Discussion and Feedback Summary: May 22, 2017 Oyster BMP Expert Panel Open Meeting

The Oyster Best Management Practice (BMP) Expert Panel hosted an open meeting on May 22, 2017 to gather early feedback from interested parties on the nitrogen and phosphorus shell assimilation protocols for private oyster aquaculture practices and the enhanced denitrification protocol for private oyster aquaculture and reef restoration oyster practices. The presentation and materials from this meeting can be found at www.chesapeakebay.net/calendar/event/25062/.

Overall, the Oyster BMP Expert Panel is evaluating eight reduction effectiveness crediting protocols based on oyster-associated processes that reduce nitrogen, phosphorus, and suspended sediments for 12 oyster practice categories involving private oyster aquaculture, oyster reef restoration, and public fishery practices (total of 96 combinations). More details concerning these combinations and the reduction effectiveness determination decision framework that the Panel is using for considering oyster practices for use as BMPs can be found in the Panel's first report (www.oysterrecovery.org/oyster-bmp-first-report/).

This meeting focused on the following crediting protocols:

- Nitrogen Assimilation in Oyster Shell
- Phosphorus Assimilation in Oyster Shell
- Enhanced Denitrification Associated with Oysters

These protocols were evaluated in relation to the following oyster practice categories highlighted in yellow below (oyster practice titles subject to change in final Panel report):

Chesapeake Bay Oyster Practices						
Oyster Fate	Oysters removed (harvested) from Bay			Oysters remain in Bay		
Fisheries Management Approach	Private oyster aquaculture (water column and bottom leases)			Oyster reef restoration (sanctuaries)		
Oyster Culture Type	Hatchery-produced oysters		Wild Oysters	Hatchery-produced oysters	Wild oysters	
Activity	Hatchery-produced oysters grown off the bottom using some sort of gear (e.g., floating rafts near the surface or cages near the bottom)	Hatchery-produced oysters grown on the bottom using no gear	Addition of substrate to the bottom to enhance recruitment of wild oyster larvae	Sanctuary creation followed by addition of hatchery-produced oysters	Sanctuary creation followed by addition of substrate	Sanctuary creation
Oyster Practice Title	**Off-bottom private oyster aquaculture using hatchery-produced oysters**	**On-bottom private oyster aquaculture using hatchery-produced oysters**	**On-bottom private oyster aquaculture using substrate addition**	**Active oyster reef restoration using hatchery-produced oysters**	**Active oyster reef restoration using wild oysters**	**Passive oyster reef restoration**

This document summarizes what was discussed during the meeting. The protocols involving shell assimilation for private oyster aquaculture practices were grouped into one discussion group since the same approach is being recommended to determine the amount of nitrogen and phosphorus assimilated (stored) in the shell. The practice-protocol combinations involving enhanced denitrification were organized into two separate discussion groups based on the fisheries management approach given the likelihood of different

considerations concerning the reduction effectiveness since for private oyster aquaculture, oysters are harvested (removed), while for oyster reef restoration practices, oysters remain in the waterbody.

Concerning these practice-protocol combinations, the Panel was particularly looking for feedback on the following:

- The Panel's presented recommended approaches during the May 8th Water Quality Goal Implementation Team meeting that could be used to determine the estimates (www.chesapeakebay.net/channel_files/24983/oyster_bmp_panel_wqgit_update_5-8-17_final_(2).pdf).
- Identification/strategies to address concerns related to unintended consequences (positive and negative).
- Thoughts on verification.

For background information, the definition list from the first report can be found in Appendix A and summary of feedback received before this meeting in Appendix B. A draft of this summary was provided to the meeting's participants for review. Additional feedback from this review can be found in Appendix C.

Summary of Oyster Practice Category Definitions from First Report

Definitions for the practice categories involving private oyster aquaculture recommended for BMP consideration were previously defined in the Panel's first report (oysterrecovery.org/oyster-bmp-first-report/) and are briefly described below:

Private oyster aquaculture: Growing and harvesting diploid or triploid oysters in areas designated for oyster aquaculture where public fishing is not allowed (e.g., State-permitted oyster aquaculture leases to private oyster aquaculturists).

Specific categories under private oyster aquaculture that the Panel recommended for BMP consideration are defined below:

Oyster Practice Title	Definition
Off-bottom private oyster aquaculture using hatchery-produced oysters	Hatchery-produced diploid or triploid oysters grown off the bottom in the water column using some sort of gear (e.g., floating rafts near the surface or cages near the bottom) in an area designated for oyster aquaculture where public fishing is not allowed (e.g., State-permitted oyster aquaculture leases to oyster aquaculturists) for eventual removal from the water.
On-bottom private oyster aquaculture using hatchery-produced oysters	Hatchery-produced diploid or triploid oysters (e.g., spat-on-shell) grown directly on bottom using no gear in an area designated for oyster aquaculture where public fishing is not allowed (e.g., State-permitted oyster aquaculture leases to oyster aquaculturists) for eventual removal from the water.
On-bottom private oyster aquaculture using substrate addition	Placing oyster shell or alternative hard substrate, such as granite, to the bottom sediment surface to attract recruitment of wild (diploid) oysters in an area designated for oyster aquaculture where public fishing is not allowed (e.g., State-permitted oyster aquaculture leases to private oyster aquaculturists) for eventual removal from the water.

While not mentioned in the meeting's background materials, it is worth noting that the private oyster aquaculture categories of on-bottom (no gear) using transplanted wild oysters (i.e., moving wild oysters from one area of the Chesapeake Bay to another) and no activity (i.e., acquiring a lease and harvesting what is already there) were not recommended by the Panel for BMP consideration in the Panel's first report. The

Panel's decision concerning which oyster practice categories they would recommend for BMP consideration was based on whether the practices included an enhancement activity that could result in the overall production of new oysters (i.e., the reduction effectiveness can be attributed to the practice). The Panel concluded that these practices did not fit that criteria.

The Panel provided only broad definitions for oyster reef restoration and public fishery in the first report, since these practices were not being evaluated yet.

- **Oyster reef restoration:** Activities aimed to restore and/or protect oysters to increase the wild oyster population.

- **Public fishery:** Managed fishery that is open to harvest by individuals holding the appropriate licenses.

More detailed definitions for the oyster reef restoration and public fishery practices will be developed in future reports.

Meeting Attendance

In person and web attendance options were made available.

In person		
Name	**Role**	**Organization**
Rich Batiuk	Chesapeake Bay Program Representative	U.S. EPA Chesapeake Bay Program Office
Mike Foreman	Facilitator	Facilitator
Todd Janeski	Facilitator	VA Commonwealth University
AJ Erskine	Guest	Bevans Oyster Co. & Cowart Seafood Corp.
Ann F. Jennings	Guest	Chesapeake Bay Commission
Ann Wearmouth	Guest	NRG Energy
Brad Rodgers	Guest	Moreland Advisors, Inc.
David Maginnes	Guest	Maginnes Productions
Kim Huskey	Guest	Ballard Fish & Oyster Company
Lynton Land	Guest	Spencer's Creek Oyster Co.
Martin Gary	Guest	Potomac River Fisheries Commission
Michael Oesterling	Guest	Shellfish Growers of Virginia
Nissa Dean	Guest	Alliance for the Chesapeake Bay
Paula Jasinski	Guest	CEC
Richard Riche	Guest	Potomac River Watermen Association
Emilie Franke	Panel Support Staff	Fisheries GIT, ERT/NOAA
Julie Reichert-Nguyen	Panel Support Staff	Oyster Recovery Partnership
Paige Hobaugh	Panel Support Staff	Habitat GIT staffer, Chesapeake Research Consortium
Ward Slacum	Panel Support Staff	Oyster Recovery Partnership
Andrew Lacatell	Panelist	The Nature Conservancy
Bill Wolinski	Panelist	Talbot County Department of Public Works
Chris Moore	Panelist	Chesapeake Bay Foundation
Jeff Cornwell	Panelist	UMCES
Julie Rose	Panelist	NOAA
Lynn Fegley	Panelist	MD DNR
Matt Parker	Panelist	University of Maryland Extension
Suzanne Bricker	Panelist	NOAA
Web		
Jim Bonbright	Guest	Linden Capital
Laurie Carroll Sorabella	Guest	Lynnhaven River Now
Emily French	Panel Support Staff	Oyster Recovery Partnership
Kyle Runion	Panel Support Staff	Habitat GIT staffer, Chesapeake Research Consortium
Lawrence P Sanford	Panelist	UMCES
Lisa Kellogg	Panelist	VIMS

Agenda

Topic	Speaker	Time
Welcome	Jeff Cornwell (Panel Chair)	10 to 10:05
Introductions	Mike Foreman (Facilitator)	10:05 to 10:15
Oyster BMP Status & Current Feedback Review	Jeff Cornwell & Julie Reichert-Nguyen	10:15 to 10:40
Feedback Process	Mike Foreman	10:40 to 11:40

Breakout groups – Go to the group you've been assigned to (group # can be found on your name tag); after 30 minutes, there will be an opportunity to switch to a group of your choice or stay with your current group (in person participants will be able to go to 2 of the 3 groups); participants on the phone will be discussing all 3 topics for 20 minutes each.

- **Group 1**: Nitrogen and Phosphorus Assimilation in Oyster Shell for Private Oyster Aquaculture Practices
- **Group 2**: Enhanced Denitrification for Private Oyster Aquaculture Practices
- **Group 3**: Enhanced Denitrification for Oyster Reef Restoration Practices

Feedback Summary	Mike Foreman, Todd Janeski & Julie Reichert-Nguyen	11:40 to 12 noon
Next Steps and Adjourn	Jeff Cornwell	12 noon

Nitrogen and Phosphorus Assimilation in Shell Protocol for Private Oyster Aquaculture Summary

The nitrogen and phosphorus shell assimilation crediting protocols for private oyster aquaculture practices (i.e., leased water column or bottom in State waters to private aquaculturists) have an underlying issue involving the need to return shell that is removed from harvested oysters back to the Chesapeake Bay. Oyster shell is a limited resource in the Chesapeake Bay and the successful implementation of oyster practices, including aquaculture and restoration, is highly dependent on the availability of shell substrate for oysters to grow on. Therefore, any BMP involving shell needs to be developed to account for the return of shell and any sequestered assimilated nitrogen and phosphorus that could dissolve back into the Chesapeake Bay.

The Panel has developed a crediting approach that removes risk to shell recycling programs. The Panel's approach to account for shell being returned to the Chesapeake Bay is to apply a deduction value to all harvested shell based on a dissolution amount over a period of time. This approach assumes that 100% of the shell will be returned to the Chesapeake Bay and the dissolution value would be based on relevant research. By assuming 100% shell return, there is no incentive to keep shell on land.

During the meeting, Group 1 and web participants discussed both the nitrogen and phosphorus protocols pertaining to shell assimilation for private oyster aquaculture practices, including providing feedback on the Panel's recommendations thus far. Summary of their discussion/feedback is presented below.

Group 1 and Web: Discussion and Feedback from Meeting Participants

Do you have any specific thoughts or concerns that you would like the Panel to consider related to the proposed approach that could be used to assign reduction estimates for the nitrogen and phosphorus shell assimilation crediting protocols?

- Stakeholder: Would crediting for the TMDL take into account where the oysters are grown? There could be differences to consider based on salinity, differences in shell matrix structure, and differences in aquaculture practices (gear vs. no gear; growing methods).
    - Panelist: The Panel is currently looking at geographic differences in the data. There were not any significant geographical differences for tissue, but will also evaluate for shell.
- Stakeholder: Also need to look at the differences between aquaculture and the public fishery/wild harvest.
    - Panelist: The Panel will be evaluating public fishery practices in a future report.
- Stakeholder recommendation: Look at credit at the point of return to the Bay instead of the current framework of crediting when it is grown. For example, credit the shell once it is returned to the Bay (for either aquaculture or restoration) versus when it is grown and the ultimate fate of the shell is unknown.
    - Panelist: As a nutrient reduction credit for the TMDL, we need to focus on where it is grown.
- Stakeholder: Is the Panel accounting for shells that are harvested elsewhere (outside of the Bay) and recycled inside the watershed and the associated nutrient additions to the Bay?
    - Panelist: We don't have a sense of how often this occurs, but are working mainly to ensure we do not de-incentivize shell being returned to the Bay.
    - Panelist: Also, we want to make sure not to overvalue the removal of nitrogen from harvested oyster shells given that shells are returned to the Bay.

What do you think of using a deduction approach based on dissolution for the BMP estimate (assumption is that 100% of removed shell is returned to the Bay) to address concerns related to the potential unintended consequence that shell won't be returned to the Bay? Are there any concerns with this approach?

- Stakeholder: Curious as to why the assumption is made that 100% of removed shell is returned to the Bay. I work in the shell recycling business with restaurants and know that this assumption isn't accurate.
    - Panelist: The Panel is using this as a placeholder (preferred outcome). We haven't been able to identify the actual percentage.
- Stakeholder recommendation: Again, think about crediting when you put shell back into the Bay (see question #1 above).
    - Panelist: Concerning the TMDL, EPA looks at the removal/reduction of nutrients; in regards to the amount of nutrients stored (sequestered) in the shell for an in-water BMP, we are still waiting for EPA's lawyers to draft a legal opinion on whether this is acceptable for reduction crediting purposes.
- Stakeholder: If the shell is moved around to other parts of the Bay, it will make a difference. For example if the origin of the shell is different than where the shell ends up.
- Stakeholder: The Panel is assuming a 100% return rate of shell to the Bay, but there are many influences on how shell is used/moved.
    - Market value of shell often drives activity.
    - Shucking houses tend to return almost all, if not all, to the Bay.
    - Shell recycling is hard to track. Shell from the Bay gets mixed with oyster shell shipped in from other places.
- Stakeholder: Need to consider policy questions jointly with the science questions. What if you know of removed shell that will not be put back in?
- Stakeholders felt that there needs to be incentives to return shell to the Bay.

- Some local oyster projects have challenges with the permitting process to put shell into the Bay.
- A tax credit could be an incentive.

Are there any suggestions for another approach that could be used that would accommodate shell crediting with shell being returned to the Bay that the Panel could consider?

- Stakeholder: Even as the shell dissolves, there is still benefit to having the shell back in the Bay (ex: habitat benefits).
- Stakeholder: Some shell is only in the water for 18 months (aquaculture). Time consideration or time-specific credits should be considered for shell for aquaculture. For restoration, shell is in for the long-term.

Are there any other negative unintended consequences the Panel should consider?

- Stakeholder: Does not want conversations to get side-tracked by potential unintended consequences related to use and spatial planning/zoning conflicts.
- Stakeholder: Need to consider that while the negative unintended consequence of crediting shell is dissolution, the positive unintended consequence is that the shell provides habitat.

Are there any ancillary benefits (positive consequences) the Panel should consider?

- Stakeholder: Benefit would be the habitat created in oyster reefs. Among other benefits from habitat creation, nutrients are taken up by these newly present organisms.
  - Panelist: It would be helpful to know how these organisms are dealt with during processing in aquaculture operations.

Do you have any specific thoughts or concerns related to verification of the shell crediting protocols?

- Stakeholder: Verification of large quantities of shell has the potential to be challenging. When collecting shell, we have stockpiles in the range of 10,000-20,000 shells. These piles become compacted and volume can be difficult to estimate.
- Stakeholder: Another consideration in verification is the origin of the shell, which we often do not know when collecting shell from restaurants.
- Stakeholder: We know the shell won't be a vector for disease, but we don't know its place of origin, use, species, etc. This adds another source of uncertainty.

What are the concerns of users and managers regarding how we proceed?

- Stakeholders: How exactly will the crediting work? Need to connect the oyster grower to the TMDL holder;
  - The Panel should categorize/prioritize research gaps.
  - Suggest exploring opportunities for public-private partnerships.
- Stakeholders: This Oyster BMP effort should not control where and how oyster growers operate their businesses.
  - Concern that municipalities would push them to grow oysters in locations based on nutrient reductions needed, without regard for whether those places were good areas to grow oysters or good locations to set up a business.
  - Concern that local governments will prioritize potential nutrient reduction over practices/sites that would be best to grow and maintain a successful business operation.
- Stakeholder: Tracking shell is an ongoing gap when thinking about verification.
  - Health/sanitation departments may have some tracking data.
  - It will take a lot of effort to track. There may be ongoing research on tracking using shell chemical signatures.
  - Stakeholder: Overall, it is valuable to see shell returned to water, but important that the crediting doesn't remove the incentive to do so. Panelist: the Panel is in agreement.

Enhanced Denitrification Protocol for Private Oyster Aquaculture and Oyster Reef Restoration Practices Summaries

Denitrification occurs in the sediment and reef material by bacteria and is the final step in a set of transformations that converts organic nitrogen to nitrogen gas, a form of nitrogen that cannot be used for growth of phytoplankton/algae. The presence of oysters can "enhance" denitrification by filtering particulate nitrogen out of the water column (where it can become bioavailable again and grow more phytoplankton/algae) and depositing it on the bottom where it can be denitrified by bacteria in the sediment (no longer bioavailable once fully denitrified; represents a reduction of nitrogen from the system). Therefore, the only "enhanced" denitrification occurring due to the presence of oysters is the denitrification of particulates that would have otherwise been remineralized in the water column (does not count the denitrification that would have already been occurring in the sediment without the presence of the oysters).

The Panel has identified two approaches for evaluating "enhanced" denitrification. The first being a simple subtraction approach where the rate of denitrification is measured at the site with the oyster practice (at the reef or below water column practice) and subtracting the rate from a nearby site that doesn't have oysters. The advantage of this approach is that there are likely studies that could be used now to determine an estimate. The disadvantage is that it doesn't take into account the fate of the biodeposits that are deposited outside the footprint area where the oysters are, which could overestimate or underestimate the reduction.

The second approach is a more robust calculation that takes into account that biodeposits are also deposited and denitrified outside the footprint area. The advantage of this approach is that it would give a more accurate estimate of the net benefit associated with oysters enhancing denitrification. The disadvantage is that we're likely lacking data at this time to validate this calculation for all locations and practices.

During the meeting, the enhanced denitrification protocol was separated into two groups: one group to discuss the protocol related to private oyster aquaculture practices (Group 2 and web participants) and another group to discuss the protocol in context of oyster reef restoration (Group 3 and web participants). The discussion and feedback from these groups are summarized below.

Group 2 and Web: Discussion and Feedback from Meeting Participants Concerning Enhanced Denitrification for Private Oyster Aquaculture

Do you have any specific thoughts or concerns that you would like the Panel to consider related to the proposed approach (consideration of the transport of biodeposits) that could be used to assign reduction estimates for enhanced denitrification pertaining to private oyster aquaculture practices?

- Stakeholder: There is a lack of information due to variability in the ecological system (e.g. salinity, season, grow-out methods, location, tides, ploidy, historic land use, construction); in particular, the data variability between VA and MD is large.
- Stakeholder: There is uncertainty whether or not a baseline is even possible to measure in the wild due to the previously mentioned variability in the ecological system.
    - Even if enough data are available, it will be difficult to agree on an estimate number due to the variability.
- Stakeholders agree that YES, private aquaculture provides a benefit to water quality, but it may be wise to drop the consideration of denitrification from private aquaculture altogether and focus on shell.
    - Stakeholders also note that the issue of shell dissolution could pose problems deciding on a shell benefit estimate as well.

- Stakeholders were unsure of the actual approach the Panel has been using to reach estimate. Would like to know what the Panel sees as needs from researchers/citizen scientists in providing data that could lead to an estimate.
    - Make approach more explicit in the presentation/introduction.
    - Is there money available for the monitoring needs of the Panel to reach an estimate decision?
- Some stakeholders feel that the framework is lacking the elements that would enable the Panel to reach an estimate decision.
    - Representative from the Chesapeake Bay Program assured the group that the process is very carefully considered and implemented.

Would an average or minimum default value be acceptable to use now until we have a larger observational data set to consider fate of biodeposits for the different practices under various types of environmental conditions?

- Some stakeholders are interested in an interim reduction estimate before information gaps are filled.
- Stakeholders are curious as to what the Panel has in mind for the next steps to account for ecosystem variability/filling information gaps; more data points?
    - Stakeholder commented that the Panel can just assume that oysters provide nutrient removal (intrinsic value of having oysters in a system), treat aquaculture as a positive, and not waste money on gathering more data.
- Stakeholder felt that it is important for the Panel to conclude with a strong message that oysters do make improvements, regardless of reduction estimates or lack thereof.
    - Benefits ARE occurring.
    - Explain variability in science/precision as well.
- Stakeholder: Does including min/max ranges help inform a future panel or will the future panel begin anew with new data?
    - Stakeholders suggest that it is important for this panel to provide a list of gaps/constraints for the new panel and to suggest opportunities for research to fill the gaps.
        - Grow-out method, ploidy, salinity, SAV presence, etc.
- Stakeholder mentioned that denitrification will not be a driver for aquaculture site selection (it's a bonus).
- Stakeholder suggested that under the condition of their public land lease, private aquaculturists can be charged with collecting data with which to inform the Panel.
    - Will be expensive; jurisdictions should prepare for the compensation of the lessee's services before the growing season; will come from tax dollars.
    - The standards required could influence leasing; cost could be prohibitive.
- Stakeholders are concerned that the Panel is not looking at the private aquaculture denitrification issue holistically; why aren't public areas being considered?
- Stakeholders agreed that the task of the Panel should be to describe the state of science and what bar should be set for the future (site specific) if the effort is deemed worthy of pursuing.
    - Rigor of future studies is important.
    - Site characteristics also important (bottom type, sand, tide, etc.).
    - Prioritize which variables to study.
- Stakeholder felt that there should be additional research before we assign a minimum or default value; denitrification is so variable within different tributaries of the Bay that a default estimation is uncomfortable.
    - Panelist: Agree that data are variable and that would be a challenge to come to agreement over. Thinks the Panel is considering a default estimate as did with tissue but hoping to gather feedback from stakeholders.
    - Panelist: The Panel is cognizant of negative consequences from siting aquaculture facilities in the wrong place. We need to consider existing conditions of waters and sediments where these facilities are sited.

Are there any negative unintended consequences the Panel should consider?

- Stakeholder mentioned macroalgae fouling on the cages; when the cages are maintained the fouling community is cleaned and this material (macroalgae) is sent around into the system; is this source of nutrients considered by the Panel? Macroalgae may grow elsewhere in the water community without oysters.
    - Panelist: The research into these negative consequences is very limited. The Panel is still developing an approach at this point.
    - Panelist: The issue is very complex – we would like to consider it but are not able to assign numbers at this time. For example, if you lift a cage and place it down somewhere else you expose material and biodeposits that can be removed easily. Dispersal mechanisms are very dependent on physical environment.

What are the concerns of users and managers regarding how we proceed?

- Stakeholders would like the Panel to provide an update of the Clean Water Act implications on in-water BMPs.
    - Panelist: EPA lawyers are currently working on this.
- Stakeholders differ in their views of what aquaculture actually means.
    - One view: Sees moving oysters from site to site as private aquaculture (from public bars to cages)
    - Another view: Cooperative harvest areas should be considered in defining private aquaculture
    - Stakeholders would like a more specific definition of private aquaculture from the Panel before the next meeting.
- The movement of wild seed/oysters between sites should be considered as a type of aquaculture.

Group 3 and Web: Discussion and Feedback from Meeting Participants Concerning Enhanced Denitrification for Oyster Reef Restoration

Do you have any specific thoughts or concerns that you would like the Panel to consider related to the proposed approach (consideration of the transport of biodeposits) that could be used to assign reduction estimates for enhanced denitrification pertaining to private oyster aquaculture practices?

- Stakeholder: Reefs could provide a means for permanent sequestration. Is the amount of nitrogen and phosphorus sequestered in the reef being taken under consideration?
    - Panelist: Yes, but it's being addressed in a different crediting protocol which will be evaluated at a later date.
- Stakeholders were interested in understanding more about which variables should be investigated to determine enhanced denitrification.
    - The group felt that sediment condition, hydrology, oyster density, and geometric complexity/structure of the reef would be important to consider.
    - Concerning oyster density, there is interest in knowing how many oysters per m^2 for enhanced denitrification to be effective.
- Stakeholder: There is potential for additional denitrification in sanctuary reefs for restoration in areas where fouling organisms and other fauna living in and under the reef.
    - Panelist: The trapping of biodeposits keeps these nutrients in place. The fouling community utilizes organic material and may result in greater denitrification.
    - Panelist: There are also other filter feeders besides oysters doing these processes but interactions are complex.
- Stakeholder: If crediting could be expanded for alternative substrate (such as oyster castles) to be classified as sanctuaries, implementation of restoration by homeowners who want to have habitat would likely increase. Virginia Beach has interested residents, but the permitting cost is prohibitive. A credit could alleviate these burdens. Castles thrive and become habitat for oysters and other organisms.

Would an average or minimum default value be acceptable to use now until we have a larger observational data set to consider fate of biodeposits for the different practices under various types of environmental conditions?

- Stakeholder: There appears to be plenty of information for a default estimate concerning nitrogen and phosphorus assimilated in the shell and tissue, but for denitrification, it would seem you need site-specific information.
- Stakeholder: A default denitrification estimate could be considered if values are from sites that are representative of the site receiving credit; main stem of the Potomac is completely different than smaller tributaries.
- Stakeholder: A default estimate must be conservative; site-specific would be best, but concerned about the lack of budget to do this.
- Stakeholder: Concerned about the lack of information to understand denitrification variability for a default estimate; current restoration projects don't typically build into their design measurements for denitrification.

Are there any other studies/ongoing work that anyone is aware of?

- Panelist: The Nature Conservancy is supporting projects where the design of the reef is in rows; brings up the question whether the method/engineering approach used to construct the reef could affect the value of enhanced denitrification.

Are there any ancillary benefits (positive consequences) the Panel should consider?

- Stakeholder: The reef also supports other filtering organisms that can influence enhanced denitrification (increase rate of biodeposit production).
- Stakeholder: Another benefit is community involvement. The City of Virginia Beach would put more effort into oyster restoration if it was more feasible economically. Outreach in school reaches 10-11k students each year to spread the knowledge of oyster value. The community becomes much more aware of the ecosystem services provided by oysters.

Do you have any specific thoughts or concerns related to verification of a default denitrification estimate for private oyster aquaculture practices?

- Stakeholder: Include monitoring guidelines to ensure that reduction is occurring and that environmental goals are being achieved.

What are the concerns of users and managers regarding how we proceed?

- Stakeholders felt that site selection will be important from a BMP standpoint; it would be useful for the Panel to recommend qualifying conditions concerning site selection; e.g., existing water quality; metrics related to optimizing denitrification enhancement, such as sediment condition and hydrology (water flow).
- Stakeholder: Objective for restoration should include water quality benefit along with other co-benefits (habitat, oyster production, etc.).
- Stakeholder: There is less concern about a default for restoration since there seems to be enough available data to justify establishing a minimum.

Parking lot (other items that were brought up, but not necessarily for the Panel to address)

- Political communication component—by not assigning a number even though information supports that oyster reefs have a water quality benefit could lead to defunding oyster restoration (would be viewed as not important); however on the flip side, if we assign a number that is not truly representative and end up counting on its reduction too much, the environmental goals won't be met.
- Funding of restoration projects should include potential to improve water quality during site selection.
- In order for oyster restoration to work, we need watermen buy-in—when do the efficiencies of the reef change where it's not as beneficial to leave oysters untouched versus allowing some harvesting.

Next Steps

- The Panel will compile notes from the open meeting and share with participants for review to clarify/elaborate on topics that were discussed. The final summary will be shared with the Chesapeake Bay Partnership and interested parties.
- The Panel will begin drafting the second report, including consideration of feedback received.
- The Panel will share a draft of this report with the Chesapeake Bay Partnership, stakeholders and the public allowing for a 30-day review period. The Panel's response to comments will be drafted after this review period.
- Tentatively, the Panel is looking to complete a draft of the report by October 2017.

Appendix A: Key Definitions related to Evaluating Oyster BMPs

Taken from the first report, oysterrecovery.org/oyster-bmp-first-report/

Assimilation: The process where oysters convert the nitrogen and phosphorus within absorbed food into substance of the body (e.g., tissue, shell).

Biodeposition: Organic matter (e.g., feces and pseudofeces from oysters) deposited on the bottom (i.e., sediment surface).

Burial: The process in which nutrients are trapped in the bottom sediment for long timescales (i.e., below the active zone where decomposition occurs).

Cultch: Material suitable for settlement of oyster larvae (e.g., oyster shell). Also, referred to as substrate.

Cultchless oysters: Single oysters produced by settling oyster larvae on pieces of substrate small enough to be indistinguishable from the adult shell at the time of harvest.

Denitrification: The process that reduces nitrates or nitrites to nitrogen gas, commonly by bacteria in the bottom sediment. Nitrogen gas ultimately escapes into the atmosphere.

Diploid oyster: Wild or hatchery-produced oysters containing two complete sets of chromosomes, one from each parent and capable of sexual reproduction.

Hatchery-produced oyster: Diploid or triploid oysters propagated outside their natural environment in private or State-run hatcheries.

Oyster hatchery: Private or State-run operations that produce diploid and/or triploid oyster larvae outside their natural environment for research, restoration, educational, and/or commercial uses.

Oyster reef restoration: Activities aimed to restore and/or protect oysters to increase the wild oyster population.

Oyster sanctuary: An area of bottom closed to oyster harvest usually with the intention of allowing oyster populations to recover.

Oyster seed: Refers to oysters below legally harvestable size and typically used in connection to oysters that are being moved from one location to another (e.g. from a hatchery to aquaculture operation or from an area with high natural recruitment to an area with lower recruitment).

Oyster shell height: The longest distance (parallel to the long axis) between the hinge and lip of the oyster.

Oyster spat: Typically refers to oysters that have settled (attached) onto substrate and are less than one year old.

Ploidy: The number of sets of chromosomes in a cell.

Private oyster aquaculture: Growing and harvesting diploid or triploid oysters in areas designated for oyster aquaculture where public fishing is not allowed (e.g., State-permitted oyster aquaculture leases to private oyster aquaculturists).

Public fishery: Managed fishery that is open to harvest by individuals holding the appropriate licenses.

Quantile regression: Type of regression analysis that estimates the conditional median or other quantiles of the response variable.

Recruitment: The number of individuals surviving to a certain size, age, or life stage (e.g., spat, reproductive maturity, etc.).

Spat-on-shell planting: Oyster larvae that have settled (attached) onto shell and have been placed on the bottom.

Substrate: Materials (e.g., shell, granite, etc.) that oyster larvae can attach to. Shell substrate is also referred to as cultch.

Substrate addition: The act of placing substrate (e.g., shell, granite, etc.) on the sediment surface to harden the bottom to enhance the potential recruitment of wild oyster larvae.

Sufficient Science: In the Panel's best professional judgment, data of sufficient quality and scope exist and can be used to generate a reasonably constrained estimate of the reduction associated with a particular oyster practice category.

Suitable for Reduction Effectiveness Consideration: In the Panel's best professional judgment, the reduction process could occur in association with a particular oyster practice category and involves an enhancement activity that could result in the production of new oysters (i.e., the reduction effectiveness can be attributed to the practice).

Suspended sediment: Very fine soil particles that remain in suspension in water for a considerable period of time without contact with the bottom.

Triploid oyster: Hatchery-produced oysters containing three sets of chromosomes, typically a result of hybridizing a diploid (2-set chromosome individual) with a tetraploid (4-set chromosome individual) via human manipulation. The resulting triploid oyster lacks reproduction capabilities.

Unintended Consequence: Potential unexpected negative or positive effects resulting from the practice. Positive unintended consequences are referred to as “ancillary benefits” in this report to match the terminology found in the BMP Review Protocol (CBP 2015).

Verifiable: In the Panel's best professional judgment, a practical method exists, or could be created, to track reduction effectiveness if the BMP is implemented.

Wild oyster: Diploid oysters produced in their natural environment without human involvement.

Appendix B: Summary of Comments Sent to Oyster BMP Expert Panel before May 22, 2017 Open Meeting

Summary of comments sent to the Oyster BMP Expert Panel related to the shell assimilation protocols			
Comment Focus	**Comment Summarized**	**Commenter**	**Letter Date**
Benefit	Do not let an argument over the long-term fate of nutrients locked in shells impact the short-term gains that habitat restoration goals may see through expanded municipal oyster restoration programs. Oyster-associated processes (assimilation and burial) helped store nutrients and total suspended sediment (TSS) in the past and will do so again if enough restoration is undertaken and succeeds (allows system to be more resilient to these pollutants). The efforts of the Bay TMDL are largely short- to mid-term and the sequestering of pollutants should be looked at from that perspective. While there certainly needs to be continued retrofit of uplands to reduce runoff, practices to meet that goal are often far more expensive than restoration. Municipalities are desperately trying to find options they can afford to meet Bay TMDL requirements. Their residents often prefer options that improve aesthetics, recreation, economics, coastal resiliency, etc. Practices such as oyster restoration benefit check many of these boxes, so are quite desirable. Regulations managing redevelopment will continue to work on runoff, but for many localities the overall Bay TMDL requirement seems hopeless without further options.	Norfolk Public Works	5/13/16
	The assumption of time degradation of returned oyster shell as the overriding factor for rerelease of n/p if returned to the water as a concern for giving n/p credit is substantially overridden by the multiple n/p values of assimilation by new oysters that attach to said shell whether through aquaculture spat on shell strike or natural strike “In Situ”, where these oysters are not receiving any nutrient credits for their function. However, the unintended Positive Consequence is acceleration of oysters and oyster shells for both restoration and balanced sustainable commercial use.	OCVA	8/15/16
Crediting Protocols	Once sequestration and other values are modeled and “reefs” can be shown to have a mean quantitative value that can be monitored, then they can receive a credit value, without having to harvest. There is a difference in annual and perpetual credits that needs to be considered when developing these models.	OCVA	10/21/16
	When shell N & P assimilation is addressed, please consider that the shells of cage-grown triploid oysters (not tumbled) tend to be thinner. This may be due to less stress and quicker growth. Growing and handling practices greatly influence shell thickness and should be taken into account.	SELC et al.	10/21/16
	Protocols need to take into account other variables; most studies were conducted in warm months; therefore Panel should consider if there are differences in other months concerning growth.	SELC et al.	2/15/16
	Except on a very small scale, restoration is impossible (see Bay Journal Forum 07/14 and 11/14). If the goal is to reduce nitrogen pollution, then can only be accomplished by reducing the pollution source (largely inefficient agricultural crop fertilization).	NAPS	5/10/17
Unintended Consequences	Concerned with unintended consequences of using shellfish as in-water BMP: shell not being returned to the Bay exacerbating shell shortage; basing water quality on organisms that could die; omit oyster shell crediting because of unintended consequence of reducing critically needed sources of oyster shell; crediting should be developed in such a way that does not provide disincentives for shell recycling programs.	CAC, CBC, CBF, SELC et al.	2/15/16
	Denitrification requires dissolved nitrate and an anoxic setting (anoxia is avoided in growing oysters commercially, where sites with good circulation are always favored); additionally pseudofeces can build up under floats causing the water to become shallower.	NAPS	5/10/17
Data Concerns	No denitrification documented above background values in aquaculture settings; one study suggests anomalously high values associated with oyster reefs; concept is very premature given available data.	NAPS	5/10/17

Summary of comments sent to the Oyster BMP Expert Panel related to the enhanced denitrification protocol			
Comment Focus	**Comments Summarized**	**Commenter**	**Letter Date**
Baseline	The Panel should consider burial and denitrification that would occur in the absence of oysters.	SELC et al.	2/15/16
Crediting Protocols	Important to LRNow that the panel continue to consider and determine crediting protocols regarding sanctuary oyster reef nutrient and sediment removal.	Lynnhaven River Now	2/15/16
Data Concerns	STAC identified spatial and temporal limitations of the data; 2013 STAC Report couldn't address all 12 questions raised by CBP, DiPasquale; therefore, if data doesn't exist 3 years later to answer questions then the Panel shouldn't derive estimates until adequate data becomes available; there wasn't many studies for STAC to review (N assimilation-5 studies; denitirification-2 studies; burial-no published rates).	CAC and SELC et al.	2/15/16
Unintended Consequences	How is the Panel addressing accumulation of nutrient heavy biodeposits in systems with heavy aquaculture operations?	SELC et al.	2/15/16
Verification	Any denitrification crediting should be accompanied with verification guidelines given that much variability exists among sites.	CBF	2/15/16
General	Oyster shell is the best substrate for oyster strike and clean shell must be returned to the water at an appropriate time and place to encourage the growth of more fertile oysters. Read: Aquatic Geochemistry, 2014, 20:291–323, doi:10.1007/s10498-014-9226-y. The amount of nitrogen and phosphorus removed by harvesting oyster tissue and/or shell is trivial. If the goal is to reduce nitrogen and phosphorus pollution, then the only way to do that is by more efficient crop fertilization. The disposal of poultry litter, manure and sewage sludge by land application causes about one quarter of Chesapeake Bay nutrient pollution. Given that sewage sludge causes about 400 pounds of nitrogen pollution per acre (Marine Pollution Bulletin, 2012, http://dx.doi.org/10.1016.j.marpolbul.2012.07.003) and that one million oysters contain about 330 pounds of nitrogen, each acre of sludge disposal would need to be offset by harvesting 1.2 million oysters (about 4,000 bushels). About 50,000 acres of cropland receive sewage sludge and about twice as much poultry litter is disposed by land application in Virginia (70% of applied chemical nitrogen is removed with the harvest, from about 3 million acres of chemically fertilized fields in Virginia, and the rest is pollution). Given the magnitude of the nitrogen pollution of Chesapeake Bay, mostly by agricultural practices, oysters cannot impact the pollution in any meaningful way. Attempts to magnify the role of oysters in removing nutrients only impedes efforts to address the real problem, nutrient pollution by agricultural practices.	NAPS	5/10/17

Acronyms:

CAC - Citizen Advisory Committee; CBC - Chesapeake Bay Commission; CBF - Chesapeake Bay Foundation; NAPS - Northumberland Association for Progressive Stewardship; OCVA - Oyster Company of Virginia; SELC et al. - Southern Environmental Law Center and others

Appendix C: Additional Feedback from Participant Review of May 22, Open Meeting Summary

A draft of this summary was provided to the meeting's participants for review. From this review, the Panel received additional feedback from one participant summarized below.

Summary of additional feedback from Dr. Lynton S. Land (e-mail received on 06/29/2017):

Nitrogen and Phosphorus assimilation in shell

- Agreed that all shell should be returned to the Bay; mentioned that it is well established that clean shell is the best substrate for larval strike.
- Emphasized that if returned shell is not harvested with attached oysters and re-used, it will ultimately be destroyed or buried, with a half-life on the order of a decade.
- Mentioned that most shell destruction is biological, not chemical; provided example of boring organisms like *Cliona*.
- Emphasized that small amounts of N and P are removed from the Bay ecosystem from shell not returned to the water or from shell that is buried and therefore, not worth pursuing.

Enhanced denitrification protocol

- Mentioned that little data exists to document that the presence of oysters increases the amount of denitrification above that typical of anoxic sediments.
- Expressed that there is a flaw with the "second approach" since you would need to be able to identify what happens to the biodeposits transported outside the footprint area.
- Felt there is no certifiable way to credit oysters unless the denitrification takes place near the oysters.
- Provided a photo of his pier from 2/15/2015 at a very low "blowout" tide showing the accumulation of pseudofeces after 19 years of growing oysters in floats; this resulted in a soupy gas-rich sediment due to currents too slow to carry the pseudofeces away; felt that the ammonia release likely exceeds denitrification (no chemical data from location) and by growing oysters in this low energy setting is likely lowering water quality.
- Mentioned that denitrification is dependent on the presence of anoxia (always present in organic matter-rich sediment, including pseudofeces accumulations) and nitrate (always in very short supply) and that limited availability of nitrate restricts the magnitude of conventional denitrification or the "anammox" reaction.
- Expressed that there is no scientific consensus that denitrification is sufficiently enhanced by the presence of oysters, especially associated with aquaculture, to be meaningful. Denitrification from pseudofeces accumulations may be larger than is true of typical sediment, but so is ammonia release.

Big Picture

- Expressed that the only way to address Chesapeake Bay's nutrient load is to reduce that load, mostly from agricultural practices, and that oysters aren't grown in sufficient numbers to be quantitatively important.
- Gave an example comparing the amount of oysters that would be needed to address the amount of sewage sludge produced in Virginia and stressed that an unrealistic number would be needed to reduce the amount of nitrogen resulting from this sewage sludge (Marine Pollution Bulletin, 2012, http://dx.doi.org/10.1016.j.marpolbul.2012.07.003).
- Felt that oysters cannot measurably impact the magnitude of nitrogen pollution in Chesapeake Bay and focusing on them, including "nutrient credits" for growing oysters, is buying time for polluters to avoid regulation and relieves pressure on agriculture to fertilize more efficiently.