Expanding Virginia's oyster industry while minimizing user conflict

Interim report (Year 2 of 3) submitted to Virginia Coastal Zone Management Program

Roger Mann, Marcia Berman, James Wesson, Melissa Southworth, Tamia Rudnicky

Virginia Institute of Marine Science
The College of William and Mary
Gloucester Point, VA 23062

Submitted December 16, 2019

This project, Task #71 was funded in part by the Virginia Coastal Zone Management Program at the Department of Environmental Quality through Grant FY2018 #NA18NOS4190152 of the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, under the Coastal Zone Management Act of 1972, as amended.

Contents

Introduction

Historically, commercial fishing, especially the oyster fishery, dominated coastal activity throughout the tidal areas of the Virginia Chesapeake Bay. For decades, communities developed along shorelines to take advantage of productive public and private (leased) oyster grounds, and to harvest other economically important species. With the expansion of oyster diseases in the late 1950s, oyster harvests began to collapse and continued to decline through several consecutive decades.

Efforts to increase oyster populations and oyster production on both public and private grounds has remained a bay-wide focus of federal, state and local entities. Revitalization of the public fishery through shell replenishment programs, that is the addition of oyster shell to a region to serve as a substrate for oyster recruitment from the larval to the attached benthic form, have attempted to restore shell budgets on public Baylor grounds to a level that can sustain recruitment and thus the fishery. Note that recruitment is often also referred to as “spat set”. Over the past decade there has been a substantial improvement in oyster production on both public and private grounds. This can primarily be attributed to increased gear efficiency among the dredge fishery on both public and private grounds as well as the expansion of intensive aquaculture practices (intensive aquaculture involves the use of containers, such as cages, floats etc. for grow-out). Figure 1 illustrates the rise in oyster harvest on both public and private grounds in Virginia since 2000. About 70% of the harvest occurring on private grounds is attributed to opportunistic fishing practices and the rise beginning around 2009 is primarily associated with more efficient dredges used on both public and private grounds. On private grounds, aquaculture accounts for just under 30% of the harvest.

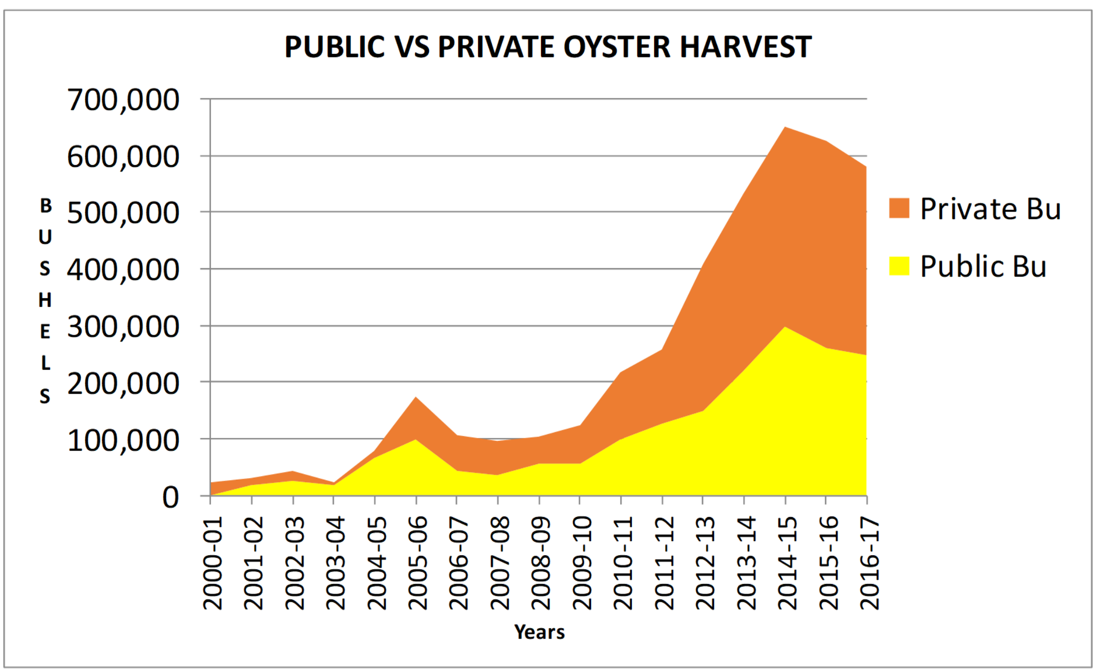

Figure 1. Harvest trends in public and private oyster fishery (2000-2017)

This study seeks to assess the sustainability of the public oyster fishery and the expansion of hatchery dependent oyster aquaculture in the Virginia portion of the Chesapeake Bay. Previous analyses have suggested that limitations in available shell resources will ultimately drive the future of the public fishery. The expansion of intensive aquaculture, already apparent in the Bay, suggests sustainability will be contingent upon the availability of bottom space and/or a shift in practices that minimize user conflict in leased areas.

Statement of the Problem

Within pubic Baylor grounds, intensive and ongoing monitoring of the shell budget on oyster reefs indicates that shell replenishment efforts provide short term increases in the shell budget. Despite intensive and ongoing replenishment efforts the future of the wild oyster fishery will be limited by available shell and the inability of oyster production to keep pace with breakdown and burial of shell material (Mann and Powell 2007, Mann et al. 2009a, 2009b).

Year 1 of this study quantified the spatial distribution of productive versus unproductive shell bottom on Baylor grounds within the Virginia portion of the Chesapeake Bay as an indicator of suitable bottom for oyster growth. Future productivity is declining due to limited shell resources and decomposition rates of shell. A geospatial analysis of data indicative of suitable bottom for oyster growth and restoration was undertaken. Four datasets were ultimately evaluated and used in the analysis. The analysis is restricted to production and restoration potential within the public Baylor grounds in the Virginia portion of the Chesapeake Bay. The boundaries for these grounds were provided by the Virginia Marine Resources Commission (VMRC), and data which extended beyond these boundaries were reduced appropriately.

Conditions of productivity were determined by 1) the known presence of productive bottom replenished through various state restoration efforts, and 2) the presence of suitable substrate material which include oyster rock, shell, and shell mixed with sand. Sources for determining productive bottom came from three primary databases: the VMRC's Conservation and Replenishment Department (CRD), the Virginia Institute of Marine Science's Virginia Oyster Stock Assessment and Replenishment Archive (VOSARA) http://cmap2.vims.edu/VOSARA/viewer/VOSARA.html, and the Haven et al. (1981) sub-aqueous bottom survey. Using ESRI's ArcMap® software the area within Baylor grounds were classified as "suitable for restoration" if the data indicated the presence of any shell material. Areas without any indicators of shell material were classified as "unsuitable for restoration".

Public Baylor grounds in the Chesapeake Bay account for 178,915 acres of state owned subaqueous bottom. The results of Year 1 found that only 39,117 acres are suitable for restoration and 139,608 acres, or 78% of the bottom is not suitable for restoration (Figure 2). The regional differences within 10 different waterbodies were computed and summarized (Table 1).

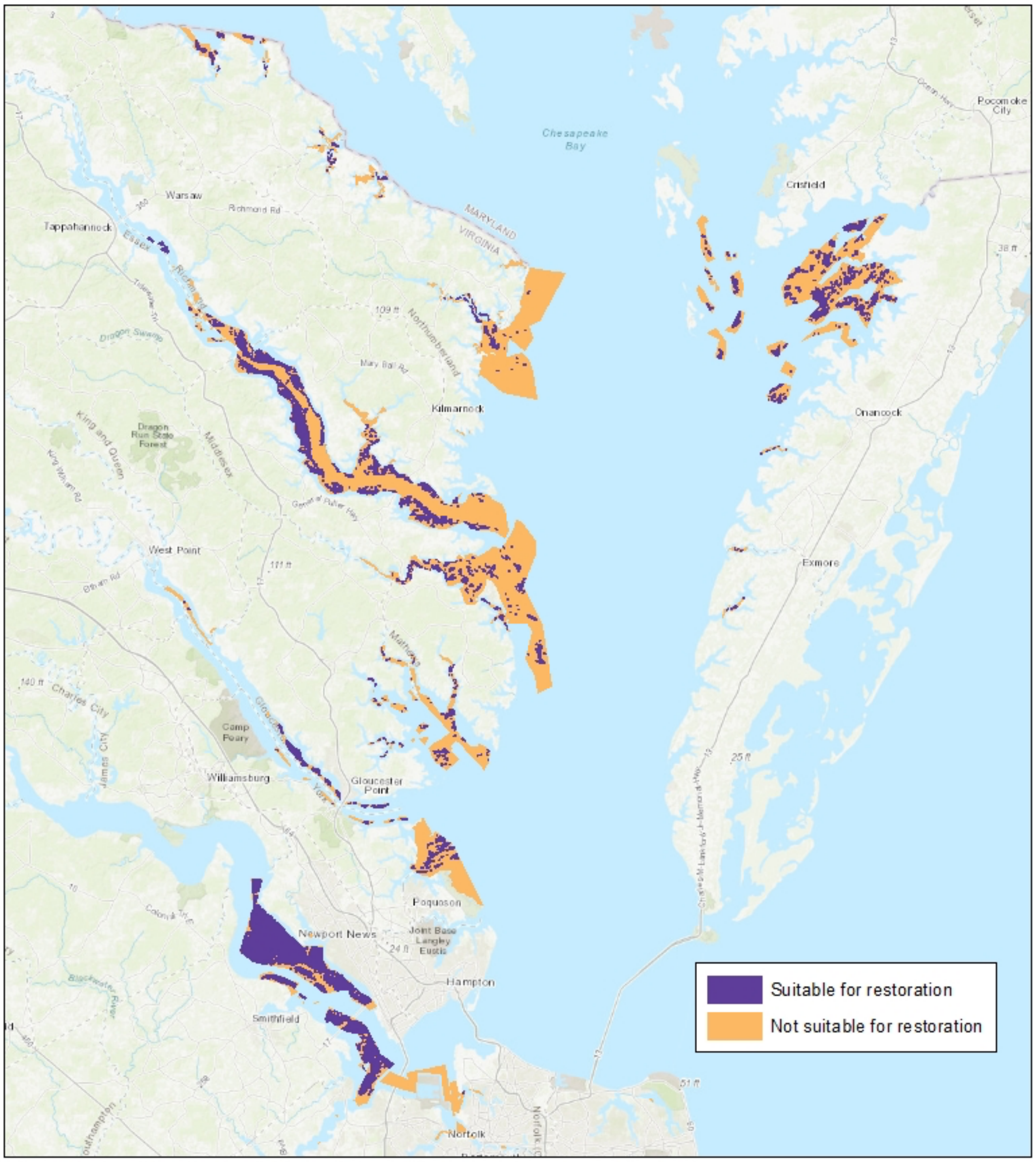

Figure 2. Targeting restoration potential within public Baylor grounds.

Location	Suitable for Restoration (acres)	Additional Suitable bottom set aside by VMRC (acres)	Not Suitable for restoration (acres)	Total Acres	% Suitable of Total
Chesapeake Bay Lower West and Poquoson	785	0	8,124	8,909	8.8
Chesapeake Bay Upper West and Fleets Bay	721	11	35,608	36,341	2.0
Great Wicomico River	455	1	2,238	2,694	16.9
James River and Tributaries	17,977	110	12,960	31,047	57.9
Lynnhaven Bay	0	48	19	67	0.0
Piankatank River and Milford Haven	915	12	7,450	8,377	10.9
Pocomoke/Tangier Sounds and Chesapeake Bay Upper East	5,862	6	26,779	32,647	18.0
Potomac River Tributaries	704	1	2,563	3,268	21.5
Rappahannock River and Tributaries	9,953	0	33,467	43,420	22.9
York River and Mobjack Bay (with tributaries)	1,745	0	10,400	12,145	14.4
Chesapeake Bay Total	**39,117**	**189**	**139,608**	**178,915**	**21.97**

Table 1. Oyster restoration potential by waterbody

These data provide a basis from which future replenishment efforts can be directed to those areas that have the highest potential for restoration success. Simply stated, continuing to support replenishment within the designated 39,117 acres of productive area is a better use of a declining state resource than attempting to restore an area where restoration efforts have been largely unsuccessful.

The following summarizes the status of shell production resulting from the analysis conducted in this study to date:

- Shell from natural mortality is the literal base of natural reefs.
- Self-sustaining reefs, with respect to shell, constitute a very small proportion of public Baylor bottom.
- With unlimited financial and shell resources we estimate that approximately 22% of the Baylor bottom could theoretically be maintained. However, shell resources are limited and will continue to be so.
- Long-term stock assessment will be used to strategically target repletion programs in the future to both maintain reef structures and maximize productivity
- The vast majority of Baylor ground (78%) cannot be maintained with available shell resources and should be considered for alternate strategies and uses.

Economically, a decline in the public fishery stimulates a likely shift in oyster production to aquaculture. Such a shift has already been documented through the expansion of the aquaculture industry in Virginia on private grounds. This study reviews and identifies opportunities and conflicts for the growing contribution aquaculture has had on oyster production on private grounds; with the most rapid expansion being hatchery-based production of cage-cultured oysters on private grounds in shallow water.

Expansion of intensive aquaculture, as it is typically practiced in Virginia, is expected to be limited principally by the amount of available space in the shallow water nearshore, where most of the production occurs today. If we set aside the possibility of utilizing the public

Baylor grounds that are unsuitable for restoration as areas for future aquaculture, the obvious next place to look is within the private leases currently on record. Year one of the study did this for a period that spanned 2013-2017. Nearly 4,000 private leases were on record during the period of study which encompassed 110,343 acres. The VMRC's Mandatory Reporting System provides the only record of use for these areas and was used to assess whether the leased areas were actively being utilized for aquaculture. The findings indicated that only 34% of the leases were reporting any type of aquaculture, and that 72,947 acres were inactive. This constitutes a significant withholding of subaqueous bottom and water column area that could potentially provide relief for this space limited industry. However, regulation in Virginia allows for limited use to persist for a period of 10 years regardless of lease size. Recent increases in permit fees have been implemented to discourage entrance into the leasing program without intended use.

This study quantifies the impact that broadening the use of the public resource for aquaculture could have at stimulating the industry and its growth without adversely affecting the public fishery. If Virginia maintains the status quo with respect to aquaculture practices, the expansion of the industry will remain restricted to shallow water. This will likely be accompanied by an expanding list of conflicts in this zone. Most notable are ecological conflicts associated with submerged aquatic vegetation and user conflicts associated with multiple uses by constituents with widely varying commercial, recreational and cultural interests. Nearshore properties, historically associated with commercial fishing long ago, have transitioned to a user group made up largely of single family, residential home owners. Conflicts ranging from view scape disputes to navigation impingement have ensued in the past decade.

Spatial Distribution and Alternative Uses of Non-Productive Baylor Grounds

Today just under 19,000 acres of bottom is available for lease in water less than 3 meters deep. The question as to why these areas have not been leased to date is debatable given that this industry is known for rapid uptake of good bottom. Following a spatial review of the location of these sites, along with conditions that make an area attractive for aquaculture, the authors conclude these bottom areas are simply undesirable to the industry for the following reasons:

- Travel time via water or public access to and from these grounds may be prohibitive
- Distance from off-loading or distribution points may also be prohibitive
- Unfavorable wind regimes due to large fetch makes the site unsuitable
- Grounds are not accessible by land without a boat
- Inability to monitor grounds and inventory from poaching
- Bottom substrate may be dominated by silt and clays and therefore undesirable
- Risk of conflict with land owners is high

Therefore, the identification of alternative areas for expansion of aquaculture is even more critical. The results of year 1 identified the suitability of public oyster grounds for restoration. Those areas classified as “Not Suitable for Restoration” represent areas where the likelihood for restoration success following replenishment efforts are low due to one or more of the following general explanations:

- They are places that were never naturally productive, but were included in the delineation by Baylor in the 1800s by default.
- Biogeochemical factors contribute to the breakdown of shell material faster than the reef can grow.
- Sediment concentrations and depositional processes cause burial of the shell material before the reef can grow vertically.

Figure 2 highlights that the distribution of these areas varies regionally, but that the amount of area is significant. In perspective, the amount of area potentially available for alternative uses, 139,608 acres, is considerably larger than the amount of area currently leased in the bay (110,343 acres). Since we know that all the areas are located within designated shellfish growing areas, the question remains as to whether the grounds may be favorable for an alternative use such as aquaculture.

Aquaculture in Virginia is practiced in both shallow and deep water. Deeper water practices are primarily reserved for extensive aquaculture where on bottom culture is achieved through the planting of shell over board and is later dredged with a mechanical dredge. Extensive aquaculture constitutes the largest type of shellfish culture in Virginia, and is naturally closest to the traditional wild harvest practices, relying on either natural spat set or the movement of seed from other locations for grow-out on the desired leased bottom. Extensive oyster culture does require larger lease holdings and the reliability of future production, the control of stock and harvest is much lower.

Intensive aquaculture has largely been pushed to the inshore areas due to the availability of space and the type of practices that have been employed in Virginia. Common types of apparatus used include rack and bags, trays, on-bottom cages and suspended floats. Many of these practices are occurring in water less than 2 meters deep. Caged-based aquaculture tends to be reserved for the outer-inshore areas and utilizes mechanical systems to raise and lower cages from shallow draft boats.

Since this study considers the alternative uses for grounds within Baylor that are not suitable for replenishment, we used geospatial techniques for delineating depth zones for the available area to determine if typical (and non-typical) aquaculture practices could be deployed in these areas. In other words, if these areas classified as unsuitable for restoration were found to be within the deepest zones of the bay, the likelihood they could be repurposed for aquaculture might be impractical given traditional practices.

Using the most recent NOAA bathymetric data, four depth zones were delineated using bathymetric contours: 0-1 m, 1-2 m, 2-3 m, and > 3m. These zones were spatially superimposed with the areas classified as not suitable for restoration to generate the data illustrated in Figure 3.

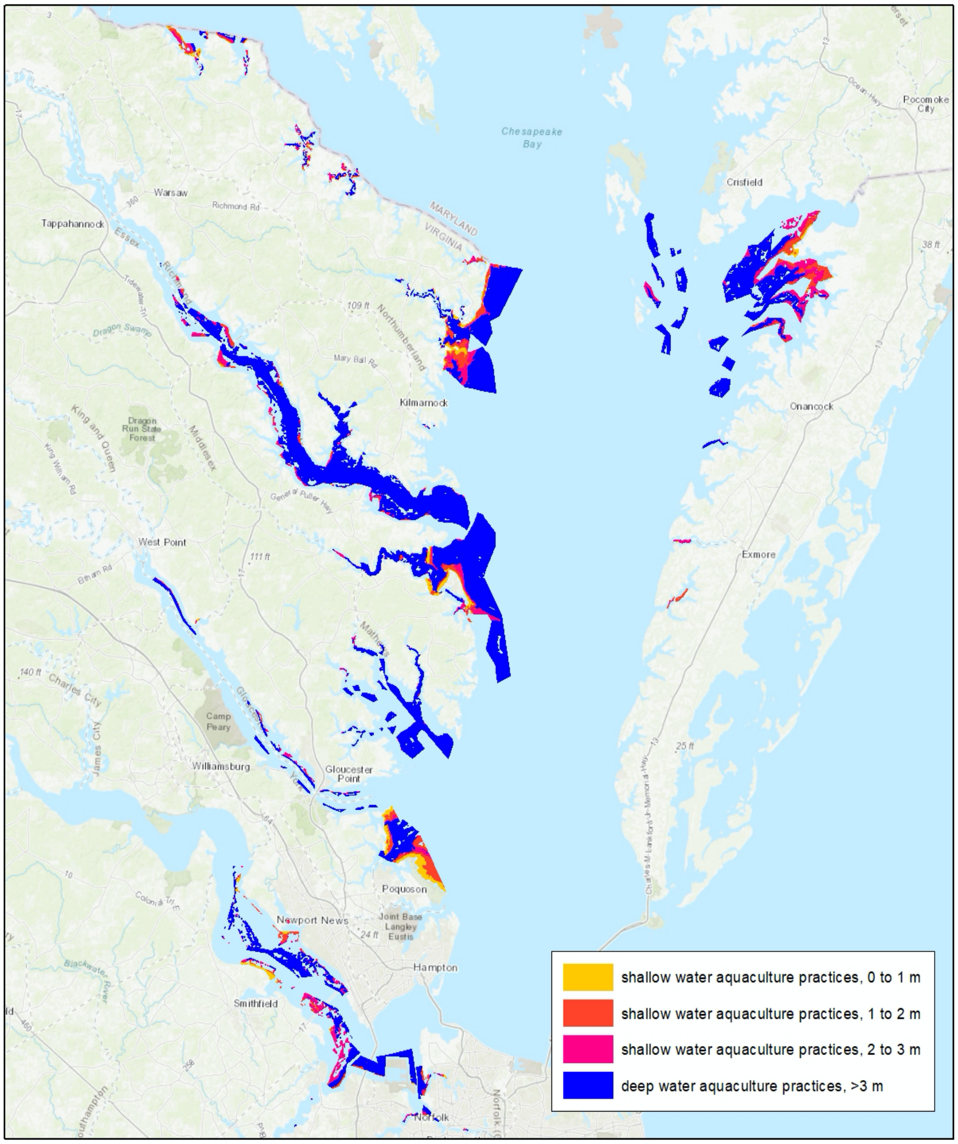

Figure 3. Bathymetric zonation of potential aquaculture areas with public Baylor bottom based on areas not suitable for restoration

Bathymetric data was available for all but 88 acres of the regions classified as not suitable for restoration. The results of the spatial analysis indicate that significant acreage is available in each depth zone throughout the Virginia portion of the Chesapeake Bay. Table 2 reports the results in acres per depth zone, with the majority of area located in water deeper than 3 meters. Therefore, there is a sizeable amount of area suitable for deep water aquaculture practices with intensive practices that utilize more of the water column. While deep water intensive culture is not typical in the United States, methods and technology to support this already exists.

Available area in less than 3 m depths still accounts for more than 33,000 acres of potential area. Allowing aquaculture in these regions could relieve pressure for space in an expanding industry of intensive aquaculture that dominates in shallow water.

Baylor Restoration Potential	Water Depth Zones (acres)				
	0 to 1 m	1 to 2 m	2 to 3 m	> 3 m	No bathymetry
Not suitable for restoration	5,188	12,863	15,013	106,455	88

Table 2. Bathymetric distribution of Public Baylor ground areas not suitable for restoration

Conflicts and Aquaculture

Shallow water practices have been generating a growing amount of conflict in two primary areas. The nearshore sociological conflicts associated with waterfront property owners, and the expanding distribution of SAV which is restricted to shallow water environments.

This study confines the assessment of conflicts to those associated with the conservation of submerged aquatic vegetation (SAV) which is regulated by the VMRC, and to conflicts affiliated with various upland or water dependent anthropogenic activities. This study focuses on intensive aquaculture since extensive culture is permitted on SAV beds, and does not generate the level of controversy that cage or float based operations do.

The first year of the study assessed the spatial distribution of intensive aquaculture as a function of harvest records and distance of private leases from the shoreline. The analysis generated nearshore environs representing zones at 100, 200, 300, and 500 feet from the shoreline, and found that 64% of all private, non-riparian leases exist within 100 feet of the shoreline.

When the analysis targeted actively used leases (i.e. removed non-riparian leases that may be held without purposeful use as indicated by harvest record history), harvest records indicate that 75% of all intensive harvesting is occurring within 100 feet of the shoreline. Furthermore, the majority of all intensive harvesting (93%) is occurring within 50 feet of the shoreline (Table 3).

Oysters and clams combined	100 ft Buffer	200 ft Buffer	300 ft Buffer	500 ft Buffer	Chesapeake Bay Totals
Total Leases	2,545	2,835	2,997	3,215	3,977
Percent Leases	63.99	71.28	75.36	80.84	100.00
Total Intensive Harvest	286	321	333	355	381
Percent Intensive Harvest (of total)	7.19	8.07	8.37	8.93	9.58
Percent Intensive Harvest	75.07	84.25	87.40	93.18	100.00

Table 3. Distribution of intensive aquaculture in shallow water environs

In the review of available bottom for leasing, the results indicated that the majority (62%) was in shallow water (1-3m), but that 73% of that bottom was more than 500 feet offshore. If the intensive harvest activity reported in table 3 is representative of this sector of the industry, it may explain why available bottom beyond 500 feet of the shoreline has not been leased for aquaculture.

Assessment of Aquaculture Conflicts and SAV

Current regulation restricts aquaculture in areas where SAV is present. New leases are not permitted in SAV areas, and use within existing leases can be restricted if SAV spreads into the area, regardless of SAV density or species. The VMRC uses data mapped by the VIMS Submerged Aquatic Vegetation program which annually surveys growth and distribution of SAV from high resolution aerial photography in the Virginia and Maryland portions of the Chesapeake Bay. VMRC uses presence/absence of SAV from the most recent 5-year period of data on record.

Results from the Year 1 analysis showed that within any selected 5-year period, a large proportion of leases with intensive aquaculture production also had SAV present. For Year 2, the data were updated to reflect the current 5-year period of record (2013-2017) from which VMRC will manage and regulate intensive aquaculture until the next SAV survey is released. The results are quantified in Table 4.

	Chesapeake Bay Totals (2012-2016)			**Chesapeake Bay Totals (2013-2017)**		
Total Leases	3977			3977		
	Number of Leases	Percent of Total	Percent of SAV Leases	Number of Leases	Percent of Total	Percent of SAV Leases
Non-Riparian Leases with SAV	948	23.84	100.00	1032	25.95	100.00
Non-Riparian Leases with No SAV	3029	76.16		2945	74.05	
Intensive Harvest - Oysters & Clams	Number of Leases	Percent of Total	Percent of Intensive Leases	Number of Leases	Percent of Total	Percent of Intensive Leases
Intensive Harvest with SAV	154	3.87	40.42	158	3.97	41.47
Intensive Harvest with No SAV	227	5.71	59.58	223	5.61	58.53
Total Intensive Harvest	381	9.58	100.00	381	9.58	100.00

Table 4. Shift in SAV distribution over time within private leases

The analysis showed that in one year there was a 2% increase in the number of non-riparian leases that showed the presence of SAV where the number of leases was unchanged. SAV had expanded into 84 more leases when compared with the previous time stamp evaluated.

A closer inspection of the variability of SAV over time with respect to areas privately leased and actively participating in intensive aquaculture was conducted. Annual distribution maps of SAV were inspected between 2010-2017. When examined over a progression of years, SAV waxes and wanes with the environmental conditions of a given year. If the water body generally had increasing coverage or density of SAV, then the area that had cages exhibited the same increase in coverage. The embedded video below was generated by combining geospatial data on the distribution and density of SAV coverage in annual time stamps from 2010-2017. The data are juxtapositioned to the private lease boundaries located in the lower Rappahannock River. The ephemeral nature of the SAV and the variability in the density of the beds is evident.

SAV_Video Presentation.wmv

Between the years 2012 and 2017, there was a general increase in density and coverage of SAV in Virginia's portion of the Bay and tributaries, which coincided with the increase in hatchery based aquaculture. The area of coverage for SAV is much larger than the coverage of intensive aquaculture, and there was no evidence of the aquaculture activity impeding SAV expansion. In years with increases in density and coverage of SAV, the footprint of the aquaculture activity is apparent within the SAV coverage, but there is no evidence of a negative impact beyond the cage footprint.

Bottom conditions that are characteristically good for intensive aquaculture operations are often ideal for SAV colonization and growth. Indeed, the filtering activity of the oysters arguably improves water quality. Most commonly on individual locations, widgeon grass (Rupia sp.) was the predominant species of SAV in association with intensive aquaculture. The general progression was for cages to be placed on a location with little or no SAV present, followed by increases in density and coverage of SAV within and around cages. In some cases, widgeon grass would significantly increase around cages within a water body over the summer and disappear during the other seasons in the same year (Figure 4).

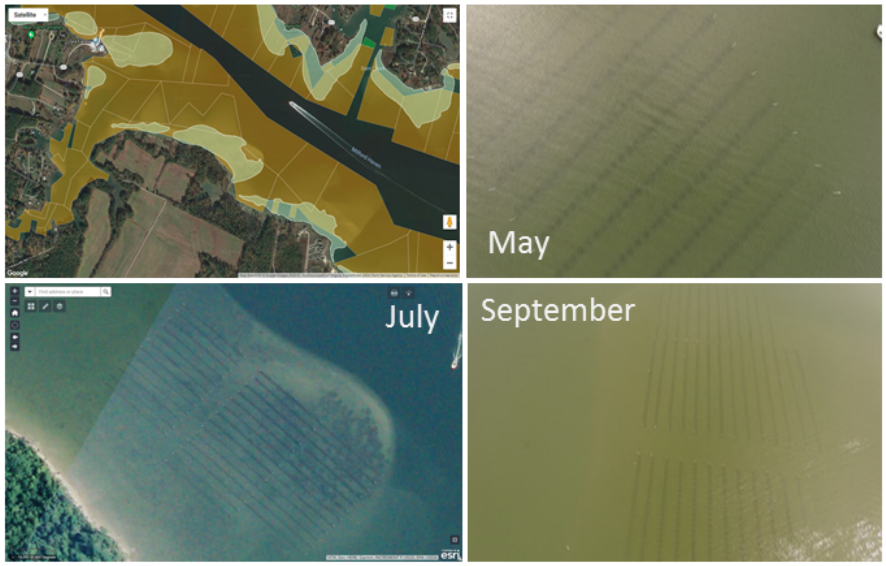

Figure 4: An aquaculture lease in Milford Haven, VA showing progression of SAV coverage over a season

The footprint of intensive aquaculture, using floating or bottom cages, as practiced in the Chesapeake Bay is proportionally quite small. This can be demonstrated mathematically. Generally, cage density as practiced is between 100 and 300 cages per acre. Most cages are between 10 and 12 square feet, resulting in footprints for intensive activity of much less than 10 percent of an acre. Based on the time series analysis of multiple, individual aquaculture operations where SAV was present, there did not appear to be impacts from intensive aquaculture activity as currently practiced in Chesapeake Bay.

The results of this analysis support the assumption that SAV and intensive aquaculture CAN co-exist. In lieu of these findings, VMRC regulation and policy on the matter; which reflects a deleterious relationship, should be reconsidered.

Regulation currently prohibits issuance of new leases in areas where SAV exist or have existed within their rolling 5 year SAV delineation window. In cases where SAV becomes established after a lease has been issued and a business plan approved by the agency; the lease holder may be allowed to continue use of his grounds, but the footprint of the aquaculture operation cannot expand into areas where the new stands of SAV have encroached. As written in regulation, "in cases where an SAV bed becomes established through natural restoration around existing or authorized structures, including aquaculture structures, such structures shall not be required to be removed. Such structures can continue to be used and replaced, but cannot be moved or relocated to cover the SAV bed." This policy directly prohibits aquaculture expansion and takes precedent over any approved use plans which may call for a future 10-15% annual farm expansion within one lease. Essentially the policy renders a lease useless.

VMRC guidance on SAV pertaining to aquaculture states "Certain aquaculture structures are authorized by Commission regulation within oyster planting ground leases provided they are not placed upon SAV beds within such leases. However, such aquaculture structures may be permitted by the Commission provided all appropriate mitigation measures to reduce impacts to SAV are included and compensation of SAV losses may be required if necessary". Such guidance suggests two things. First, that the encroachment is anticipated and therefore the compensatory mitigation is negotiated prior to leasing; and second, that there are clear and reasonable compensatory mitigation guidelines for SAV impacts. Encroachment is never anticipated in the process of acquiring bottom to lease as the potential leaseholder goes to a measurable financial commitment to have the grounds surveyed and necessary permits for use put in place. The authors found only mitigation guidelines that can be attributed to tidal wetlands and therefore there are no clear guidelines for what is considered reasonable compensatory mitigation for future impacts to SAV.

It remains within the authority of VMRC to force the aquaculture operation to be severely restricted, cease or be relocated regardless of: harvest history, longevity of lease holding, or consistency with approved use plan on file. This has been enforced in more than one instance in Virginia over recent history.

Preliminary Review of Policy and Regulation

Utilizing intensive aquaculture within the areas of the public grounds that are no longer naturally productive or not likely to become productive in the future offers a potential way to achieve the dual goals of maintaining oyster production and providing employment opportunity for watermen or others in rural, economically challenged communities. We have, in collaboration with colleagues at William and Mary (Grau 2019), explored two options. These are redefining the boundaries of public grounds to open unproductive areas for private leasing, and to expand the types of uses that are allowed within existing boundaries.

The Virginia General Assembly has authority to define and determine public grounds by surveys or otherwise. VMRC also has limited authority under state code. The agency may reestablish, relocate, and remark lines when the previous marks have been lost or destroyed; however, the agency's authority to alter the boundaries are much more limited – such as when private oyster ground leases have been mistakenly granted on public grounds. In these instances, there are time specifications associated with this authority.

Even though it is technically feasible, we do not believe a complete overhaul of the existing Baylor Grounds is required to accommodate an expanding aquaculture industry. Rather we favor an incremental, case-by-case approach. For example, in Maryland, individuals can petition the state to declassify sections of the public fishery if certain criteria are met - such as quantitative activity, commercial harvest activity, and a biological survey. Similarly, in New Jersey when approving a leasing application for caged aquaculture in public waters along the state's Atlantic Coast, the Bureau of Fisheries must issue a biological survey which assesses whether the public ground on the coastline is so naturally unproductive that aquaculture would enhance harvesting in that area. The General Assembly could establish a similar system in Virginia wherein areas within the Baylor Grounds that are determined to be no longer naturally and sustainably productive can be removed from the Baylor Grounds on a case-by-case basis and made available for aquaculture.

A second option, rather than removing areas from Baylor, is to modify the types of uses that are allowed within unproductive areas. Baylor Grounds are held in public trust and regulated as a public fishery, with established harvest seasons, harvest areas, and gear restrictions. Intensive aquaculture gear, like cages, is arguably no more damaging to the public grounds than current harvest gear. If this second option is to be explored, it would be beneficial to evaluate the licensing framework regarding other gear placed in Baylor, such as pound nets, to determine whether such an approach could be developed for intensive aquaculture. VMRC regulations regarding pound nets include procedures for licensing; location, measurements, and marking of the gear; renewal priority rights; and limits on the number of licenses. So a template for aquaculture use exists, but what would be its scope in implementation? A long experimental approach would be time consuming and constrict future private investment in aquaculture. We suggest a reasoned incremental approach as the most productive approach to optimal use of Baylor Grounds.

In addition to Baylor Grounds, Virginia has substantial bottom that is available for lease "for the purpose of planting or propagating oysters[.]" The framework for the management of Virginia's private leasing grounds is changing, and we proffer the opinion that the option to lease for intensive aquaculture should be part of this evolution. The implementation of use criteria (evidence of production) and use plans to support lease renewal are both reasonable yardsticks, and are used by other states to support aquaculture. For example, both Maine and Rhode Island require descriptions of species, source of seed stock, production estimates and timetables, gear types and maintenance schedules and more. None of these are unreasonable given that they are standard operating procedures on shellfish farms. Amending existing permitting application forms to incorporate additional information, especially in digital applications, is a modest task (Burchard 2019).

What are reasonable minimum use criteria? VMRC has the authority to deny a leaseholder's application for renewal when "there has been no significant production, no reasonable plantings, or no significant operation." VMRC can also weigh the public benefits and impacts of shellfish aquaculture and factors listed in 28.2-1205 of the Virginia Code. Again, other states provide working examples based on either (i) quantitative input or output requirements, or (ii) more open-ended active use criteria. Minimum planting or production requirements, and associated waivers and opportunities for appeal, also exist in MD, FL, DE, and NC. Annual mandatory reporting (preferably via a digital portal to VMRC) presents a simple communication between VMRC and the culturist to insure compliance and facilitate lease renewal.

The issue of criteria for lease renewal is currently being debated by the VMRC's Aquaculture Management Advisory Committee (AMAC). The proposed guidelines outline required activity to maintain lease status, which does little to advance aquaculture opportunity. That level of activity is so small that it cannot be verified, and thus provides no mechanism for enforcement.

Finally, lease applications that are respectful of SAV co-occurrence in farm footprints should be considered in that our analysis indicates co-existence IS possible and the ephemeral nature of SAV should not present substantial impediments to private investment where co-existence is possible. A modification of the current regulatory restrictions would provide more stability to the shellfish industry. Recently, legislation in Maryland (House Bill 841) "authorizes for water column leases, the placement of shellfish, bags, nets, or structures in at least 10% of the area where submerged aquatic vegetation is present." This allows the practice to continue to expand within leased boundaries and still allows for the SAV within those beds to be counted toward SAV restoration goals.

References

Burchard, N. 2019 Student White Paper, Shellfish Production in Virginia: Private Leasing Grounds, VA., VA Coastal Policy Center, W&M Law School, https://law.wm.edu/academics/programs/jd/electives/clinics/vacoastal/reports/index.php.

Geoffrey Grau, 2019. Student White Paper, *Shellfish Production in Virginia: Public Grounds*, Va. Coastal Policy Center, W&M Law School, https://law.wm.edu/academics/programs/jd/electives/clinics/vacoastal/reports/index.php

Haven, D. S., J. P. Whitcomb and P. Kendall. 1981. The present and potential productivity of the Baylor Grounds in Virginia. Virginia Institute of Marine Science, special report Applied Marine Science of Ocean Engineering No. 243. 154 pp.

Mann, R. and E. N. Powell 2007. Why oyster restoration goals in the Chesapeake Bay are not and probably cannot be achieved. *J. Shellfish Res.* 26(4):905-917.

Mann, R., J. M. Harding. and M. Southworth. 2009. Reconstructing pre-colonial oyster demographics in the Chesapeake Bay, USA. *Estuar. Coast. Shelf Sci.* 85:217-222

Mann, R., M. Southworth, J. M. Harding and J. A. Wesson. 2009. Population studies of the native oyster *Crassostrea virginica* (Gmelin, 1791) in the James River, Virginia, USA. *J. Shellfish Res.* 28(2):193-220.

Acknowledgement

The authors would like to thank the following for their input and guidance: Angela King and Elizabeth Andrews of the Virginia Coastal Policy Center at the William & Mary Law School; and Ben Stagg and Andrew Button of the Virginia Marine Resources Commission.