
- There have been efforts to maintain and preserve working waterfronts, especially on the Middle Peninsula (see the section below under *Priority Needs and Gaps* for additional information).
- There has been enhanced funding from NOAA to VIMS to continue or expand oyster monitoring with regard to the success of oyster restoration efforts and reef restoration modeling, including the effects of cownose ray predation. Cownose rays pose a significant threat to shellfish aquaculture as they feed on clams and oysters (especially those grown with spat-on-shell cultivation methods), and some restored oyster reefs have been damaged due to ray predation. Although many aquaculturists have increased on-site protection methods such as augmenting nets and stakes, rays continue to be a threat. In addition, there has been an effort to try to increase the edibility profile for rays to increase the market and thus fishing of rays.
- Virginia Tech completed a two-part study, *Economic Implications of Alternative Management Strategies for Virginia Oysters and Clams*, in 2008 with CZM funding on the economics and choices for promoting aquaculture, including concepts of enterprise zones, permitting choices and potential reassessment of public grounds.
- An economic impact study was conducted within DEQ, with CZM funding, focusing on development with a discussion about opening the Baylor grounds as Enterprise Zones (see the *Priority Needs and Gaps* section for more information about Baylor grounds), as well as discussion around reorganization and changes to Baylor grounds. There have been no draft policy changes at this point, however the concept of reassessing use of Baylor grounds is being considered under the seaside Special Area Management Plan.
- Other studies have been conducted around the Baylor grounds as well, including basic mapping of the grounds to determine what grounds are suitable and optimal for oyster and clam growth. These include the 2008 CZM-funded study by the Center For Coastal Resources Management, Virginia Institute Of Marine Science, *Shellfish Aquaculture Suitability Within Baylor Grounds of the Lower Rappahannock River*; and the 2008 study by G. Santopietro, *An Economic Analysis of Proposed Management Plans for the Public Oyster Grounds of the Rappahannock River*, which is available at the website: <http://www.deq.state.va.us/coastal/documents/task92-04-06.pdf>. The final reports were made to the Virginia Coastal Management Zone Program, and are available from the CZM website.
- Additional CZM funded studies include the 2007 *Shellfish Aquaculture Vulnerability Model* Report by VIMS and the 2008 *Identification of Management Strategies for Promoting Aquaculture in Virginia* Report by VIMS.
- There is ongoing research regarding nutrient removal by oysters, including the 2006 report *Nutrient Assimilation Credits: Opportunities from Enhanced Native Oyster Production* by Kurt Stephenson, Bonnie Brown, Leonard Shabman, and Darrell Bosch, through the Chesapeake Bay Targeted Watersheds Grant Program of the National Fish and Wildlife Foundation.

Aquaculture facilities are currently not allowed on Baylor grounds, in areas that interfere with riparian rights, nor in areas with submerged aquatic vegetation (SAV). The Baylor grounds have been set aside as public bottomlands in perpetuity, as they were determined to have oysters or shellfish growing on them during a survey conducted in the late 1880's. However, there has been considerable discussion recently about the need to reexamine the protection of the Baylor grounds, or to reassess their status, given so few oysters remain on those grounds and vast areas of Baylor are barren.

Part of the discussion among state agencies has called for a resurvey of the Baylor Grounds as a step toward redefining or declassifying them as public grounds. There is more support for opening the Baylor grounds up on the Eastern Shore as there is more pressure to identify additional grounds for shellfish aquaculture activities.

Many growers state that all desirable lands have already been leased on the seaside of the Eastern Shore. This is especially urgent for clams, as hard clams have fairly specific environmental requirements for higher salinity, while oysters can tolerate less salinity. However, in the western Shore, the issue of opening up the Baylor grounds is a more contentious political issue. Others have stated that they would like to see "sanctuaries" being created on Baylor Grounds.

Some people have declared that up to one-third to one-half of the Baylor grounds might be suitable for shellfish aquaculture. Others have stated that there is a strong need to conduct a comprehensive survey of the viability of existing Baylor grounds for the purpose of oyster and shellfish growing and restoration. This will continue to be a widely discussed and researched topic in the near future. In the 2010 General Assembly session, Delegate Lynwood Lewis introduced HJ 74 regarding a Study on Eastern Shore bottomland habitat. This bill requests the Virginia Institute of Marine Science to study management options for state-owned submerged lands on the seaside of the Eastern Shore. Additionally in 2010, Delegate Albert Pollard introduced HB 138 which authorizes the Virginia Marine Resources Commission to establish aquaculture opportunity or enterprise zones (at the local level) for the propagation of commercial shellfish.

Several CZM-funded studies on use conflicts focused on resolving conflicts between shellfish farming and other uses of shallow, nearshore waters. The first study looked at shorebird foraging versus clam farming (with grants to VIMS and the William and Mary, Center for Conservation Biology in 2004 - 2006). Through grants to VIMS and the Middle Peninsula Planning District Commission (MPPDC) in 2006 - 2008, a third study looked at all potential conflicts among near-shore uses using suitability modeling and matrices. VIMS reviewed uses from a state perspective and MPPDC from a local perspective of Gloucester County.³⁶ Finally, the CZM program funded surveys of submerged aquatic vegetation distribution and abundance with grants to VIMS in 2007, 2008 and 2009. All of these studies point to the need for what many are now calling "marine spatial planning" which can be regarded as a subset of "special area management planning." Clearly federal, state and local governments and all stakeholders need to work together, area by area to create management plans that allow for efficient sustainable use of coastal waters.

³⁶ From the website: <http://www.deq.virginia.gov/coastal/sf2008magshellfishsquaculture.html>

The success of submerged aquatic vegetation (SAV) restoration on the seaside of the Eastern Shore is beginning to create a fear of use conflicts by shellfish growers. This a large part of the rationale for the Virginia CZM Program to continue the Seaside Special Area Management Planning (SAMP) largely as a marine spatial planning effort that seeks to accommodate multiple uses such as SAV/oyster/bay scallop restoration, shellfish cultivation, recreation and marine area conservation. A separate project is being funded around designating priority estuarine conservation zones throughout all Virginia coastal waters. Climate change must also be considered in marine spatial planning as species usual habitats may shift northward.

Asian oysters faced an unknown future at the time of the last assessment. The US Army Corps of Engineers conducted an Environmental Impact Statement (EIS) around Asian oysters, with VIMS conducting the research. The EIS did not endorse the use of Asian oysters in any form. Sterile Asian oysters had been used by growers, but now the use of Asian oysters has been formally denied.

During the past few decades, some individuals and corporations have used their privately leased submerged land to grow out hatchery or nursery-reared oysters and hard clams. There has been significant recent growth in noncommercial oyster gardening. VIMS estimates about 2,000 people in the state are growing between 1,000 to 5,000 oysters each, for environmental purposes (water quality improvement) and personal consumption, which cumulatively constitute a significant economic impact. Disease-resistant oyster seed is purchased from commercial hatcheries, and floats are either purchased as a unit or built from purchased materials.

While there has been some research into ocean acidification, there is a strong need for additional research. The industry is threatened by acidification, and measurable changes have been recorded this year (see below under *Priority Needs and Information* for additional information). Cherrystone Aquafarms recorded a 0.2 pH drop in ocean water and a 0.5 pH drop in the Chesapeake Bay, both becoming more acidic, at their facilities in the past two years. Cherrystone has reported crashes in algae culture when algae stopped growing in 2008, which could have significant ramifications as algae is a food source for shellfish larvae. Cherrystone has communicated with scientists and growers around the region and world, who have also reported similar problems, including that algae has been failing. Other Virginia hatcheries have also reported similar problems. Other significant impacts of rising carbon dioxide levels and ocean acidification include:

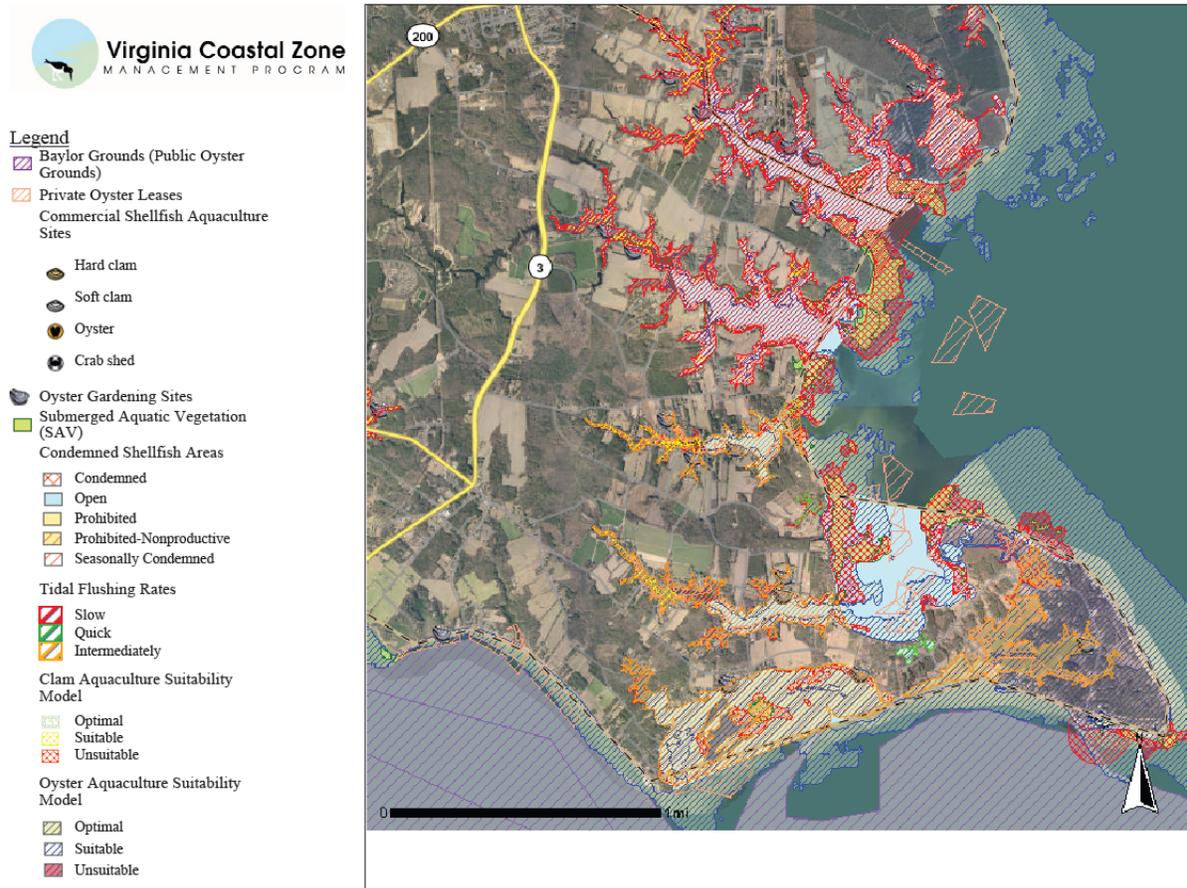
- shellfish shells dissolving (which would affect all similar marine fauna that form calcium carbonate as their shell or exoskeleton, including many small organisms at the base of the ocean food chain);
- shellfish may begin to significantly dissolve before they can grow to a significant or harvestable size; and
- as pH changes, nutrients will have varying degrees of availability to shellfish.

Mapping

Mapping through the CZM-funded Coastal GEMS program has been a significant change since the last assessment. Coastal GEMS contains a large number of map layers relevant to shellfish aquaculture issues, including public oyster grounds, privately leased grounds, shellfish

aquaculture permit sites, SAV distribution, clam and oyster suitability and vulnerability, tidal flushing rates, condemned shellfish grounds, state constructed oyster reefs, oyster gardening sites, protected uplands and many more. It has been a very effective tool for building a more comprehensive understanding of Virginia's coastal zone. Below is an example of a Coastal GEMS map with aquaculture and other map features from the website:

<http://www.deq.virginia.gov/coastal/coastalgems.html>



Other new aquaculture mapping includes:

- The Tidewater Oyster Gardeners Association (TOGA) has mapped the location of the private oyster gardens, available in this report from the TOGA website: <http://wmpeople.wm.edu/site/page/vspain/togafolksdointheirthing>
- The Center for Coastal Resources Management at VIMS has developed an Aquaculture Vulnerability Model Interactive Map, which was CZM funded and available on Coastal GEMS but can also be viewed at: http://ccrm.vims.edu/gis_data_maps/interactive_maps/aquaculture_vulnerability/aquaculture_vulnerability_model.html.

Aquaculture education & outreach

The abandoned clam net awareness program has been effective (as mentioned above under *Program Guidance*), although growers report that derelict nets continue to be a problem. Additionally, the BMP guide involved industry leaders, and VDACS has embraced the BMP guide as policy they want to use for shellfish aquaculture in Virginia (available at the website: http://web.vims.edu/adv/aqua/MRR%202008_10.pdf?svr=www).

A statewide aquaculture listserv is maintained, and education and outreach is conducted through that resource. Mike Oesterling of the Sea Grant Marine Extension program holds an annual shellfish culture forum looking at hot topics within the industry. Additionally, the Virginia Aquaculture Association hosts an annual aquaculture meeting and conference. Finally, VIMS and Sea Grant circulate shellfish aquaculture outlook reports to industry, agencies and localities. These are available on the website: www.vims.edu/adv/aqua. The Tidewater Oyster Gardeners Association (TOGA) is an active resource for education and outreach for non-commercial oyster gardeners. VDACS maintains a Virginia Aquaculture Advisory Board, as well as a staff member that serves as the State Aquaculture Coordinator. Finally, the East Coast Shellfish Growers Association is an active resource for the industry, although it does not have a strong membership base in Virginia. The Virginia Shellfish Growers Association was dissolved several years ago.

Many colleges and universities such as Old Dominion University, Virginia Tech, and VIMS (at William and Mary) are offering courses and training in aquaculture, and doing research that is grant or industry-funded. For example, the Aquaculture Genetics and Breeding Technology Center at VIMS offers a 6-month paid Oyster Aquaculture Training program where four participants spend an intense training period working with the breeding program.

Priority Needs and Information Gaps

Using the table below, identify major gaps or needs (regulatory, policy, data, training, capacity, communication and outreach) in addressing each of the enhancement area objectives that could be addressed through the CMP and partners (not limited to those items to be addressed through the Section 309 Strategy). If necessary, additional narrative can be provided below to describe major gaps or needs.

Gap or need description	Type of gap or need (regulatory, policy, data, training, capacity, communication & outreach)	Level of priority (H,M,L)
1. Marine Spatial Planning: Several needs have been expressed regarding marine spatial planning, increasing aquaculture opportunities and preserving working waterfronts, and examining areas in which shellfish aquaculture takes place. These include:	Regulatory, Policy, Data, Capacity, Communication & Outreach	H*

<ul style="list-style-type: none"> • Comprehensive plans and zoning tools for localities need to reflect water-based territorial boundaries to afford local governments a correct representation of spatial areas under their jurisdiction as localities need to be aware of their offshore boundaries to effectively manage various uses. • A comprehensive and aggressive effort is needed to preserve and protect working waterfronts among localities, perhaps through a working waterfronts training effort for local officials to find a way to share and replicate the model that Mathews County is developing. Additionally, education and dialogue is needed to address some of the issues of homeowner complaints around the visual impacts of aquaculture activities and to highlight the importance of traditional maritime activities and to preserve working waterfronts. • Shellfish aquaculture should be recognized as a “right by use” and an activity that should be encouraged. There is a need for a policy stating what the interest of the State is in aquaculture so that when some of the questions arise with private property rights and public bottom, a statewide policy or statement regarding aquaculture can be considered (such as a right-to-farm statement), which would make the management of aquaculture more straightforward. • There is a strong need to update the current Virginia Marine Resources Commission (VMRC) fee structure and lease program, and to make them more efficient in the immediate to near future. A mechanism needs to be developed for releasing specific areas from large parcels held in lease from the VMRC, to free up more bottomlands for diverse activities, and to address inactive bottom leases. This could happen through withdrawing some long-held inactive leases, examining how other coastal states manage bottom resources, allowing an individual to keep a portion of the leased grounds for the operations they are interested in and to make the rest of the grounds available for re-leasing to others, and to enforce and verify that lease holders are actually using the bottomland (which is currently self-reporting; only a small portion of the leased grounds were considered “active” by VMRC in a recent study). Additionally, the cost of leasing bottomland should be reexamined. The cost is \$1.50 per acre per year to lease land, but clam growers can produce \$60,000 of gross profits every 2-3 years per acre. Other states have significantly higher use fees for leasing, and there is a need for VMRC to explore increasing leasing fees. To help increase shellfish viability, increasing leasing fees should be directed toward protecting water quality, reducing cost/increasing availability of seed, and increasing growth rates through research. 		
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<ul style="list-style-type: none"> • Re-characterization of the Baylor grounds is needed to inform policy development and next steps, and a public dialogue is needed around this issue. There is a need to update the method in which subaqueous grounds are leased and to examine the grounds that are currently available for leasing. Although small changes have been made, there hasn't ever been a comprehensive revision of leasing regulations, particularly with consideration of the best sites for shellfish farms. • There is a need to connect aquaculture with local land-use decision-making and the state's capacity to manage good water quality, and knowledge is needed of that linkage throughout Virginia's entire coastal zone. Aquaculture could become an indicator for all water-based industries with setting the standard for good water quality. In addition, to determine the best locations and scale for aquaculture, there is a need to better understand the economic, ecological and social consequences of both the scale and distribution of facilities. • Expand funding for current aquaculture suitability modeling is needed with a focus on the impact that development would have on aquaculture for the western shore, especially for using this risk assessment for expanding aquaculture within the comprehensive planning process of localities. The project, which could be housed at VIMS, could further be expanded to look at the suitability and risk assessment for what areas are the most suitable for aquaculture in Virginia's coastal zone. 		
<p>2. Nutrient removal by shellfish aquaculture: There is a need to gather data and information about shellfish aquaculture and the resulting scale of nutrient removal that is currently occurring, specifically to understand the details of and gaps around how large scale shellfish aquaculture affects nutrient removal and nutrient dynamics within a body of water. These issues are important in several arenas, including providing information to property owners adjacent to aquaculture sites, understanding effects on eutrophication, understanding how nutrient removal might play into a "nutrient trading credit" system, and how other marine species are influenced by shellfish aquaculture. For example, on a single clam farm, significant amounts of algae grow on the nets. The clams filter nutrients and absorb some nitrogen, but the algae uptakes the rest. However, clam growers need to remove the algae after they harvest the clams, and the algae may end up on an adjacent homeowner's beach, which could upset the homeowner. Further research may indicate methods the clam farmer could use to put the algae on land for agriculture, to compost it, or to otherwise utilize it in a beneficial way.</p>	Data	H*

There is a need to explore how aquaculture could help meet pollution prevention and Chesapeake Bay Total Daily Maximum Load (TMDL) goals through nutrient uptake.		
3. Impacts of shellfish aquaculture: Data is needed on the effects of shellfish aquaculture farms on surrounding ecosystems, on competing uses for the creeks in which clam aquaculture takes place, and the overall effects on the creeks. Once the negative effects are known, marine zoning could address some of these issues –such as allowing shellfish aquaculture to exist only in certain areas and to occupy only a certain percentage of space. Use conflict studies need to be conducted, particularly around riparian land practices and clam culture.	Regulatory, Policy, Data & Capacity	H*
4. Clean waters: There is a need for additional regulation to cover all Virginia waters to promote and protect clean waters, similar to the recent discharge regulation adopted by the Department of Environmental Quality for the Eastern Shore (see the section above under <i>Regulations</i> for additional information),	Regulation and Policy	H*
5. Research on breeding: There is a need to continue the progress in oyster breeding and domestication to achieve higher gains and increase the suitability of oysters for cultivation.	Data	H*
6. Funding BMPs: There will be a need for a cost-share program or to find grant funding options if aquaculture BMPs are made a requirement for growers.	Regulatory, Capacity	H*
7. Taxing aquaculture as agriculture: There is a need to examine taxation on aquaculture activities, as aquaculture is a form of agriculture and land-use taxation applies to other agricultural operations. The land-use taxation policy should be extended for aquaculture (where it is currently inferred), but should explicitly state that aquaculture is exempt under land-use taxation.	Regulatory	H*
8. Education support: There is a need for an Sea Grant? extension agent for aquaculture that is dedicated to education and outreach. This person could be housed at VIMS, VMRC, or VA Tech (or another location). This position is needed as a resource for questions on starting hatcheries, and for other information needs.	Training, Capacity, Communication & Outreach	H*
9. Research on acidification: There is a strong need for research into ocean acidification, a significant threat to the industry.	Data, Regulatory, Capacity, Education and Outreach	H*

<p>10. Research on Economic Impacts and Policy: There is a need to examine the potential impacts on the industry of FDA regulations on the potential ban on raw shellfish, as well as exploring alternatives to a full ban. There is a need by the industry to know about new regulations in advance.</p>	Data	M – H*
<p>11. Research on breeding: There is an overall need to lower the price of shellfish seed, enhance seed availability, and increase growth rates of shellfish through breeding research.</p>	Data, Capacity	M – H*
<p>12. Discarded Nets: There is a need for more growers to utilize the BMP guide that has been developed, and to find a way to make sure that clam nets are properly clean up and not discarded into the ocean. There is a strong need for research into the potential to recycle clam nets (similar to the sheets of polyethylene used to grow tomatoes that are now recycled). Enforcement is needed to ensure that the nets aren't allowed to float loose into the ocean, which could be a safety hazard to boaters. Although a program was tried in which the nets were tagged with the growers information, the tags were frequently ripped off. A new system is needed to make sure the nets are disposed of properly, and recycled if possible.</p>	Regulatory, Education, Outreach	M – H*
<p>13. Research on algae: More baseline research is need on water quality monitoring to determine sources of impacts to algae health, and routine monitoring of various types of algae health as its is connected to successful shellfish aquaculture.</p>	Data, Education	M – H*
<p>14. Research on eel grass: There is a need to research aquaculture and eel grass preservation. A greater number of areas have been set aside for eel grass preservation and restoration in recent years, and there is a perceived threat to aquaculture due to this restoration effort. However, it isn't known whether the eel grass will adversely affect clam aquaculture activities as eel grass growers at deeper levels than the clam nets are generally set, and it hasn't appeared to have a detrimental effect on either clam aquaculture or on eel grass restoration to date. There is a potential for conflict between the increasing oyster aquaculture activity and eel grass restoration efforts though.</p> <p>There is a need to map grass beds to look at effects on and compatibility with aquaculture activities. More research is needed to see what marine flora might be compatible with shellfish aquaculture and restoration efforts. Cherrystone</p>	Data, Education	M - H*

<p>Aquafarms has a series of photos of clam beds which initially had a small amount of zostra eel grass growing and over the years, developed a thick solid mass of zostra around clam beds, indicating the two may be compatible.</p>		
<p>15. Research on harvesting methods: Data is needed into what harvesting methods are currently used with shellfish aquaculture, and to examine how new harvesting methods affect water quality and habitats.</p>	<p>Data</p>	<p>M</p>
<p>16. Policy review of transport: There is a need for review and clarification of existing policies that affect the movement and transport (interstate and interregional) of aquaculture organisms. The current review of regulations has happened on a piecemeal basis especially regarding the importation of various aquaculture organisms and within the state. Clarification of the system and suggestions for synthesis existing regulations is needed, and more coherent and comprehensive policy is needed for aquaculture activities, especially as the industry aquaculture expands.</p>	<p>Regulatory, Policy, Data & Capacity</p>	<p>M</p>
<p>17. Promotion and funding: There is a need for programs to promote aquaculture, with marketing and advertising for the aquaculture industry and its products. There is a need for increased funding to the aquaculture industry for research around the potential environmental benefits of shellfish aquaculture and as well as funding for increased advertising. For example, Canadian aquaculturists just received \$1 million for new research, and Florida has several programs to support aquaculturists.</p>	<p>Capacity, Outreach</p>	<p>M</p>
<p>18. Education and outreach: There needs to be an increase in the release of information regarding the distribution of wild oysters on the Eastern Shore as there isn't widespread knowledge of the level of accuracy of existing data about the persistence of wild oyster populations.</p> <p>There may be a need to look at the historic distribution of oysters to conduct spatial mapping the persistence of oysters over time, although researchers aren't sure if the data would support this study.</p> <p>SAV distribution, restoration and protection has become an issue as well, and more data is needed on that topic.</p>	<p>Data & Capacity</p>	<p>L</p>

* While the majority of needs listed above are ranked high, further assessment and prioritization of how to address them is dependent upon additional staff resources and increased program capacity.

Enhancement Area Prioritization

1. What level of priority is the enhancement area for the coastal zone (including, but not limited to, CZMA funding)?

High ✓
Medium
Low

Briefly explain the level of priority given for this enhancement area.

The interagency Coastal Policy Team reviewed and ranked this issue at its February 17, 2010 meeting according to the following criteria: feasibility; importance and appropriateness. Up to 5 points were allotted to each of the three criteria so that a maximum score would be 15. Scores from 0-4.99 are considered low priority; 5–9.99 is medium priority and 10-15 is high priority. Aquaculture received a score of 11.54.

2. Will the CMP develop one or more strategies for this enhancement area?

Yes
No ✓

Briefly explain why a strategy will or will not be developed for this enhancement area.

Virginia CZM has focused on aquaculture for several rounds of Section 309 5-year strategies. Virginia currently has a good regulatory framework for promoting aquaculture and the industry is moving ahead at a reasonable pace. The last remaining aquaculture management issue is securing adequate space for the industry to grow. This means ensuring sufficient waterfront for hatcheries and other related facilities as well as submerged lands (for clams) and either submerged land or water column for oysters. The issue of waterfront accessibility will be explored through the CSI: Working Waterfronts Strategy. The issue of additional appropriate space for shellfish cultivation is being explored through the Seaside SAMP Marine Spatial Plan. The Seaside SAMP will allow Virginia to test various management options on a smaller scale and in a location that generally has very strong support for its shellfish aquaculture industry.

2000 Assessment

High ✓
Medium
Low

2005 Assessment

High ✓
Medium
Low

This Assessment (2010)

High ✓
Medium
Low