WA Eelgrass and Shellfish Aquaculture Workshop Report

A summary of presentations, discussions, and outcomes from the workshop hosted by:

National Marine Fisheries Service West Coast Region
NOAA Sand Point Campus, 7600 Sand Point Way, Seattle, WA 98115
Tuesday, April 11, 2017

Disclaimer: Please note that this report captures the presentations and dialogue that occurred during the April 11, 2017 workshop; it does not represent all data, knowledge, or discourse across the eelgrass and aquaculture landscapes, nor does it signify a consensus across agencies, tribes, researchers, and industry.

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Executive Summary

On April 11, 2017, NOAA's National Marine Fisheries Service (NMFS) West Coast Region (WCR) convened over 70 scientists and agency, tribal, and shellfish industry representatives for an all-day workshop to discuss inconsistencies and challenges related to the management of native eelgrass (*Zostera marina)* and shellfish aquaculture in Washington. Specifically, the workshop sought to:

- Increase understanding about eelgrass and shellfish aquaculture interactions in Washington;
- Determine where and why inconsistencies in eelgrass management related to shellfish aquaculture exist; and
- Develop a path forward for addressing eelgrass inconsistencies in the state.

State of the science and discussion of ecosystem functions & services
Presentations from five scientific experts (Ron Thom, Steve Rumrill, Kurt Fresh, Jennifer Ruesink, and Brett Dumbauld) reviewed:

- The status of eelgrass in Washington
- Ecosystem functions and services provided by eelgrass and aquaculture
- Salmonid use of eelgrass
- Small-scale and landscape-scale effects of aquaculture on eelgrass
- Effects of aquaculture on eelgrass in Willapa Bay

While it is understood that eelgrass provides many ecosystem functions and services, and is relatively resilient in Willapa Bay and Puget Sound, genetically diverse, and variable across landscapes, there are still significant knowledge gaps. It was noted that over a century of observation by shellfish growers and land managers, historical photos, and maps suggest that commercial shellfish and eelgrass can and do coexist. In addition, members of the industry are concerned that despite the many ecosystem services provided by commercial shellfish, those services are not being valued or appropriately considered in regulations.

Some key questions identified in this session include:

- How to design aquaculture in a way that maintains eelgrass ecosystem function?
- How can we best measure and monitor eelgrass ecosystem functions?
- How do current management metrics (e.g., shoot density and percent cover) correspond to the ecological value of eelgrass habitat?
- How can we examine eelgrass ecosystem function on a broader spatial (landscape) and temporal scale?
- What are the ecosystem functions and services provided by shellfish aquaculture?

Eelgrass management, regulatory context in the context of shellfish aquaculture, and identification of inconsistences and challenges
Laura Hoberecht (NMFS WCR, on behalf of the Shellfish Interagency Permitting Team) summarized the complex and multi-layered permit application process for shellfish aquaculture, identifying where in the process eelgrass is considered. Bill Dewey (Taylor Shellfish Farms, representing the shellfish industry) presented the origins of the complex regulatory context, as well as the industry's frustrations by regulatory burdens and lack of opportunity for industry engagement. Growers would like to be involved in ensuring regulations are based on sound science and achieve environmental goals while supporting the economic vitality of aquaculture.

Several inconsistencies and challenges around eelgrass management identified include:

- Conflicting, poorly-defined, or inconsistent goals and regulatory application;
- Gaps in scientific knowledge to help identify best management practices and set appropriate permit conditions;
- Lack of open dialogue with industry;
- Eelgrass management is focused on certain eelgrass parameters (e.g., density, percent cover) and does not necessarily account for all ecological functions provided by eelgrass and/or cultured habitat; and
- Parameter or protocol inconsistencies across agencies including use of buffers, shoot density, bed definition, survey protocols, and monitoring protocols.

Recommendations for future actions to achieve consistency in management

As a general outcome of the workshop, participants agreed that industry and the regulatory community should embrace a management approach that supports the protection of eelgrass functions and services as well as sustainable aquaculture, and that scientists should be involved in development of this approach. To achieve this goal, a more open dialogue between shellfish growers, scientists, and regulators, as provided through this workshop, should be continued. Specific recommendations from this discussion include:

- **Better define goals of eelgrass management in the context of aquaculture** and pathways to reconcile application of economic, ecological, and other mandates to eelgrass management across agencies.
- **Develop an adaptive management approach** that can provide the framework to manage eelgrass amidst uncertainty and allow regulatory program investments in assessing unanswered questions (e.g., how appropriate eelgrass is as a proxy to ecosystem health?). It should be noted that experimentation in permitting metrics may be challenging for agencies who have to defend policy decisions in litigation.
- **Explore Washington's Forests and Fish Law** as a model for adaptive management under some of the same constraints (public and private lands, economic benefit, multiple Endangered Species Act (ESA) species).
- **Provide feedback on eelgrass survey protocols** to the Army Corps of Engineers (Corps) and other entities in an effort to bring more consistency between them.
- **Identify best management practices,** in collaboration with scientists and growers, which may be applied as permit conditions. Could build from voluntary best management practices developed by the Pacific Coast Shellfish Growers Association and required permit conditions identified by the Shellfish Aquaculture Regulatory Committee.
- **Determine and pursue funding to address science gaps** that answer management questions.
- **Find opportunities to coordinate and cost-share** activities related to monitoring, evaluation, and research on a state or region-wide scale.
- **Utilize the Shellfish Interagency Permitting Team** (or similar type forum) with the inclusion of scientists and industry to pursue the questions and recommendations identified at the workshop.

The workshop provided an educational and networking opportunity for its many participants. It also set the stage for future, longer-term efforts to address the challenges discussed.

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I. Background and Workshop Overview

Native eelgrass (*Zostera marina*) occurs in bays, estuaries, and nearshore areas across Washington and is currently managed in different ways by different agencies. In an effort to move toward a common understanding of how eelgrass is managed in and around shellfish farms in the state, NMFS WCR hosted an all-day workshop for over 70 participants on April 11, 2017 (see Appendix A for workshop agenda). This workshop addressed the Washington Shellfish Interagency Permitting Team's recommendation to "develop consistent, practicable, and effective best management practices," by bringing together scientific experts, regulators, tribes, and shellfish industry representatives to:

- Increase understanding about eelgrass and shellfish aquaculture interactions in Washington
- Determine where and why inconsistencies in eelgrass management related to shellfish aquaculture exist, and
- Develop a path forward for addressing inconsistencies

Workshop participants included scientists, regulators, and representatives from the shellfish industry, tribes, local government and state and federal agencies (see Appendix B for a complete list of attendees). Participants heard a series of presentations on the current state of scientific knowledge as well as both agency and aquaculture industry perspectives on the current regulatory landscape related to eelgrass and aquaculture. They also participated in three discussions throughout the day on the following topics:

- Eelgrass ecosystem function/services
- Identification of inconsistencies in eelgrass management related to shellfish aquaculture
- Resolution and opportunities for consistency

Highlights and key action items from both the presentations and discussions are included in this report.

II. Eelgrass State of Knowledge

Five presentations from scientific experts addressed questions posed by participants in a pre-workshop survey (see survey responses in Appendix C). Highlights from these presentations are noted below. In addition to these presenters, other scientists with expertise in eelgrass assisted in answering questions and contributing to the discussion.

Status of Eelgrass in Washington State

Presented by Ron Thom, Pacific Northwest National Laboratory

Key Subject: Current distribution and historical changes of eelgrass

- Eelgrass populations in Washington have most likely seen overall losses since the 1800s; however, they have been generally stable since the early 1970s. Across Puget Sound, eelgrass area was relatively constant between 2000 and 2015.
- Despite this overall stability, there is great local variability. Localized collapses have been observed in areas such as Southern Hood Canal and Vashon Island, while other local populations have expanded, e.g., in the Nisqually and Skokomish deltas (perhaps driven by dike removal around tidal marshes), the Columbia River estuary (may be the result temporarily due to salinity increased focused by lower river flows during the 2014-2015 drought), Willapa Bay and Grays Harbor. The respective causes of these collapses are yet to be verified.
- Some areas seem more vulnerable to population decrease than others, e.g., South Puget Sound, San Juan Islands, and sites at the heads of inlets and bays.

Key Subject: Eelgrass (Z. marina) populations in Willapa Bay and Puget Sound appear to be resilient

- Eelgrass exhibits a wide variation in population structure. Factors that could influence eelgrass variability include:
    - Climate (there is evidence of dramatic variation in Sequim Bay between La Nina and El Nino years)
    - Increased distribution of the invasive eelgrass species *Z. japonica* may facilitate expansion of *Z. marina,* to higher tidal elevations, particularly in Willapa Bay
    - Low flows in the Columbia River estuary (this may facilitate expansion)
- Observations indicate that eelgrass has the ability to recover from disturbances. In a study from Morro Bay (CA), a few small new patches of eelgrass were observed in 2016 after a complete collapse of almost all of the meadow between 2010 and 2013. The cause of the collapse is under study.
- Data from the Clinton ferry terminal area in Puget Sound indicate that shoot density, biomass, growth rate and distribution can increase 5-fold within a 10-year period.
- Recovery is probably driven by variations in system capacity, which is in turn driven by light, temperature, salinity, substrate, and space. Factors that allow for successful flowering and seed dispersal probably assist in rate and scope of recovery. Areas rich in sediment organic matter were the strongest correlation to success. In management, it is important to make sure disturbances do not occur beyond the capacity of the system to recover. In management, it is important to make sure disturbances do not occur beyond the capacity of the system to recover.

Key Subject: Restoration in Puget Sound is complicated

- The Puget Sound Partnership's goal of increasing eelgrass by 20% by 2020 uses a baseline of 22,000 hectares, with the goal of restoring 4,400 hectares by 2020. There are currently 6,292 hectares of potential eelgrass habitat (highly to very highly suitable conditions), however this scale of restoration may be difficult in Puget Sound.
- Eelgrass restoration goals are affected by numerous eelgrass stressors (e.g., sea level and temperature rise, suspended sediment, shoreline armoring, and aquaculture, etc.), and the full effect of many stressors still remain poorly understood and uncertainties remain.
- Transplants have been successful in some restoration sites, though not all. A multi-step adaptive management framework is being used to maximize success.

Q&A

- Q: Does the 18.6-year tidal mode affect eelgrass?

  A: It could. From a grower's perspective, eelgrass seems to be expanding right now, and we're not having extreme low tides in this part of the 18.6-year cycle.
- Q: Is the Puget Sound Partnership's "20% by 2020" appropriate?

  A: The Puget Sound Partnership's "20% by 2020" goal[1] was a policy decision originating from an intent to support more eelgrass. That decision was based on a 1990 study indicating that there had been a decrease in eelgrass.

[1] http://www.psp.wa.gov/vitalsigns/eelgrass.php

Ecosystem Services and Functions Provided by Eelgrass and Commercial Shellfish Mariculture
Presented by Steve Rumrill, Oregon Department of Fish and Wildlife

Key Subject: Eelgrass beds and shellfish aquaculture both provide a diverse set of valuable ecosystem services and ecosystem functions.

- Ecosystem services are the benefits people obtain from ecosystems, while the ecosystem functions are the interactions of the ecosystem structure and processes that provide the capacity of an ecosystem to deliver goods and services.
- Ecosystem services and functions provided by eelgrass include primary production and detritus, sediment trap and nutrient exchange, water quality improvement, carbon sequestration, and habitat (nursery and/or forage areas) for juvenile fish, shellfish, and shorebirds. Eelgrass also regulates the daily pH cycle of estuarine waters, and might be a buffer in acidifying waters.
    - Results from a model that assumes eelgrass increases the productivity of several fishes do in fact indicate that increased eelgrass coverage in Puget Sound was associated with increases in commercial and recreational fishing and a small decrease in bird watching.
- Shellfish aquaculture's ecosystem services and functions include secondary production of food for human consumption, generation of income for coastal communities, sediment trapping and support of erosion control, improvement of water quality, and habitat provision (nursery and/or forage areas) for juvenile fish, shellfish, crab, and shorebirds.
    - Aquaculture and eelgrass beds provide many similar ecosystem functions, but they occupy distinct positions in energy flow and nutrient cycling. Eelgrass provides primary production of organic material and carbon uptake, which aquaculture does not. Heterotrophic organisms used in aquaculture cycle nutrients (e.g., ammonium), which can then be absorbed by eelgrass through roots and leaves.

Key Subject: Observations of species' use of eelgrass- and aquaculture-based habitats show variability across bays.
For example, research by Sund (2015)[2] indicates:

- For Dungeness crab, the largest densities observed in Willapa Bay were among oyster beds, while the largest densities observed in Yaquina Bay were on bare (unvegetated) ground.
- For surfperch, the largest densities observed in Willapa Bay were in eelgrass, while the largest densities observed in Yaquina Bay were on bare (unvegetated) ground.

Key Subject: Stronger adherence to specific metrics, parameters, and units is needed to allow for comparisons among services and to develop better estimates of economic valuation.

- Advanced modeling approaches can also help evaluate and assess the ecological and economic significance of the ecosystem services provided by eelgrass and shellfish aquaculture on large and relevant spatial scales.

[2] Sund, D. 2015. Utilization of the non-native seagrass, *Zostera japonica*, by crab and fish in Pacific Northwest estuaries. Master's Thesis. Marine Resource Management, Oregon State University, Corvallis, OR.

Juvenile Salmon Use of Eelgrass

Presented by Kurt Fresh, NMFS, Northwest Fisheries Science Center

Key Subject: Eelgrass provides benefit to fish at the individual and population scale.

- For individual fish, eelgrass provides food consumption and growth opportunities, refuge from predation, and production of organic material and prey habitat.
- At the population scale, eelgrass helps fish population performance, viability, and resilience.

Key Subject: Function depends on the characteristics of the eelgrass habitat and the salmon.

- Eelgrass characteristics (e.g., patch size, adjacency, fragmentation, connectivity, location) seem to dictate how salmon use the habitat.
- Similarly, salmon life history determines when and how they use eelgrass habitat. Juvenile salmon in the Pacific Northwest are commonly found associated with eelgrass during their spring outmigration. In general, eelgrass is most important to Chinook fry, coho fry, chum fry and pink fry in spring and early summer. It appears to be generally less important to yearling fish, including Chinook, coho, and steelhead.
- Eelgrass provides forage areas and refuge. Juvenile salmon forage on organisms produced in eelgrass. While prey resources are not unique to eelgrass, they are typically more abundant, often by orders of magnitude, in eelgrass. A number of studies outside the Northwest suggest that seagrass can provide a refuge from predation for a variety of species.
- Evidence suggests that salmon both “do” and “do not” prefer eelgrass.

Key Subject: There is still a lot unknown about how fish use eelgrass.

- Studying migratory species is difficult, and most studies have not been specifically designed to compare some aspect of function while trying to minimize effects of other variables.
- Remaining questions include:
    - What are population level effects of eelgrass?
    - What are the effects of landscape attributes on function, such as effect of spatial position scale, connectivity?
    - What is the role of eelgrass as refuge from predators?
    - Is eelgrass preferred?
    - How do functional aspects of eelgrass for salmon change within a spatially and temporally dynamic landscape?

Q&A

- Q: What is the role of a floating mats of eelgrass?

  A: Floating mats seem to host a lot of fish, though this may not have been scientifically documented.

Small-scale Effects of Shellfish Aquaculture on Eelgrass

Presented by Jennifer Ruesink, University of Washington

Key Subject: Shellfish aquaculture effects eelgrass in three ways: individual organisms, structures, activities.

- Organisms: On-bottom shellfish (ground culture) with approximately 10% cover begin to compete for space with eelgrass. Two potential linkages that could allow bivalves to increase eelgrass productivity are by clearing water (improving light penetration) and by fertilizing

shoots. These linkages have been tested in a few sites in Washington State but have not demonstrated improved eelgrass productivity with bivalves.

- Structures: Structures make shade as a function of their density, whether they are fixed or mobile, and their distance above the bottom. As a consequence, some studies that examined light and eelgrass around different shellfish-growing structures found effects, and others did not. From first principles of hydrodynamics, low-density structures can accelerate flow and cause sediment scour, while high-density structures can slow flow and cause sediment deposition. Thus, effects of structures on sediment properties are possible but may not always be in the same direction or of the same magnitude. Effects of a given structure may also depend on prevailing flow speed and direction.
- Activities: Digging and dredging immediately reduce eelgrass density, however these activities can reduce intraspecific competition and result in increased eelgrass branching and seedling performance.
- Studies of the spatial extent of effects of aquaculture on eelgrass generally show that these are restricted to footprint (<1-2 meters away). In a study from British Columbia (Kelly and Volpe, 2007)[3], eelgrass was observed to be largely absent from shoreline with oysters, even though the two species occupied different intertidal zones (suggesting a more long-distance effect).

Key Subject: Effects are negative, positive, and variable.

- Eelgrass density can be reduced by shellfish aquaculture, but the effects are variable.
- Aquaculture can reduce intraspecific competition by improving resource availability in some cases.
- Dredging has a dramatic, immediate impact on eelgrass density, with resilience possible through remnant shoots and seedling recruitment, whereas other harvest methods may have a less dramatic initial impact but greater long-term impact through changes in light or sediment.

Key Subject: Eelgrass is diverse in Washington.

- *Z. marina* has "hidden diversity," and is much more genetically diverse than salmon and other managed species.
- Populations diverge genetically due to local adaptation and restricted movement.
- Whether diversity influences response to shellfish aquaculture is not known.

Q&A

- Q: In Willapa Bay, there are observationss that *Z. japonica* outpaces *Z. marina* and takes over the habitat. Is it possible that their relationship is location-specific?

  A: There are three publications related to this: Bando (2006)[4], Hannam and Wyllie-Echeverria (2015)[5], and Horwith (2011)[6]. It is possible that their relationship could be location-specific. In follow-up conversation, a key consideration has to do with sediment

[3]Kelly, J.R., and J.P. Volpe. 2007. Native eelgrass (*Zostera marina* L.) survival and growth adjacent to non-native oysters (*Crassostrea gigas* Thunberg) in the Strait of Georgia, British Columbia. Botanica Marina 50:143-150.

[4]Bando, K.J. 2006. The roles of competition and disturbance in a marine invasion. Biological Invasions 8:755–763.

[5]Hannam, M.P., and S. Wyllie-Echeverria. 2015. Microtopography promotes coexistence of an invasive seagrass and its native congener. Biological Invasions 17:381-395.

[6]Horwith, M. 2011. Plant behavior and patch-level resilience in the habitat-forming seagrass *Zostera marina*. Ph.D. Dissertation. Department of Biology, University of Washington, Seattle, Washington.

elevation, because shallow tidal pools are generally occupied by *Z. marina*, but if these fill in and therefore drain at low tide, they become more suitable for *Z. japonica*.

Shellfish Aquaculture and Seagrass Seascapes in Willapa Bay, Washington

Presented by Brett Dumbauld, USDA Agricultural Research Service – Hatfield Marine Science Center

Key Subject: Small-scale studies suggest oyster aquaculture does impact eelgrass in Willapa Bay.

- Eelgrass density declines with oyster density in aquaculture areas due to space competition and/or shading and light.
- Eelgrass relative growth rate, plant size, and production is affected by oyster aquaculture, but not always negatively. It depends on the culture method.
- Harvest disturbance significantly affects eelgrass density. Density is lowest in mechanically harvested beds, but eelgrass growth is slightly higher in these beds and recovery is site specific ranging from 1-4 years.

Key Subject: Landscape-scale analysis shows minimal impacts to eelgrass coverage In Willapa Bay.

- Using GIS methods to quantify the spatial distribution of eelgrass and oyster aquaculture across Willapa's intertidal habitat, analysis suggests aquaculture only minimally reduces eelgrass presence at the landscape scale (less than 1.5%); many areas had more eelgrass than what models predicted.
- Scale is an important consideration, and not often reflected in a permit.

Key Subject: Eelgrass and oyster coexistence hasn't changed much since pre-1800s, but is expected to in the future.

- Historic records suggest that oysters and eelgrass have likely coexisted in the seascape for a long time though the tidal elevation of both has changed. Willapa's eelgrass overlap with native oysters may have been 45%, compared to 43% today with current commercial aquaculture.
- Sea level rise modeling predicts an increase of eelgrass coverage across the tidal flat for all scenarios and years, with a net increase of as much as 3-11% within aquaculture beds**.**
    - By 2100, 80% of beds (3,770 ha) will have >30% *Z. marina* coverage, assuming beds have not been moved.
    - Mean coverage among all existing beds is projected to increase from 41% (current) to 44-52%.
    - Another consideration of eelgrass cover is burrowing shrimp, which is observed to have little overlap with eelgrass. It is likely that shrimp control has increased eelgrass presence on shellfish beds in Willapa Bay.

Q&A

- Q: With regards to sea level rise, were other variables considered besides absolute water height and whether the sediment level would change?

    A: For the most part, no, there were not – except as it relates to the variables for which we had spatial data.

III. Discussion of Ecosystem Functions and Services

On ecosystem services and functions provided by aquaculture

Q: Our observations as shellfish growers suggest that in the early spring, when vegetation has blown out from winter storms, aquaculture structures provide forage and refuge for salmonids in the absence of eelgrass. How do shellfish provide the same services for salmonids that you described for eelgrass?

> A: Structures are most analogous to services provided by eelgrass, and it would be great to get additional science on the services provided by them. It's likely that non-homogenous cultures are better for salmonids – i.e., ground culture with bag culture, etc. – since fish also benefit from non-homogenous eelgrass structures. Shellfish cannot produce detritus in the same way, however.
>
> A: Effect size is a very important statistical parameter that should be considered. For example, what does a 1.5% population difference mean for the species or the ecosystem? Our studies show significant differences in the community of organisms inhabiting cultured vs. non-cultured areas, but it is not known what the tradeoff is. Juvenile outmigrating salmon are shown to be food-limited, but switch food sources readily.

Q: Has there been any study on foraging behaviors in eelgrass vs. shellfish beds to see where salmonids perform more foraging behavior, depending on prey?

> A: This question is perfect for being addressed with a camera technique. Video does tell us that pelagic fish move slower in eelgrass, and benthic fish move slower in aquaculture beds. Foraging behavior may also relate to body morphology and eye position.
>
> A: There are very few studies on what fish are eating. Video can now detect species, and we just put hydroacoustic camera methods in a proposal. We are on the verge of having tools to answer these questions.

Q: Is there a function that is lost in the natural overlap of eelgrass and oysters? Can we recreate that function in some way?

> A: It's a hard question to answer due to the influence of burrowing shrimp. Most aquaculture currently occurs in higher intertidal areas, above where native oysters occurred. Aquaculture may have helped eelgrass in those tidal flats. Native oysters would have created patchiness.

Q: If there is a 100 m of shoreline, what is best: eelgrass, aquaculture, or a mix? Is ecosystem function or biogenetics the right currency? Where are scientists/managers answering this bigger question for the ecosystem?

> A: In previous study on coastal estuaries, Chinook and coho populations seemed to only be influenced with the percent of estuary in pristine condition (not total area or presence of oyster aquaculture).
>
> A: If you have a meadow and start doing aquaculture, its function will change and it will tend to support more diversity.

Q: Is there any research on the positive effects of shellfish aquaculture on eelgrass, e.g., from long line cultures? If spaced too closely, long lines can shade out eelgrass, however it seems that when you increase spacing, the structures can increase sediment deposition and facilitate eelgrass expansion. Properly designed aquaculture can potentially increase the abundance and heterogeneity of eelgrass.

> A: That kind of local knowledge from shellfish growers is welcome. We would love to get to a point where we can work together to site your facility for the best ecological outcome.
>
> A: There was an experiment performed in Humboldt Bay to test the effects of long line spacing on eelgrass. It does suggest a decrease in eelgrass biomass with an increase in line density, so there appears to be a tradeoff between oyster and eelgrass production.

On eelgrass density and distribution

Q: What range of eelgrass densities are equivalent, or are they are all showing significant change? For example, if there are 50 shoots/m^2, does a 10 shoots/m^2 decrease change the function of the eelgrass patch? Are there ideal density thresholds that should be considered?

> A: It is unknown if that kind of decrease would make a difference, although natural patchiness and bed complexity is important. Long skinny beds create migratory pathways, for example.

Q: Is eelgrass more resilient from reproducing sexually and asexually? This often occurs in areas of intense farming.

> A: Research suggests eelgrass will be more resilient in areas where it reproduces both sexually and asexually as opposed to areas where it only reproduces asexually.

Q: With sea level rise, will there be a different effect on eelgrass distribution in places that have shoreline armoring vs. those that don't?

> A: There could be a different effect. Where armoring cuts off a beach, for example, eelgrass could migrate further up the shore, however water depth and light would also be a factor. For a while, sea level rise will likely increase the size of the population but eventually turbidity will limit the deeper ranges of distribution.
>
> A: Shoreline armoring will play out differently in shorelines vs. flats. Along a shoreline, there are adaptation opportunities, but flat areas where there is a lot of eelgrass may not have anywhere to go.
>
> A: This could be important to watch for in Samish Bay, where the elevation is decreasing because the Skagit sediment source is no longer delivering sediment.

On species use across eelgrass bed types

Q: Do different species use eelgrass meadows vs. fringes?

> A: In mapping eelgrass along shoreline in King County, fish and invertebrates are observed responding to patches. Salmon are mostly edge feeders. Water depth is important, though – if it is deep enough, fish will swim over meadows. Fish have been caught in fringes as well as meadows.
>
> A: Small shoots are typically very dense, whereas large shoots are less so, and have more naturally fringing areas. Fringe is defined as how much area is in the band of the shoreline, and flats are defined as being more than 600 m. In Puget Sound, eelgrass is made up of approximately 50% expansive flats and 50% fringes, however there are regional differences.

Q: Are small shoot, high density beds valued differently than large shoot, low density beds?

> A: Primary production capacity and flow regimes will likely be different between those two different kinds of beds. Studies outside the Northwest have shown a biological response from a 90% reduction in shoot density.

Q: From observation and industry knowledge, salmon are using meadow habitat in estuaries, and have adapted to areas with patchiness. Is this good or bad?

> A: From a natural history perspective, salmon have dropped into a diverse mosaic habitat. Creating more diverse habitat is conceptually a good idea.

Q: Has there been any research using enclosure studies?

> A: There is one study – Semmens (2008)[7]. These kinds of studies are very challenging to do well, especially with a mobile species like salmon and the risk of "enclosure effect." It might be possible to take a bioenergetics approach and set up a framework for collecting data on fish using meadows vs. small patches.

Q: Are there studies on eelgrass vs. aquaculture as a preferred herring spawning substrate?

> A: The most common substrate for herring to spawn is eelgrass, however it doesn't appear that herring is actively selecting eelgrass, just that it is available to them. They also spawn on algae and aquaculture structure. That said, there is a lot of variation and noise. We have not studied shellfish aquaculture specifically as a herring spawning substrate because there does not appear to be a lot of overlap between where herring spawn and shellfish are cultured (some exceptions are Dabob Bay and Chuckanut Bay).
>
> A: Industry is required by the Corps permit to monitor and protect herring eggs until they have spawned if we observe them on our gear.

[7] Semmens, B.X. 2008. Acoustically derived fine-scale behaviors of juvenile Chinook salmon (*Oncorhynchus tshawytscha*) associated with intertidal benthic habitats in an estuary. Canadian Journal of Fisheries and Aquatic Sciences 65:2053-2062.

Q: Is there any information on the positive benefits of eelgrass on higher aquaculture yields (e.g., mass per shell increase)?

A: No – there are no data on shell size and yield as a result of eelgrass' detrital contributions.

IV. Eelgrass Management Related to Shellfish Aquaculture

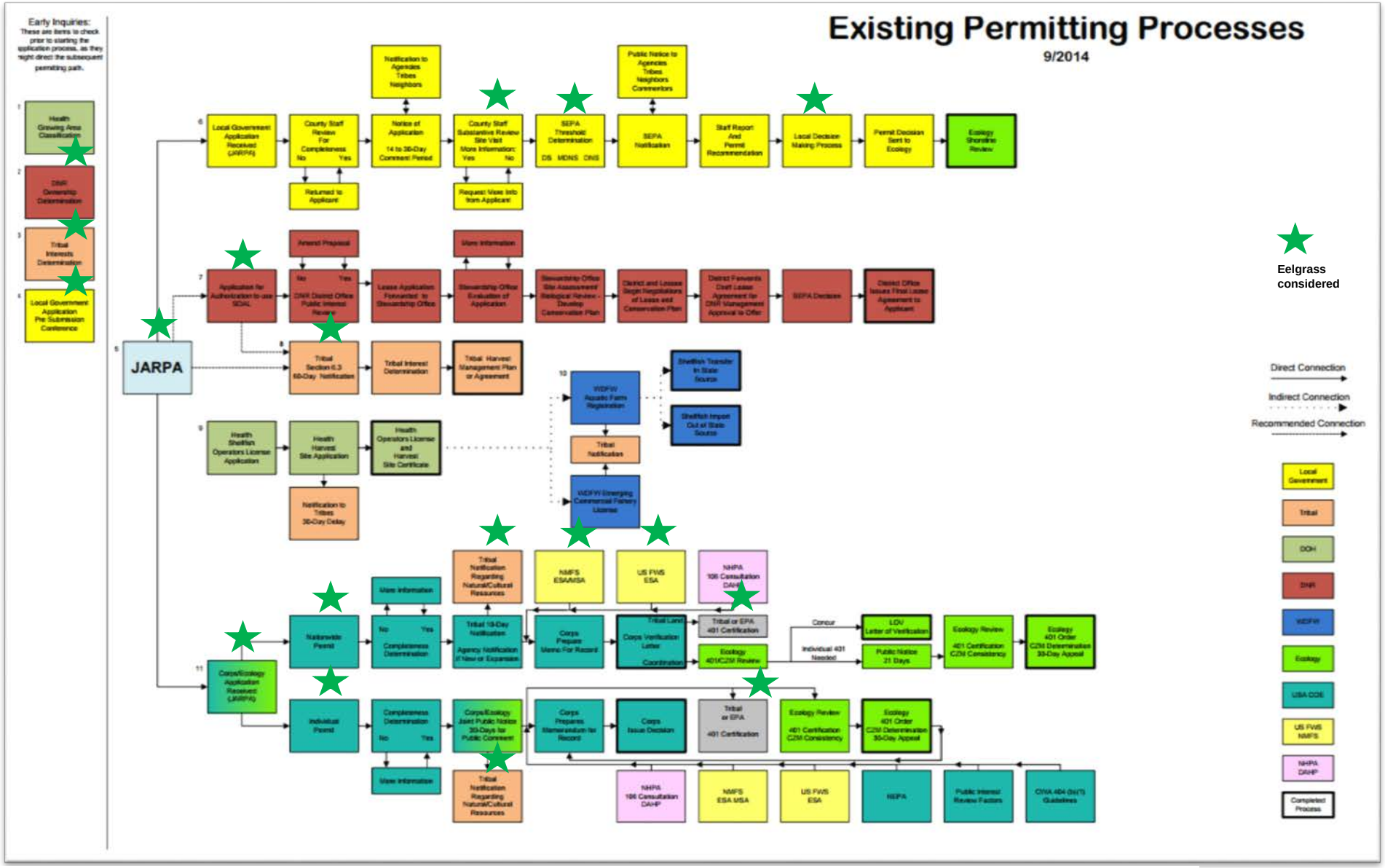
Regulatory Overview of Eelgrass and Shellfish Aquaculture in Washington

Presented by Laura Hoberecht, NMFS WCR (Shellfish Interagency Permitting Team co-chair)

The existing permit application process for new shellfish farms (facilitated by the Joint Aquatic Resource Permit Application, or JARPA) is complex and eelgrass is considered at multiple stages, including at points during early inquiries prior to application submittal, in local government processes, and in federal, state, and tribal review and consultation.

The Shellfish Interagency Permitting Team, made up of representatives from tribes, local governments, and state and federal agencies, developed a flowchart to illustrate the permit process for shellfish aquaculture. The team also developed a suite of products to help applicants navigate the permit process, including guidance for how to fill out a JARPA. All are available at: http://www.ecy.wa.gov/programs/sea/aquaculture/sip.html.

See the following page for the flowchart and stages where eelgrass is considered, as discussed in the presentation.



High resolution flowchart available at: http://www.ecy.wa.gov/programs/sea/aquaculture/pdf/PermitChart.pdf. Green stars included in this version indicate where in the process eelgrass is considered.

Eelgrass Management Related to Shellfish Aquaculture, An Industry Perspective

Presented by Bill Dewey, Taylor Shellfish Farms

Key Subject: Frustrations from shellfish industry

- **Focus on eelgrass as a single species as opposed to the ecosystem as a whole.** There should be more interest and research on how shellfish and eelgrass interact to make the ecosystem function better.
- **Failure of regulators to account for the ecosystem services provided by aquaculture**. We know that cultured shellfish provides some of the same ecosystem services as wild shellfish. As an example, eelgrass often becomes established in our crops where it hadn't been growing before. This is likely a result of some of these ecosystem services, however this is not well documented. These beneficial ecosystem services are often not considered by resources managers focused solely on negative impacts to eelgrass instead of overall health and function of the ecosystem.
- **Inconsistency of permit conditions imposed by state, federal, and local regulators.** The permitting process is complex and costly and permit conditions are not consistent between agencies. For example, eelgrass bed definitions vary from a single blade, to "you know it when you see it." Eelgrass survey requirements and buffers vary as well by agency. To survey per the recently released Seattle District of the Corps delineation protocols is estimated to cost as much as $40,000 per acre[8].
- **Lack of willingness to engage shellfish growers on proposed permitting conditions.** The industry has a vested interested in healthy functioning ecosystems and would like to be brought to the table during review of proposed conditions so we can help achieve environmental goals with the least amount of impact on business.

Key Subject: Historical context of regulations

- **Bush and Callow Acts**: In 1895, the Bush and Callow Acts were passed in Washington State, selling 47,000 acres of tideland into private ownership specifically for shellfish and setting the stage for Washington to become a national leader in commercial shellfish production. Historic photographs indicate that oyster farming has occurred integrally in eelgrass since the early 1900s.
- **Rivers and Harbors Act (RHA) Section 10 and Nationwide Permit (NWP) 4:** Prior to 1991, the only Corps permit that growers were aware of that applied to shellfish aquaculture on the West Coast was related to installing structures such as docks and pilings, and fell under the RHA Section 10. Unbeknownst to all growers, harvesting activities were also covered by NWP 4, a programmatic permit for fishing.
- **Changes to NWP 4:** In 1991, the Corps made a policy decision to remove shellfish seeding in Submerged Aquatic Vegetation (SAV) from NWP 4. This resulted in a cease and desist order against Coast Seafoods in Humboldt Bay. Coast ended up with a very costly Individual Corps permit and radically altered practices to continue farming. Concerned about the potential for similar action by other districts and inconsistencies with shellfish permitting by the Corps around the country, West Coast growers met with Assistant Secretary of the Army (ASA).
- **NWP 48 issued:** An outcome of the meeting with the ASA was a jurisdictional review of what shellfish culture activities warranted permitting by the Corps, and the Corps issuing NWP 48 in

[8] Please note that the Seattle District Corps' eelgrass survey guidance is being updated based on feed-back from users of the guidance received in the past year. An updated guidance is expected to be released in Fall, 2017.

2007 to cover all existing shellfish farms including those in submerged aquatic vegetation. In 2012, this permit was amended to include *expansions* of existing farms and *new* farms. The new NWP served as a federal nexus to trigger consultation requirements under the ESA, Magnuson Stevens Act (MSA), National Environmental Policy Act, etc. The number of conditions associated this permit as a result of these consultations has increased from 16 (in 2007) to 33 conditions (in 2016) some of which, in the growers' opinion, are beyond ESA/MSA jurisdiction. This is a big change for west coast growers who previously had only RHA permits with limited or no conditions.

- **Today:** As a result of these policy changes, the practice of farming in eelgrass has come under scrutiny, and the shellfish industry's activities have been restricted. The industry does not anticipate returning to pre-1991 conditions, but does want to be engaged in the conversation to ensure regulations are based on sound science and achieve environmental goals in a way that minimizes impacts to businesses.

Key Subject: Observed historic coexistence of shellfish culture in eelgrass and ecological vitality in aquaculture beds

- Historic (early 1900s) and current photos show oyster culture occurring integrally in eelgrass
- Photos show kelp and sea lettuce growing in bottom culture, and smolts in mussel rafts.
- Video footage shows oyster-eelgrass mosaics support sculpin, shiner perch, and crab.
- Long-line culture and flip bags show abundant eelgrass and starry flounder, shiner perch, Dungeness crab, gunnel, hairy crab, and stickleback.
- In early spring, much of the eelgrass vegetative mass has been blown away by winter storms and shoots are beginning to emerge. Aquaculture crops and structures such as long lines provide habitat and refuge as well as protecting eelgrass against winter storm damage.
- Geoduck culture on the Fisk Bar in Samish Bay allowed eelgrass to colonize an area that was historically bare sand. Micah Horwith's research[9] demonstrated how harvest of the geoduck reduces the eelgrass density, but it recovered quickly as the farm was reseeded and another crop cycled. The nursery tubes for the third crop are now colonized by macroalgae.

V. Summary of Management Inconsistencies and Challenges Discussion

Workshop participants identified several inconsistencies and challenges, both general and specific.

Overall management inconsistencies and challenges discussed

- **The goal of eelgrass management in the context of aquaculture is conflicting, poorly defined or inconsistent across agencies.** NOAA's goals are to expand sustainable aquaculture, while protecting, recovering and restoring protected species and their critical habitat (through the ESA), and sustaining healthy ecosystems for federally managed species (through Essential Fish Habitat provisions), per NOAA's Aquaculture Policy. Other agencies have different goals and legal authorities, e.g., the state protects "critical saltwater habitat" which includes both eelgrass and shellfish, the Corps protects "special aquatic sites" (which includes eelgrass) through the Clean Water Act. The regulatory framework is designed to protect eelgrass first, but the context for that protection varies by agency.
- **Regulations are inconsistently applied, and regulators require different permitting information.** The application of regulations and how they are being implemented are not

[9] Horwith, 2011.

consistent between agencies and sometimes even within the same agency. The shellfish industry wants to be able to provide information that will be accepted by all agencies and have consistent interpretation and implementation of the regulations that is predictable and affordable. The shellfish industry perceives that the economic viability of aquaculture and maintaining regulatory compliance are currently in conflict.

- **Timelines for eelgrass survey expiration and the permit process are misaligned.** Eelgrass surveys, required at the start of an application for a new farm, must be conducted between June 1st and October 1st and are good for one year, however the permit application process often extends beyond one year, requiring survey work to be repeated. This is costly to farms and can be a barrier to establishing new farms.
- **Scientific confirmation of best practices is inconsistent across culture methods.** For example, we know which long-line spacing and stocking rates minimize impacts to eelgrass, but we don't have that information for bottom culture.
- **Regulatory uncertainty is high.** Conditions outlined in the Corps' permits are subject to change every five years based on new science, and Washington Department of Natural Resources' (DNR) leases are also subject to change.
- **Eelgrass management is focused on certain eelgrass parameters (e.g., density, percent cover) and does not necessarily account for all ecological functions provided by eelgrass and/or cultured habitat**. It is very complex and costly to monitor the ecosystem functions that eelgrass provides, so eelgrass density and percent cover area are used as proxies. These metrics may not be the most appropriate proxies and furthermore, the ecosystem services of shellfish are not being considered or valued.
- **Eelgrass abundance can vary based on environmental factors that are out of a grower's control.** Current eelgrass levels appear to be at an all-time high for recent decades, and new survey requirements will document these historically high levels of eelgrass. Meanwhile, environmental factors outside of a grower's control such as extreme low tides (18.6-year cycle), sea level rise, and disease (among other variables) can negatively impact the overall abundance of eelgrass. This presents mitigation challenges for growers.
- **The prescriptiveness of eelgrass regulations does not match the complexity and variability of eelgrass.** Scientific research shows that eelgrass reacts differently across estuaries, however eelgrass regulations are not customizable to account for location-specific behavior.

Specific inconsistent parameters and protocols across agencies regulating eelgrass management. (Note: All regulators agreed that if eelgrass moves in to an aquaculture site where it has not existed previously, operations will be allowed to continue at the site with no new restrictions.)

Parameters and protocols	Notes and/or context
Buffer	• The Corps does not directly require buffer, but does use for compliance with ESA per NMFS. NMFS uses **5m**, whereas Washington State Department of Natural Resources (DNR) may use **8m** (and allows culture inside the buffer with monitoring), and Washington State Department of Ecology (Ecology) has approved **3m.** • NMFS' recent recommendation to use 5m is based on the distance that allows for maximum bed expansion. The primary goal is to protect eelgrass for salmonids under the ESA and essential fish habitat under the MSA. • Buffer research is inconclusive about optimal size, and difficult to conduct (due to regulations that do not allow work inside of buffers). • How eelgrass is behaving reproductively (sexually and/or asexually) reflects its resiliency and may be an appropriate variable to inform buffer length or necessity. • Existing farms are not required to have a buffer. These sites could be used to inform potential for new farms in eelgrass or adaptive management of buffer size.
Shoot density	Included in the Tier 2 Corps survey guidance (see below).
Bed definition	• NMFS provides a definition for eelgrass habitat in the California Eelgrass Mitigation Policy (CEMP)[10]. • DNR provides a definition for eelgrass bed in their Technical Memorandum[11]. • The Corps' guidelines recommend both the NMFS and DNR definitions in their methods for defining eelgrass habitat[12].

[10] The CEMP is available at:
http://www.westcoast.fisheries.noaa.gov/publications/habitat/california_eelgrass_mitigation/Final%20CEMP%20October%202014/cemp_oct_2014_final.pdf
[11] The DNR Technical Memorandum is available at:
http://file.dnr.wa.gov/publications/aqr_hcp_eelgrass_boundary_tech_memo.pdf
[12] The US Army Corps guidelines are available at:
http://www.nws.usace.army.mil/Portals/27/docs/regulatory/Forms/Components%20of%20Eelgrass%20Delineation%205-27-16.pdf?ver=2016-05-27-131522-740

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Parameters and protocols	Notes and/or context

Survey protocol	• Considerations include:
	  o **Seasonality and frequency** (when and how often should surveys be completed?)
	  o **Survey objective** (i.e., growers design surveys differently based on the survey objective e.g., eelgrass protection vs. salmonid protection). It would be good to identify appropriate parameters based on the different survey objectives.
	  o **Sensitivity** (what level of change are we looking for?)
	• NMFS defers to DNR's technical memo[13] on survey protocols related to setting a buffer.
	• The Corps has no official survey protocol, however they do have a survey guidance document[14]. In the guidance:
	  o Tier 1 projects proposed outside eelgrass beds must survey bed boundaries. (The Corps will likely add a "Tier 0" for projects proposed where there is no nearby eelgrass to reduce the level of effort for farmers.)
	  o Tier 2 projects proposed in eelgrass beds must also survey shoot density.
	  o Surveys only need to be completed at the beginning of application process, with partial updates throughout.
	  o The Corps is willing and able to accept other survey methodologies.
	• Local jurisdictions (i.e., counties) rarely have resources to develop their own survey protocols but can accept methodologies from other agencies (i.e. Corps, DNR, NMFS). Some Counties may require additional surveys if permits are appealed.

Monitoring protocol	Considerations include natural variability, area, sea level rise, 18.6 year tidal node, disease, and density.

[13] Donoghue, 2013, Operational Definition for Determining Edge of Eelgrass (*Zostera marina*) Presence), DNR Technical Memorandum.
[14] Please note that the Seattle District Corps' eelgrass survey guidance is being updated based on feed-back from users of the guidance received in the past year. An updated guidance is expected to be released in Fall, 2017.

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VI. Recommendations for Future Actions to Achieve Consistency in Management

Opportunities for "and"

As a general outcome of the workshop, participants agreed that industry and the regulatory community should embrace a management approach that supports both eelgrass protection and sustainable aquaculture (an "and" perspective) in an effort to overcome conflict between the two (an "either/or" perspective), and scientists should be included in the development of this approach. To achieve this, a more open dialogue between shellfish growers, scientists, and regulators, as provided through this workshop, should be continued.

Recommended future action items

- **Better define the goals of eelgrass management in the context of aquaculture** and pathways to reconcile application of economic, ecological, and other mandates to eelgrass management across agencies.
- **Develop an adaptive management approach** that can provide the framework to manage eelgrass amidst uncertainty and allow regulatory program investments in assessing unanswered questions (e.g., how appropriate eelgrass is as a proxy to ecosystem health?). It should be noted that experimentation in permitting metrics may be challenging for agencies who have to defend policy decisions in litigation.
- **Explore Washington's Forests and Fish Law** as a model for adaptive management under some of the same constraints (public and private lands, economic benefit, multiple ESA species).
- **Provide feedback on eelgrass survey protocols** to the Corps and other entities in an effort to bring more consistency between them.
- **Identify best management practices (BMPs),** in collaboration with scientists and growers, that may be applied as permit conditions. BMPs could build from voluntary practices developed by the Pacific Coast Shellfish Growers Association and required permit conditions identified by the Shellfish Aquaculture Regulatory Committee.
- **Determine and pursue funding to address science gaps** that answer management questions.
- **Find opportunities to coordinate and cost-share** activities related to monitoring, evaluation, and research on a state or region-wide scale.
- **Utilize the Shellfish Interagency Permitting Team** (or similar type of forum with professional facilitation) with the inclusion of scientists and industry to pursue the questions and recommendations identified at the workshop[15].

Potential future research questions/needs[16]

- Develop a comprehensive list of all current research related to eelgrass and shellfish aquaculture.
- What are the species, culture methods, and extent of aquaculture compatible with varying eelgrass functions?
- What is the ideal bottom culture density and/or spacing that supports healthy eelgrass?

[15] A list of individuals and entities interested in participating in this effort was generated at the workshop (see Appendix D)

[16] Please note this is not a comprehensive list of all research needs, just those that were identified and discussed during the workshop.

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- Building off of DNR's current research, how do eelgrass edges evolve? To what extent, to where, and at what pace does eelgrass normally expand in the absence of aquaculture? In the presence of aquaculture?
- How can we best measure and monitor eelgrass and cultured shellfish ecosystem functions?
- How do current management metrics (e.g., density and percent cover) correspond to the ecological value of eelgrass habitat?
- How can we examine eelgrass ecosystem function on a broader spatial (seascape) and temporal scale?
- How can we account for the fact that eelgrass beds are not static, and that changing ocean conditions will play a role on resource distribution in the future?
- Does the presence of eelgrass beds reduce effects of ocean acidification near natural shellfish beds and shellfish aquaculture sites?
- What are ecosystem functions and services provided by shellfish aquaculture and how do they compare to those provided by eelgrass?
    - How do Chinook salmon use aquaculture sites, and are those sites providing the same ecosystem services to those fish as eelgrass?

Conclusions

The workshop provided an educational and networking opportunity for the participants. Many participants expressed their appreciation for the open, non-confrontational dialogue. It was critical that both scientists, the shellfish industry, and regulators were included in this discussion to ensure that any restrictions placed on shellfish growers to protect eelgrass are scientifically based and able to be implemented. The workshop sets the stage for future, longer-term efforts to address the inconsistencies and challenges identified, and move toward a consistent and predictable permit process.

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Appendices

Appendix A. Workshop Agenda

WA Eelgrass and Shellfish Aquaculture Workshop

NOAA Sand Point Campus, Building 9 Auditorium
7600 Sand Point Way, Seattle, WA 98115
Tuesday, April 11, 2017 9:00 AM – 4:00 PM

Agenda

Objective: The intent of the workshop is to bring together scientific experts, regulators, tribes, and the regulated community to increase understanding about eelgrass and shellfish aquaculture in Washington, determine where and why inconsistencies in eelgrass management related to shellfish aquaculture exist, and develop a path forward for addressing inconsistencies in the state.

9:00 AM Welcome and Introduction (Laura Hoberecht)

9:10 AM Overview of Meeting (Angie Thomson)

9:15 AM Eelgrass State of Knowledge

- Status of eelgrass in WA (Ron Thom)
- Ecological functions of eelgrass & shellfish aquaculture (Steve Rumrill)
- Salmonid use of eelgrass (Kurt Fresh)
- Shellfish aquaculture & eelgrass overview (Jennifer Ruesink)
- Shellfish aquaculture & eelgrass case study (Brett Dumbauld)

10:40 AM Break

11:00 AM Discussion 1: Ecosystem Function/Services (please refer to Survey Summary handout)

- Identification/comparison
- Methods
- Spatial/temporal

12:00 PM Eelgrass Management Related to Shellfish Aquaculture

- WA Regulatory Overview (Perry Lund)
- Industry Perspective (Bill Dewey)

12:30 PM LUNCH (on your own—brown bag or cafeteria)

1:30 PM Discussion 2: Identification of Inconsistencies in Management

(please refer to Survey Summary handout)

2:15 PM Break

2:30 PM Discussion 3: Resolution, Opportunities for Consistency

3:30 PM Wrap-up; Action items

4:00 PM Adjourn

Appendix B. List of Workshop Participants

First name	Last name	Representing
Lisa	Abernathy	NMFS, WCR
Scott	Anderson	NMFS, WCR
Jude	Apple	Padilla Bay Reserve
Margaret	Barrette	Pacific Coast Shellfish Growers Association
Matt	Bennett	US Army Corps of Engineers
Rachel	Berkowitz	Puget Sound Institute
Phil	Bloch	Confluence
Amy	Borde	Pacific Northwest National Laboratory
Maya	Buhler	Thurston County
Amanda	Carr	Plauche & Carr
Alan	Chapman	Lummi Nation
Bryant	Chesney	NMFS, WCR
Bart	Christiaen	WA State Department of Natural Resources
Diane	Cooper	Taylor Shellfish
Jeff	Cordell	University of Washington
Janet	Curran	NMFS, WCR
Leah	Davis	County Thurston
Kyle	Deerkop	Pacific Seafood
Lauren	Dennis	EnviroIssues
Bill	Dewey	Taylor Shellfish
Cinde	Donoghue	WA State Department of Natural Resources
Brett	Dumbauld	US Department of Agriculture
Bridget	Ferriss	NMFS, NWFSC
Kurt	Fresh	NMFS, NWFSC
David	Fyfe	Northwest Indian Fisheries Commission
Catherine	Gockel	US Environmental Protection Agency
Matt	Goehring	WA State Department of Natural Resources
Matt	Goldsworthy	NMFS, WCR
Molly	Good	US Fish & Wildlife Service
Laura	Hoberecht	NMFS, WCR
Margaret	Homerding	Nisqually Tribe
Julie	Horowitz	Office of Governor
Bobbi	Hudson	Pacific Shellfish Institute
Tony	Kantas	County Thurston
Peter	Kiffney	NMFS, NWFSC
Brian	Kingzett	Goose Point Oyster
Nathan	Lubliner	WA State Department of Ecology
Michelle	McMullin	NMFS, WCR
Ryan	McReynolds	US Fish & Wildlife Service
Marlene	Meaders	Confluence

First name	Last name	Representing
Susan	Meyer	US Environmental Protection Agency
Zach	Meyer	WA State Department of Ecology
Lori	Morris	US Army Corps of Engineers
Tim	Morris	Pacific Seafood
Rick	Mraz	WA State Department of Ecology
Peter	Murchie	US Environmental Protection Agency
Brad	Murphy	County Thurston
Deborah	Nelson	US Army Corps of Engineers
Conrad	Newell	NMFS, WCR
Dave	Palazzi	WA State Department of Natural Resources
Franchesca	Perez	Stillaguamish Tribe
Christine	Raczka	Port Gamble S'Klallam Tribe
Lisa	Redfern	Seattle Shellfish
Scott	Redman	Puget Sound Partnership
Blain	Reeves	WA State Department of Natural Resources
Jason	Ragan	Taylor Shellfish
Ralph	Riccio	Jamestown S'Klallam Tribe
Miranda	Ries	National Fish and Oyster
Gabrielle	Robinson	US Fish & Wildlife Service
Mary	Root	US Fish & Wildlife Service
Jen	Ruesink	University of Washington
Steve	Rumrill	Oregon Department of Fish & Wildlife
Beth	Sanderson	NMFS, NWFSC
Pam	Sanguinetti	US Army Corps of Engineers
Korie	Schaeffer	NMFS, WCR
Steve	Seymour	Drayton Harbor Shellfish
Marilyn	Sheldon	Northern Oyster/WGHOGA
Ole	Shelton	NMFS, NWFSC
Robert	Smith	County Thurston
Eric	Sparkman	Squaxin Island Tribe
John	Stadler	NMFS, WCR
George	Stearns	Puyallup Tribe of Indians
Dave	Steele	Rock Point Oyster
Linda	Storm	US Environmental Protection Agency
Ron	Thom	Pacific Northwest National Laboratory
Angie	Thomson	EnviroIssues
Kelly	Toy	Jamestown S'Klallam Tribe
Tiffany	Waters	Hama Hama
Jim	Weber	Northwest Indian Fisheries Commission
Paul	Williams	Suquamish Tribe

Appendix C. Summary of Pre-Workshop Survey Responses – Workshop handout

Category	Sub-Category	Question/Issue
A. Ecosystem Function/Services	(1) Identification/ Comparison	Identify and compare ecosystem functions and services of eelgrass and shellfish aquaculture
		Can eelgrass function be effectively replaced by shellfish aquaculture
		What is the irreplaceable function of eelgrass
		Interactions between eelgrass and shellfish aquaculture
	(2) Methods	How best to assess overall ecosystem services of a certain habitat
	(3) Spatial/Temporal	Density and size of eelgrass bed
		Landscape versus single eelgrass bed/farm scale
		Continuous eelgrass beds & meadows versus patchy
		Seasonal variation in species use of eelgrass and aquaculture habitat
B. Inconsistencies in management of eelgrass/shellfish aquaculture	(1) Identification	Where do inconsistencies exist (e.g., buffers, density, management for variety of aquatic species)
		Eelgrass survey methods can vary with goal of survey (e.g., the focus of permit requiring the survey)
		Compatibility of aquaculture with eelgrass restoration efforts
		Long term variation in environmental conditions factored into eelgrass management (e.g., 18-yr tidal cycle could shift eelgrass habitat range)
	(2) Context	Are inconsistencies justified/necessary due to different regulatory drivers and context of regulatory action (e.g., species, locations, health of eelgrass in that region)
		Context of shellfish aquaculture/eelgrass interaction: location (e.g., Willapa vs. South Puget Sound), species, and method of aquaculture
	(3) Resolution	Develop a path forward
		Eelgrass mitigation (e.g., requirements, effectiveness)
		Credit to shellfish farms for ecosystem service& function (e.g., including benefits to eelgrass)
		Compensation to growers if need to dedicate land to conservation instead of farming
		What are agency requirements to minimize impacts (e.g., buffers)

Appendix D: Participant Comment Response Matrix

The workshop organizers circulated a draft of the report to workshop participants for review, and received many comments back. In the following table, all substantive feedback is listed anonymously and organized by page number, with NMFS' corresponding response. Smaller, less substantive typographical or corrective edits were incorporated in the report and not included in this matrix.

It should be noted that many commenters provided valuable supplemental information and ideas for future discussion, however, the report attempts to summarize the discussions held within the workshop. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. Where comments went beyond the scope of the workshop, we have responded accordingly.

Relevant section or language	Pg.	Comment	NOAA's response
Executive summary	5-6	One aspect that is underrepresented in the executive summary (and the report as a whole) is that presence of eelgrass is not necessarily detrimental for the shellfish industry. For example, eelgrass beds may provide benefits in terms of a buffering effect for ocean acidification. Protection against effects of ocean acidification is a common cause for both shellfish growers and the regulatory community.	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic.
It was noted that over a century of observation by shellfish growers suggests that commercial shellfish and eelgrass can and do coexist.	5	I would argue that it is not just observation by shellfish growers, Bill Dewey referenced historical photographs, area land managers have witnesses this as well, and Brett Dumbauld referenced historical maps of overlap between eelgrass and aquaculture at the top of page 10.	**Revised sentence:** It was noted that over a century of observation by shellfish growers and land managers, historical photos, and maps suggest that commercial shellfish and eelgrass can and do coexist.
What are the ecosystem functions and services provided by shellfish aquaculture?	5	1) Several of the key questions for eelgrass involve the measurement of ecosystem functions and services. For symmetry it would be appropriate to consider not just what the services are, but also how they are measured. 2) Consider whether there are differences in areas where eelgrass and aquaculture co-occur from areas whether either occurs in isolation...	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic.

Relevant section or language	Pg.	Comment	NOAA's response
Disconnect in managing for eelgrass as opposed to overall ecosystem health	6	I would phrase this differently. Eelgrass is an indicator species for healthy coastal ecosystems. Managing for eelgrass (in)directly benefits overall ecosystem health, so there really is no "disconnect". I think the key point here is that other land uses (such as aquaculture) could also provide benefits for the ecosystem, and that the industry would like that this is taken into account.	**Revised sentence:** Eelgrass management is focused on certain eelgrass parameters (e.g., density, percent cover) and does not necessarily account for all ecological functions provided by eelgrass and/or cultured habitat.
Identify best management practices, in collaboration with scientists and growers, that may be applied as permit conditions and build on those already identified by the Shellfish Aquaculture Regulatory Commission and Pacific Coast Shellfish Growers Association.	6	This bullet references voluntary BMPs (PCSGA's) as well as permit condition requirements that have already been incorporated into local government regulations (SARC). This has caused confusion in the past. It may be cleanest to just state "Identify best management practices, in collaboration with scientists and growers."	**Revised sentence:** Identify best management practices, in collaboration with scientists and growers, that may be applied as permit conditions. Could build from voluntary best management practices developed by the Pacific Coast Shellfish Growers Association and required permit conditions identified by the Shellfish Aquaculture Regulatory Committee.

Relevant section or language	Pg.	Comment	NOAA's response
Eelgrass populations in Washington have most likely seen overall losses since the 1800s	8	Request clarification of this statement. I don't believe the loss of eelgrass since the 1800's was across all of WA as this makes it sound. I thought they actually said there was a net gain in eelgrass in Willapa but I'm not positive about that. I guess if the gains in Willapa and other areas haven't outpaced the losses in some areas it would be a true statement, but seems like too much of a blanket statement to me.	**Revised sentence:** Despite this overall stability, there is great local variability. Localized collapses – mostly unexplained – have been observed in areas such as Southern Hood Canal and Vashon Island, while other local populations have expanded, e.g., in the Nisqually and Skokomish deltas (perhaps driven by dike removal around tidal marshes), the Columbia River estuary (may be the result temporarily due to salinity increased focused by lower river flows during the 2014-2015 drought), Willapa Bay, and Grays Harbor. The respective causes of these collapses are yet to be verified.

Eelgrass (*Z. marina*) appears to be a resilient species	9	Resilience is not a characteristic of the species by itself, but is function of the entire ecosystem. A resilient seagrass ecosystem is usually characterized by good water quality, a healthy food web (top-down interactions are important for maintaining grazer populations that keep epiphytes in check), relatively large seagrass beds (size matters: bigger beds = higher potential for recruitment), high genetic diversity, etc. For more information on this concept, see Unsworth R.K.F., Collier C.C., Waycott M., Mckenzie L.C., Cullen-Unsworth L.C. (2015). A framework for the resilience of seagrass ecosystems. Marine Pollution Bulletin 100(1), 34-46. • The increased distribution of the non-native *Zostera japonica* does not appear to have an impact on eelgrass populations in Puget Sound. As for Willapa, *Z. japonica* seems to be more of concern for shellfish aquaculture than native eelgrass populations. Other factors, such as water quality, are more important than the presence of *Z. japonica*. • Eelgrass does not always recover from disturbances. On a global scale, there are many examples of places where eelgrass populations never recovered after being disturbed. I am not 100% familiar with the situation in Morro Bay, but it appears that eelgrass in Morro Bay is still only a fraction of what it used to be, despite large restoration efforts (http://www.mbnep.org/wp-content/uploads/2014/12/MB_State-of-the-Bay-2017_Final_3-7-2017_web.pdf; http://www.mbnep.org/2015/09/03/understanding-eelgrass-decline-and-evaluating-restoration-activities/)	**Revised section header:** Eelgrass (*Z. marina*) populations in Willapa Bay and Puget Sound appear to be resilient

Relevant section or language	Pg.	Comment	NOAA's response
Increased distribution of the invasive eelgrass species *Z. japonica*, particularly in Willapa Bay	9	I believe the comment here (Ron Thom could clarify) was that *Z. japonica* may have facilitated expansion of *Z. marina* to higher elevations in Willapa Bay.	**Revised sentence:** Increased distribution of the invasive eelgrass species *Z. japonica* may facilitate expansion of *Z. marina,* to higher tidal elevations, particularly in Willapa Bay
Eelgrass (*Z. marina*) appears to be a resilient species	9	Eelgrass resiliency is an important consideration in management, and the potential to recover from small scale disturbances, such as shellfish aquaculture. Ron also mentioned this as making sure that you are not disturbing beyond the capacity of the system to recover, which is harder to figure out in terms of appropriate management strategies and also varies by location, but well worth pursuing because eelgrass and shellfish aquaculture have such a long history of coexistence.	**Added to final bullet of section:** In management, it is important to make sure disturbances do not occur beyond the capacity of the system to recover.

Relevant section or language	Pg.	Comment	NOAA's response
The cause of the collapse is under study.	9	Collapse is an awkward term. In some places populations have become locally extirpated (e.g., completely absent), while in other areas the population has declined from recent levels and only small remnant populations remain. Ecologically these are very different situations that require different management approaches. In addition, for clarity, none of these 'collapses' have been associated with aquaculture activities (and to my knowledge aquaculture is not under study as a mechanism for causing collapse in any of these locations).	The information given in previous sentences gives appropriate context (temporal and extent of the eelgrass disappearance) for this use of the term "collapse". The previous sentence is repeated here. "In a study from Morro Bay (CA), a few small new patches of eelgrass were observed in 2016 after a complete collapse of almost all of the meadow between 2010 and 2013."
The 20% goal was a policy decision originating from an intent to support more eelgrass. That decision was based on a 1990 study indicating that there had been a decrease in eelgrass.	9	The Puget Sound Partnership decision document (Feb. 17, 2010) states "This target reflects the average percentage increase [in eelgrass] seen in other estuaries in the United States that have established aggressive restoration programs." There are separate documents and research which suggest eelgrass in Puget Sound has likely decreased "primarily due to filling and dredging" activities. These activities are qualitatively different from aquaculture in that they cause a habitat conversion such that nearshore habitats are no longer able to support eelgrass.	Link to the Puget Sound Partnership's eelgrass goals added to text.
Observations indicate that eelgrass has the ability to recover from disturbances. In a study from Morro Bay (CA), a few small new patches eelgrass were observed in 2016 after a complete collapse of almost all of the meadow between 2010 and 2013. The cause of the collapse is under study.	9	This example -- that a few small new patches were observed in 2016 -- does not support the declaration that eelgrass has the ability to recover from disturbances. It might support the statement that it is harder to wipe out an eelgrass bed than one might think.	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic. These statements came from and were reviewed by the presenter, Ron Thom.

Relevant section or language	Pg.	Comment	NOAA's response
Recovery is probably driven by variations in system capacity, which is in turn driven by light, temperature, salinity, substrate, and space. Factors that allow for successful flowering and seed dispersal probably assist in rate and scope of recovery. Areas rich in sediment organic matter were the strongest correlation to success.	9	Are the previous two bullets the sources of data that support this statement? If not, what are the bases for this statement?	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic. These statements came from and were reviewed by the presenter, Ron Thom.
Eelgrass restoration goals are affected by numerous eelgrass stressors (e.g., sea level and temperature rise, suspended sediment, shoreline armoring, etc.), and the full effect of many stressors still remain poorly understood and uncertainties remain.	9	Is shellfish aquaculture a "stressor"? If not, then why not? Does shoreline armoring have a greater impact on eelgrass than shellfish aquaculture? If so, it would be helpful to say so and to provide a link to the data that support the statement. The statement in the summary implies that shoreline armoring does have a greater effect than shellfish aquaculture. Given that the goal of this whole process is to try to figure out how to have peaceful/supportive coexistence between nearshore habitat that supports salmon and shellfish aquaculture, don't we need to be able to openly acknowledge that shellfish aquaculture is a stressor and that NMFS' current assessment based on best available science is that expanding ground culture into eelgrass beds is not consistent with avoiding impacts to critical habitat for salmon.	**Revised sentence:** Eelgrass restoration goals are affected by numerous eelgrass stressors (e.g., sea level and temperature rise, suspended sediment, shoreline armoring, and aquaculture, etc.), and the full effect of many stressors still remain poorly understood and uncertainties remain.
Does the 18.6-year tidal mode affect eelgrass? A: It could. From a grower's perspective, eelgrass seems to be expanding right now, and we're not having extreme low tides in this part of the 18.6-year cycle.)	9	Are there other perspectives on this besides the growers'? I suspect that Ron Thom's perspective is more that of a scientist than a grower.	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic.

Relevant section or language	Pg.	Comment	NOAA's response
Is the Puget Sound Partnership's "20% by 2020" appropriate? A: The 20% goal was a policy decision originating from an intent to support more eelgrass. That decision was based on a 1990 study indicating that there had been a decrease in eelgrass.	9	Is this the complete answer to the question? Regardless of what one thinks of the policy decision, I suspect the answer is probably a bit more complex than what is conveyed here.	Link to the Puget Sound Partnership's eelgrass goals added to text.
Shellfish aquaculture's ecosystem functions include secondary production of food for human consumption, and generation of income for coastal communities	10	Is "generation of income for coastal communities" an ecosystem service? If so, wouldn't coal-mining be an activity that produces ecosystem services?	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic.
Shellfish aquaculture's ecosystem functions include secondary production of food for human consumption, and generation of income for coastal communities. Other ecosystem services worthy of investigation include how shellfish aquaculture helps trap sediments and support erosion control, improve water quality, provide habitat (nursery and/or forage areas) for juvenile fish, shellfish, and shorebirds.	10	If we are going to look at the ecosystem services provided by shellfish aquaculture, don't we need to look at them in comparison to just allowing shellfish to grow (and be harvested) naturally? Shouldn't we be assessing the net difference in ecosystem services of shellfish aquaculture to natural shellfish production? If not, then what is the baseline for ecosystem service comparison?	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic.
For surfperch, the largest densities observed in Willapa Bay were in eelgrass, while the largest densities observed in Yaquina Bay were on bare (unvegetated) ground.	10	What does this mean for Puget Sound?	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic.

Relevant section or language	Pg.	Comment	NOAA's response
Advanced modeling approaches can also help evaluate and assess the ecological and economic significance of the ecosystem services provided by eelgrass and shellfish aquaculture on large and relevant spatial scales.	10	So is the goal of researching impacts of shellfish aquaculture on eelgrass to "develop better estimates of economic valuation"?	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic.
The primary ecosystem service provided by eelgrass is supporting habitat. Its essential functions include primary production and detritus, sediment trap and nutrient exchange, water quality improvement, carbon sequestration, and habitat (nursery and/or forage areas) for juvenile fish, shellfish, and shorebirds. Eelgrass also regulates the daily pH cycle of estuarine waters, and might be a buffer in acidifying waters	10	There is some confusion in the terminology of this paragraph between ecosystem services and essential functions. The important point, however, is that this paragraph appears to suggest that there is only 1 ecosystem service provided by eelgrass (e.g." supporting habitat"). This fails to recognize the value of the many other ecosystems services being provided by eelgrass. Carbon sequestration, wave attenuation/shoreline stabilization and water quality improvement (pH buffering, pathogen removal) are also some of the important ecosystem services being provided by eelgrass. This paragraph needs to be re-written to clearly articulate the important ecosystem services being provided by eelgrass, in addition to habitat support. In order to consider tradeoffs between eelgrass and shellfish, there must be a full accounting of ALL the ecosystem services being provided by both systems.	**Revised sentence:** Ecosystem services and functions provided by eelgrass include primary production, detritus, sediment trap, nutrient exchange, water quality improvement, carbon sequestration, and habitat (nursery and/or forage areas) for juvenile fish, shellfish, and shorebirds. Eelgrass also regulates the daily pH cycle of estuarine waters, and might be a buffer in acidifying waters

Relevant section or language	Pg.	Comment	NOAA's response
Aquaculture and eelgrass may provide nearly the same ecosystem functions	10	We need to be careful about making such a black and white statement, which, if taken out of context, could convey an inaccurate message. As acknowledged in the rest of the bullet, aquaculture and eelgrass do things differently. A full consideration of all the ecosystem services being provided by eelgrass (see comments above) reveals that many of the important ecosystem services provided by eelgrass cannot be replaced by shellfish, simply by virtue of the fact that one organism is a primary producer, and the other is a consumer. It is more accurate to say both aquaculture eelgrass provide beneficial ecosystem functions	**Revised sentence:** Aquaculture and eelgrass beds provide many similar ecosystem functions, but they occupy distinct positions in energy flow and nutrient cycling.
Eelgrass provides primary production of organic material and carbon uptake, which aquaculture does not	10	Arguable. I don't recall him making this point in the talk. Some argue that shellfish sequester carbon in shell development, and help buffer water through shell dissolution (could be aside the point.)	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic.

Relevant section or language	Pg.	Comment	NOAA's response
Aquaculture and eelgrass beds provide nearly the same ecosystem functions, but they occupy distinct positions in energy flow and nutrient cycling.	10	There is a study in San Quintin Bay (e.g., Sandoval-Gil et al. 2015, 2016) that indicates there may be a beneficial role in increasing the potential for eelgrass to be a primary producer in the presence of shellfish aquaculture. There is also some anecdotal information associated with a decrease in eelgrass wasting disease in the presence of areas with shellfish. Would be worth exploring the relationship both ways (positive and negative) for both organisms. References: Sandoval-Gil, J., A. Alexandre, R. Santos, and V.F. Camacho-Ibar. 2016. Nitrogen uptake and internal recycling in Zostera marina exposed to oyster farming: Eelgrass potential as a natural biofilter. Estuaries and Coasts 39(6):1694-1708. Sandoval-Gil, J.M., V.F. Camacho-Ibar, M. del Carmen Ávila-López, J. Hernández-López, J.A. Zertuche-González, and A. Cabello-Pasini. 2015. Dissolved inorganic nitrogen uptake kinetics and δ15N of Zostera marina L. (eelgrass) in a coastal lagoon with oyster aquaculture and upwelling influence. Journal of Experimental Marine Biology and Ecology 472:1-13.	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic.
Observations of species' use of eelgrass- and aquaculture-based habitats show variability across bays. For example, two specific studies indicate….	10	Would be good to cite the studies here for reference.	The reference was added to the text.

Relevant section or language	Pg.	Comment	NOAA's response
Q&A from Kurt Fresh's presentation	11	There was also a question about whether there is merit in pursing management more closely aligned with when fish are using eelgrass (spring and early summer) rather than just avoidance year-round. It could work in some areas, and worth discussing further.	This question was not recorded in our note taking so we can't accurately represent it, or a response, here.
Shellfish with approximately 10% cover begin to compete for space with eelgrass.	11	Worth noting that this is for ground culture. Aquaculture methods matter in terms of effects, and that is something that should be discussed in more detail.	**Revised sentence:** On-bottom shellfish (ground culture) with approximately 10% cover, begin to compete for space with eelgrass.
Activities (under Jenn Ruesink's presentation)	11	This is again linked to Ron Thom's ideas about resiliency and leaving enough eelgrass in place for recovery of activities.	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic.
Organisms: Shellfish with approximately 10% cover begin to compete for space with eelgrass. There is no evidence regionally that bivalves improve light or nutrients for eelgrass; fertilization of seagrass by bivalves has been documented elsewhere but has not been found in several studies in Washington State.	11	We recall Jennifer stating that eelgrass doesn't need improvement in light or nutrient, that it is vibrant and healthy in the estuaries of WA right now. This statement (if confirmed by Jennifer) should be captured somewhere in this section.	**Revised sentence:** Organisms: On-bottom shellfish (ground culture) with approximately 10% cover begin to compete for space with eelgrass. Two potential linkages that could allow bivalves to increase eelgrass productivity are by clearing water (improving light penetration) and by fertilizing shoots. These linkages have been tested in a few sites in Washington State but have not demonstrated improved eelgrass productivity with bivalves.

Relevant section or language	Pg.	Comment	NOAA's response
In a study from British Columbia, eelgrass was observed to be largely absent from shoreline with oysters, even though the two species occupied different intertidal zones (suggesting a more long-distance effect).	12	Would be good to cite the literature associated with some of these more specific comments.	The reference was added to the text.
...(suggesting a more long-distance effect).	12	This seems extremely speculative. I would strike this supposition.	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic.
Effects are negative, positive, and variable	12	Recovery timing and scale was not discussed in much detail. Jennifer, Brett, and Ron all have information on this (among others). It would be good to broaden this discussion related to management of specific activities.	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic.
Eelgrass is diverse in Washington	12	Another topic that is related to diversity is whether eelgrass needs disturbance (up to a certain extent) in order to maintain its resiliency. For an organism that is primarily located in a dynamic environment, it would make sense that disturbance is both what it has adapted to handle and something that maintains its genetic diversity. Is there more work on this topic?	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic.

Relevant section or language	Pg.	Comment	NOAA's response
Dredging has a dramatic, immediate impact on eelgrass density, with resilience possible through remnant shoots and seedling recruitment, whereas other harvest methods may have a less dramatic initial impact but greater long-term impact through changes in light or sediment.	12	Answers like this would be more helpful if there were more details. For example, if the data indicates that eelgrass recovers 3-5 years after disturbance by harvest -- but that harvest occurs every 5 years -- that tells you something about the extent to which eelgrass "recovers" in an area subject to the kind of shellfish aquaculture that disturbs eelgrass.	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic.
Harvest disturbance significantly affects eelgrass density. Density is lowest in mechanically harvested beds, but eelgrass growth is slightly higher in these beds and recovery is site specific ranging from 1-4 years.	13	This is useful. Is there any understanding as to whether these impacts are more significant or less significant than, say, temperature or shoreline armoring? If there is no understanding, then is there a basis for some of statements made earlier about the various eelgrass "stressors"?	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic.
Scale is an important consideration, and not often reflected in a permit.	13	So, is this an argument in favor of evaluating the impacts of all the permits, together? Doesn't this mean that we should be looking at the amount of shellfish aquaculture (and associated culture methods) Sound-wide?	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic.
Sea level rise modeling predicts an increase of eelgrass coverage across the tidal flat for all scenarios and years, with a net increase of as much as 3-11% within aquaculture beds. o By 2100, 80% of beds (3,770 ha) will have >30% *Z. marina* coverage. o Mean coverage among all beds is projected to increase from 41% (current) to 44-52%.	13	These estimates are interesting, but one wonders how much reliance can be placed on them, given the statements in Ron Thom's presentation about the complexity and variety of factors affecting eelgrass. How should these be reconciled?	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic.

Relevant section or language	Pg.	Comment	NOAA's response
Willapa's eelgrass overlap with native oysters may have been 45%, compared to 43% today with current commercial aquaculture.	13	It's also worth mentioning that overlap has changed in terms of location within the intertidal. For example, with clam culture there is mostly an avoidance of native eelgrass (higher in the intertidal). This, again, brings up both the question of disturbance needs for eelgrass and the patchiness of the seascape in terms of what fish and other species need (discussed later). The central management question here seems to be: does the landscape still have enough of a complex mosaic to support a wide variety of species?	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic.
By 2100, 80% of beds (3,770 ha) will have >30% *Z. marina* coverage.	13	This assumes that oyster beds are not allowed to move also in response to sea level rise. This is an important issue that eelgrass and aquaculture both need planning to accommodate sea level rise scenarios.	**Revised sentence:** By 2100, 80% of beds (3,770 ha) will have >30% *Z. marina* coverage, assuming beds have not been moved.

Relevant section or language	Pg.	Comment	NOAA's response
Q: Our observations as shellfish growers suggest that in the early spring, when vegetation has blown out from winter storms, aquaculture structures provide forage and refuge for salmonids in the absence of eelgrass. How do shellfish provide the same services for salmonids that you described for eelgrass? A: Structures are most analogous to services provided by eelgrass, and it would be great to get additional science on the services provided by them. It's likely that non-homogenous cultures are better for salmonids – i.e., ground culture with bag culture, etc. – since fish also benefit from non-homogenous eelgrass structures. Shellfish cannot produce detritus in the same way, however.	14	One additional comment: Eelgrass beds tend to have lower aboveground biomass, but they do not disappear in winter in Washington State. Eelgrass beds are usually present year-round.	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic.
Sea level rise modeling predicts an increase of eelgrass coverage across the tidal flat for all scenarios and years, with a net increase of as much as 3-11% within aquaculture beds. - By 2100, 80% of beds (3,770 ha) will have >30% Z. marina coverage - Mean coverage among all beds is projected to increase from 41% (current) to 44-52%.	13	Add statement here capturing Brett's slide showing no overlap between burrowing shrimp and eelgrass, i.e. complete displacement of eelgrass by burrowing shrimp. The disruption of the system by burrowing shrimp is brought up again by Brett in one of his answers at the very top of page 11, not sure why it got left off here as it sets up the context for his answer.	**Added bullet:** • Another consideration of eelgrass cover is burrowing shrimp, which is observed to have little overlap with eelgrass. It is likely that shrimp control has increased eelgrass presence on shellfish beds in Willapa Bay.

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Sea level rise modeling predicts an increase of eelgrass coverage across the tidal flat for all scenarios and years, with a net increase of as much as 3-11% within aquaculture beds. - By 2100, 80% of beds (3,770 ha) will have >30% Z. marina coverage - Mean coverage among all beds is projected to increase from 41% (current) to 44-52%.	13	Add statement here capturing Brett's slide showing no overlap between burrowing shrimp and eelgrass, i.e. complete displacement of eelgrass by burrowing shrimp. The disruption of the system by burrowing shrimp is brought up again by Brett in one of his answers at the very top of page 11, not sure why it got left off here as it sets up the context for his answer.	**Added bullet:** • Another consideration of eelgrass cover is burrowing shrimp, which is observed to have little overlap with eelgrass. It is likely that shrimp control has increased eelgrass presence on shellfish beds in Willapa Bay.
In previous study on coastal estuaries, Chinook and coho populations seemed to only be influenced with the percent of estuary in <u>pristine condition</u> (not total area or presence of oyster aquaculture).	14	I think it should be mentioned that "pristine condition" was defined by level of hard armoring along the shoreline not by presence of shellfish aquaculture. There is research on a reduction of fish use and other ecosystem functions associated with armored shorelines (e.g., Shipman et al. 2010, Dethier et al. 2016). Note that metrics of development along shorelines and 'pristine' character have not typically included aquaculture in their analyses. References: Dethier, M.N., W.W. Raymond, A.N. McBride, J.D. Toft, J.R. Cordell, A.S. Ogston, S.M. Heerhartz, and H.D. Berry. 2016. Multiscale impacts of armoring on Salish Sea shorelines: Evidence for cumulative and threshold effects. Estuarine, Coastal and Shelf Science 175:106-117. Shipman, H., M.N. Dethier, G. Gelfenbaum, K.L. Fresh, and R.S. Dinicola (eds). 2010. Puget Sound Shorelines and the Impacts of Armoring: Proceedings of a State of the Science Workshop, May 2009: U.S. Geological Survey, Reston, Virginia, Scientific Investigations Report 2010–5254, 266 pp.	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic.

Relevant section or language	Pg.	Comment	NOAA's response
Research suggests eelgrass will be more resilient in areas where it reproduces both sexually and asexually as opposed to areas where it only reproduces asexually.	15	What was not addressed was whether sexual reproduction is increased in areas with farming. I think there is some information to address this question. Whether or not that is bad or good cannot be addressed, but it opens up the conversation for the disturbance needs of eelgrass and whether there can be a management discussion around that idea.	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic.
It's a hard question to answer due to the influence of burrowing shrimp. Most aquaculture is occurring in higher intertidal areas, similar to where native oysters occurred. Aquaculture may have helped eelgrass in those tidal flats. Native oysters would have created patchiness.	14	This statement should be a consideration in assessing the relative ecosystem services provided by shellfish aquaculture as compared to natural production.	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic.
Q: Are there studies on eelgrass vs. aquaculture as a preferred herring spawning substrate? A: The most common substrate for herring to spawn is eelgrass, however it doesn't appear that herring is actively selecting eelgrass, just that it is available to them. They also spawn on algae and aquaculture structure. That said, there is a lot of variation and noise. We have not studied shellfish aquaculture effects on rearing spawning.	16	My notes for this particular answer also indicate that it was stated that "eelgrass is the most common substrate for herring spawning." Additionally, my notes indicate that it was stated that they hadn't looked at shellfish aquaculture as a herring spawning site because there was not much overlap.	**Revised sentence:** We have not studied shellfish aquaculture specifically as a herring spawning substrate because there does not appear to be a lot of overlap between where herring spawn and shellfish are cultured (some exceptions are Dabob Bay and Chuckanut Bay).

Relevant section or language	Pg.	Comment	NOAA's response
Do we see different species using eelgrass meadows vs. fringes?	16	Taken as a whole these responses emphasize that both habitat types provide value to different resources and contribute to ecologically diverse ecosystems.	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic.
Primary production capacity and flow regimes will likely be different between those two different kinds of beds. Studies outside the Northwest have shown a biological response from a 90% reduction in shoot density.	16	Can this be incorporated into a management discussion of density reduction? Most studies indicate that shellfish aquaculture methods do not reduce eelgrass to this extent, or if they do there is recovery within 1-4 years. Does that make a difference in terms of how these areas are managed in the presence of shellfish aquaculture?	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic.
We have not studied shellfish aquaculture effects on rearing spawning.	16	I think that this was meant to say something like, "We have not studied shellfish aquaculture effects on egg survival and rearing of herring larvae." Very true, that egg survival studies have not been conducted very much. It's hard to separate out predation or just "egg loss" from survival on various substrates. Shelton et al. 2014 is the only one that comes to mind that has attempted this to a large extent, and that was on different macroalgae and eelgrass species. Reference: Shelton, A.O. T.B. Francis, G.D. Williams, B. Feist, K. Stick and P.S. Levin. 2014. Habitat limitation and spatial variation in Pacific herring egg survival. Marine Ecology Progress Series 514:231-254.	**Revised sentence:** We have not studied shellfish aquaculture effects on herring spawning.

Relevant section or language	Pg.	Comment	NOAA's response
Q: Is there any information on the positive benefits of eelgrass on higher aquaculture yields (e.g., mass per shell increase)? A: No – we don't have data on shell size and yield as a result of eelgrass' detrital contributions.	17	See comment above related to work in San Quintin Bay.	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic.
Existing Permitting Process flowchart	18	This needs to be higher quality so that the small print can be read	Link to a high resolution version added to text.
To survey per the recently released Seattle District Corps delineation protocols is estimated to cost as much as $40,000 per acre.	19	This statement may be referring to the first version of the Corps' delineation protocol guidance. The delineation protocol has since been revised and will be made available to the public summer 2017. The revisions reduce the level of effort commensurate with potential impacts. The Corps also held an eelgrass delineation guidance workshop per the revised methods that was well-attended by consulting firms. Positive feedback was received for the changes to the guidance.	**Footnote added to read:** Please note that the Seattle District Corps' eelgrass survey guidance is being updated based on feed-back from users of the guidance received in the past year. An updated guidance is expected to be released in Fall, 2017
Observed historic coexistence of shellfish culture in eelgrass and ecological vitality in aquaculture beds - Historic (early 1900s) and current photos show oyster culture occurring integrally in eelgrass - Photos show kelp and sea lettuce growing in bottom culture, and smolts in mussel rafts. -Video footage shows oyster-eelgrass mosaics support sculpin, shiner perch, and crab. - etc……	20	So, if the tribes were to provide photos of historic salmon harvest levels being much higher than they are currently, are those photos then "evidence" they can use to assert that implementing harvest at historic levels is entirely compatible with promoting salmon recovery? If not, then why is that considered a reasonable argument for promoting undiminished shellfish aquaculture?	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic.

Relevant section or language	Pg.	Comment	NOAA's response
The goal of eelgrass management in the context of aquaculture is conflicting, poorly defined or inconsistent across agencies. NOAA's goals are to expand sustainable aquaculture, while protecting, recovering and restoring protected species, and sustaining healthy ecosystems, per NOAA's Aquaculture Policy. Other agencies have different goals and legal authorities, e.g., protecting critical saltwater habitat which includes both eelgrass and shellfish.	20	One of NOAA's critical habitat and EFH goals is to protect nearshore habitat, including habitat supporting eelgrass. What about the Corps' CWA obligation to avoid cumulative impacts to vegetated shallows? One of the more important comments made at the meeting was by an EPA rep who noted that: Eelgrass is part of critical habitat; it's a special aquatic site, too. The law prioritizes eelgrass protection over non-native shellfish aquaculture. We need to see where shellfish aquaculture intersects with protection of eelgrass." While those may not have been her exact words, those are the words I wrote down in my notes. Arguably, her statement of the issue is the approach that this process should be using in trying to formulate answers on how to assure that shellfish aquaculture is compatible with nearshore habitat protection and function.	**Revised paragraph:** The goal of eelgrass management in the context of aquaculture is conflicting, poorly defined or inconsistent across agencies. NOAA's goals are to expand sustainable aquaculture, while protecting, recovering and restoring protected species and their critical habitat (through the ESA), and sustaining healthy ecosystems for federally managed species (through Essential Fish Habitat provisions), per NOAA's Aquaculture Policy. Other agencies have different goals and legal authorities, e.g., the state protects "critical saltwater habitat" which includes both eelgrass and shellfish, the Corps protects "special aquatic sites" (which includes eelgrass) through the Clean Water Act. The regulatory framework is designed to protect eelgrass first, but the context for that protection varies by agency.
Regulations are inconsistently applied, and regulators require different permitting information. The application of regulations and how they are being implemented are not consistent between agencies and sometimes even within the same agency.	20	One of the key reasons for inconsistencies between agencies is because agencies usually have different regulatory authorities and objectives. This will often result in different management requirements and information needs. This is a sign of good government, not bad government. Should the Corps of Engineers, NMFS, and local government all have the same objectives? Should we be at all surprised if they don't? Implementing Section 404 is not the same nor should it be the same as implementing the SMA.	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic.

Relevant section or language	Pg.	Comment	NOAA's response
The economic viability of aquaculture and maintaining regulatory compliance are currently in conflict.	21	Where is the data supporting the statement that the economic viability of aquaculture and maintaining regulatory compliance are currently in conflict? If this is just an assertion of opinion by an industry representative, then it should be labeled as such and not attributed to be, or implied to be, a statement supported by all workshop participants.	**Revised sentence:** The shellfish industry perceives that the economic viability of aquaculture and maintaining regulatory compliance are currently in conflict.
Scientific confirmation of best practices is inconsistent across culture methods. For example, we know what long-line spacing and stocking rate support eelgrass, but we don't have that information for bottom culture.	21	NMFS" determination that both new and existing projects should not enter/expand into eelgrass beds with ground culture is supposedly based on best available science. The statement in the text implies that ground culture is good for eelgrass, we just don't have the data yet that proves it. As NMFS Section 7 consultation staff noted at the conference, there are folks arguing that shellfish aquaculture provides the same services to chinook as eelgrass does. However, NMFS is unwilling to issue a biop that asserts that, unless there is data showing that shellfish aquaculture provides the same services to chinook as eelgrass does. The various subdivisions of NMFS need to get coordinated.	**Revised sentence:** For example, we know what long-line spacing and stocking rate minimize impacts to eelgrass, but we don't have that information for bottom culture.
The prescriptiveness of eelgrass regulations does not match the complexity and variability of eelgrass. Scientific research shows that eelgrass reacts differently across estuaries, however eelgrass regulations are not customizable to account for location-specific behavior.	21	Customizing regulations to location specific behaviors of eelgrass beds may increase the complexity of the regulatory environment and could easily lead to even more inconsistencies in regulations and the way regulations are applied	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic.

Relevant section or language	Pg.	Comment	NOAA's response
NMFS' recent recommendation to use 5m is based on the distance that allows for maximum bed expansion.	22	We believe the 5 m is based on the distance that allows for "average" bed expansion.	NMFS' recommendation is supported by DNR's Tech Memo (Donoghue, 2013, Operational Definition for Determining Edge of Eelgrass (*Zostera marina*) Presence), Table 12, Metrics Relevant for Developing Buffers, which states: Maximum documented annual bed expansion of +4m, and contraction of -5 m (DNR unpublished data- 2 different sites sampled over 4 year period).
Bed definition • NMFS defines the edge of a bed as the edge of a meadow or solid contiguous patch. • The Corps accepts the NOAA Fisheries and DNR definition; survey guidance document includes methods for finding a bed edge. • The NOAA California Eelgrass Mitigation Policy also provides a definition of bed edge, which is slightly different than the others	22	The Corps accepts both DNR and NOAA's CA Eelgrass Mitigation Policy methods to define bed edge. Not sure what NMFS method they are referring to in the first sentence.	**Revised sentence:** • NMFS provides a definition for eelgrass habitat in the California Eelgrass Mitigation Policy (CEMP). • DNR provides a definition for eelgrass bed in their Technical Memorandum. • The Corps' guidelines recommend both the NMFS and DNR definitions in their methods for defining eelgrass habitat.
Survey Protocol • The Corps is willing and able to accept other survey methodologies, and just went through a public comment period on the guidance document.	23	The Corps did not go through a public comment period on the guidance document as it is guidance and not regulation. Instead, the Seattle District has requested feed-back from users of the guidance document and is issuing a revised guidance this summer based on feed-back received this past year.	**Revised sentence:** The Corps is willing and able to accept other survey methodologies Plus footnote added: Please note that the Seattle District Corps' eelgrass survey guidance is being updated based on feed-back from users of the guidance received in the past year. An updated guidance is expected to be released in Fall, 2017

Relevant section or language	Pg.	Comment	NOAA's response
The Corps has no official survey protocol, however they do have a survey guidance document.	23	Subsequent to the workshop, but prior to this report being finalized, the Corps issued a revised protocol (Draft Version 2) in conjunction with a series of trainings on its guidance. Changes include the addition of a "Tier 0" as referenced in the workshop notes. Unclear whether this version has been made available officially on the Seattle District's website (I was unable to locate). Growers were told during a June 2017 Seattle District informational meeting that they could contact the Seattle District to receive a copy. Suggest referencing in a footnote that Corps' guidance has been updated since the April 2017 workshop.	**Footnote added:** Please note that the Seattle District Corps' eelgrass survey guidance is being updated based on feed-back from users of the guidance received in the past year. An updated guidance is expected to be released in Fall, 2017
Counties defer to the Corp's guidance, however they do require that surveys occur at the submittal of application and, if there is a hearing, at the time of hearing, and after the hearing.	23	Suggest deleting or, at a minimum, clarifying. Growers do not recall this information being provided at the conference, and do not understand this to be counties' position (and do not believe there is a position shared by all counties on this topic). Why would counties require three surveys? This would be very costly and present implementation challenges, in part because the survey window only runs June 1 - October 1. Are counties requiring three surveys that comply with the Corps' guidance? Would delineations performed consistent with other agency protocols (i.e. DNR, NOAA) also be acceptable? Is this all counties or just one county?	**Revised sentence:** Local jurisdictions (i.e., counties) rarely have resources to develop their own survey protocols but can accept methodologies from other agencies (i.e. Corps, DNR, NMFS). Some Counties may require additional surveys if permits are appealed.

Relevant section or language	Pg.	Comment	NOAA's response
Comment submittal letter	23	An eelgrass survey lasts a year through the Corps, but there is no management strategy to get permitting done within that time or address the potential need to verify the survey around the same time that the survey was conducted (i.e., reducing seasonal or annual variability).	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic.
Comment submittal letter	23	The requirement to have an eelgrass survey at the time of application submittal, at the time of a hearing, and after the hearing. That is a minimum of 3 surveys (not accounting for the survey lasting a year and permitting typically taking longer) for potentially costly surveys. The questions should be asked: what is the purpose of the survey for management? That will more appropriately guide how many surveys are needed. For example, if the purpose is to show avoidance of eelgrass using appropriate buffers, then there shouldn't be a requirement to have three surveys for one permit application.	**Revised sentence:** Local jurisdictions (i.e., counties) rarely have resources to develop their own survey protocols but can accept methodologies from other agencies (i.e. Corps, DNR, NMFS). Some Counties may require additional surveys if permits are appealed.
NMFS' recent recommendation to use 5m is based on the distance that allows for <u>maximum bed expansion.</u>	22	It should be noted that this is based on lateral expansion (along the shoreline), not toward the shore or away from the shore. This was discussed in the DNR workshop and is included in the DNR Draft Aquatic Lands HCP.	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic.

Relevant section or language	Pg.	Comment	NOAA's response
Counties defer to the Corp's guidance, however they do require that surveys occur at the submittal of application and, if there is a hearing, at the time of hearing, and after the hearing.	23	That equates to a total of 3 surveys before the farm is even permitted. This can be very costly. The other thing that should be included in the survey protocol is the management objective. Is it to show that eelgrass will be avoided (should not require multiple surveys once it is determined that avoidance is possible) or is it to define mitigation?	**Revised sentence:** Local jurisdictions (i.e., counties) rarely have resources to develop their own survey protocols but can accept methodologies from other agencies (i.e. Corps, DNR, NMFS). Some Counties may require additional surveys if permits are appealed.
Monitoring protocol	23	Should also include permit timing vs. survey timing to reduce the number of times that a site needs to be surveyed.	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic.
NMFS' recent recommendation to use 5m is based on the distance that allows for maximum bed expansion. The primary goal is to protect eelgrass for salmonids under the ESA and essential fish habitat under the Magnuson Stevens Act.	22	NMFS ESA and EFH goals are not mentioned in the discussion of important agency goals and obligations.	**Added clarification to bullet on page 16:** NOAA's goals are to expand sustainable aquaculture, while protecting, recovering and restoring protected species and their critical habitat (through the ESA), and sustaining healthy ecosystems for federally managed species (through Essential Fish Habitat provisions), per NOAA's Aquaculture Policy.
How eelgrass is behaving reproductively (sexually and/or asexually) reflects its resiliency and may be an appropriate variable to inform buffer length or necessity.	22	So is it being suggested that research be done on the means of reproduction by X% of the eelgrass within a proposed area and that when the composition of eelgrass found to reproduce one way or another reaches Y%, then that determines what BMPs a grower uses? Do people really think that is an effective and efficient way of protecting eelgrass and fostering shellfish aquaculture?	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic.

Relevant section or language	Pg.	Comment	NOAA's response
Existing farms are not required to have a buffer. These sites could be used to inform potential for new farms in eelgrass.	22	This bullet regarding the absence of buffer requirements seems very inconsistent with the 3rd bullet that complains about the research problems caused by buffer requirements.	**Revised bullets:** • Buffer research is inconclusive about optimal size, and difficult to conduct (due to regulations that do not allow work inside of buffers). • Existing farms are not required to have a buffer. These sites could be used to inform potential for new farms in eelgrass or adaptive management of buffer size.
….a more open dialogue between shellfish growers, scientists, and regulators, as provided through this workshop, should be continued.	24	This meeting was not an open process and was not a good model for how to proceed in the future. An important constituency (environmental groups) was excluded from this process. Excluding them from the process will not contribute to better regulations and less litigation.	The intent of the workshop was to bring together the scientists, regulators (including tribal co-managers), and regulated community, to discuss the science and have a dialogue about the subject matter.
Better define the goals of eelgrass management and pathways to reconcile economic vs. ecological mandates across agencies.	24	The goals/objectives/standards for eelgrass management (aka nearshore habitat protection) are not limited to economic versus ecological. There are legal requirements for protecting nearshore habitat (aka critical habitat and essential fish habitat and vegetated shallows). Protecting and restoring treaty rights to take both fish and shellfish are also legal requirements.	**Revised sentence:** Better define the goals of eelgrass management and pathways to reconcile application of economic, ecological, and other mandates to eelgrass management across agencies.

Relevant section or language	Pg.	Comment	NOAA's response
Develop an adaptive management approach that can provide the framework to manage eelgrass amidst uncertainty and allow regulatory program investments in assessing unanswered questions (e.g., how appropriate eelgrass is as a proxy to ecosystem health?). It should be noted that experimentation in permitting metrics may be challenging for agencies who have to defend policy decisions in litigation.	24	Other folks (including Forests and Fish) recognize the importance of involving all interested parties in the adaptive management process. Sound science that helps answer important management questions can actually help quell discord.	Noted and will be taken into consideration as we move forward.
Identify best management practices, in collaboration with scientists and growers, that may be applied as permit conditions and build on those already identified by the Shellfish Aquaculture Regulatory Commission and Pacific Coast Shellfish Growers Association. Clearly communicate when referring to BMPs if they are voluntary recommendations or required permit conditions.	24	Whether one likes it or not, the public has a right to be involved in the process of developing regulations for protection of the environment. It doesn't help the "credibility" of this process to have it set up so that it appears to be as cozy with the industry as it currently does.	Noted and will be taken into consideration as we move forward.
Find opportunities to coordinate and cost-share activities related to monitoring, evaluation, and research on a state or region-wide scale.	24	Funding is always challenging, but it will be even more so if those who are excluded from the process choose to challenge the legitimacy of the funding requests. By excluding folks, you make it easy for them to argue that the recommendations are flawed simply because they are the product of a flawed process.	Noted and will be taken into consideration as we move forward.

Relevant section or language	Pg.	Comment	NOAA's response
What is the level of aquaculture that is compatible for eelgrass functions?	24	The level of aquaculture that is compatible with eelgrass function -- or perhaps more accurately, "compatible with assuring nearshore function for salmonids and their food chain" -- is the central policy issue of the whole process. How we respond to that question will likely change with the ebb and flow of both science and politics. Arguably, this is the determination that should be listed as the goal of the entire process. Ironically, while there was much complaining about the excesses and inconsistencies of regulations for protecting eelgrass and other nearshore resources, the conference did not discuss what the current levels of eelgrass/nearshore protection that are required by DNR, local governments, the Corps, or NMFS. Getting those facts on the table would help put some of the issues and complaints into context.	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic.

Relevant section or language	Pg.	Comment	NOAA's response
Recommended future actions	24	There are two elements that were perhaps not enunciated during the meeting that might be considered: 1) Develop an understanding and approach for managing the resource where eelgrass and aquaculture co-occur. Rather than an either/or paradigm, evaluate the value where these resources co-occur. 2) The existing paradigm tends to freeze the land/ecosystem management in the current configuration. Sea level rise and other issues will contribute to a need for geographic flexibility in managing both resources (eelgrass and aquaculture) which the current approach to management lacks.	Regarding #1: This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic. Regarding #2: While not explicitly stated as a future action, #2 was discussed during the science and regulatory portions of the workshop. Thus, the following bullet has been added to the "future research questions" section: • How can we account for the fact that eelgrass beds are not static, and that changing ocean conditions will play a role on resource distribution in the future?
Provide feedback on survey protocols and provide feedback to the Corps and counties on their guidance documents in an effort to bring more consistency between them	24	What County/counties' guidance documents are being referred to here? What inconsistencies exist? What are County requirements for eelgrass surveys? This was not part of the discussion at the workshop (so far as I recall) and I don't believe that the regulated community has been part of these conversations.	**Revised sentence:** Provide feedback on eelgrass survey protocols to the Corps and other entities in an effort to bring more consistency between them.
What is the level of aquaculture that is compatible for eelgrass functions?	24	This should be elaborated. What species, culture methods, and what type of eelgrass beds/functions?	**Revised sentence:** What are the species, culture methods, and extent of aquaculture compatible with varying eelgrass functions?

Relevant section or language	Pg.	Comment	NOAA's response
What is the ideal bottom culture density and/or spacing that supports healthy eelgrass?	24	Does this refer to density and spacing of bottom culture only, or density of bottom culture and spacing of other cultivation methods (presumably longlines)?	This refers to bottom culture only, as research presented at the workshop indicated we already have information about this for long-lines.
Future research questions	24	One pertinent research question in relation to shellfish/eelgrass interactions is to what degree the presence of eelgrass beds could buffer effects of ocean acidification near natural shellfish beds and shellfish aquaculture sites.	While not explicitly stated as a future action, this idea was discussed during the science and regulatory portions of the workshop. Thus, the following bullet has been added to the "future research questions" section: **Bullet added:** • Does the presence of eelgrass beds reduce effects of ocean acidification near natural shellfish beds and shellfish aquaculture sites?
What is the ideal bottom culture density and/or spacing that supports healthy eelgrass?	24	maximizing healthy eelgrass and maximizing healthy ecosystems may be at different levels. There are risks to distorting the ecosystem by maximizing protection of one resource at the expense of others.	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic.
Q&A sections throughout	n/a	Suggest including attribution for the answers in Q&A/discussion sections, in case there is a need to obtain clarification or additional information in the future.	Unfortunately we were able to capture who was speaking during the Q&A sessions.

Relevant section or language	Pg.	Comment	NOAA's response
Comment submittal letter	n/a	There should be a discussion of eelgrass resiliency related to disturbance and recovery. Shellfish aquaculture, for most operations in Washington, represents short-term disturbance that results in either full (or nearly full) recovery. It is also an activity that has been performed in eelgrass for over 100 years in areas that continue to have eelgrass. While there may be a change in baseline, the two are not mutually exclusive.	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic.
Comment submittal letter	n/a	Management is most helpful at the habitat mosaic/landscape perspective because the species for which we are typically managing are using the habitat at this larger scale (see Figure 1; developed in discussion with Dr. Brett Dumbauld and Dr. Steve Rumrill).	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic.
Comment submittal letter	n/a	It is important to consider the timing and needs of species that use eelgrass vs. shellfish aquaculture areas. There will be tradeoffs, depending on the culture methods, but these tradeoffs may not represent a change in the ability for the overall habitat (i.e., habitat mosaic) to support managed species.	This report attempts to summarize the workshop discussions. The intent is not to present a "state of knowledge" summary or a review of all perspectives on a topic, unless they were explicitly stated. We feel we have kept faithful to the discussion on this topic.

Relevant section or language	Pg.	Comment	NOAA's response
Comment submittal letter	n/a	We think that in order to make real progress on harmonizing shellfish aquaculture with nearshore salmon habitat protection, we (the region) need to start being a bit more disciplined about the kind of processes that are used to attempt to address issues. The April 11 workshop did not adequately reflect a process that is objective, inclusive, and cooperative. A consensus process between industry reps and some government regulators does not reflect the inclusivity and objectivity that are necessary to harmonize shellfish aquaculture with nearshore salmon habitat protection. Where do the salmon interests fit in? Where do environmental groups fit in? One does not have to agree with them to recognize that they have a place in the process. The Commission's member tribes generally support approaches that both allow for good shellfish aquaculture and protection and restoration of productive nearshore salmon habitat. There needs to be good science underlying those policy choices. We need a more inclusive process that better recognizes the legal obligations involved – including treaty rights – and that supports research designed to provide sound answers to important management questions. It appears that we have a ways get to go – which is why there may be merit in investigating an adaptive management model that is more like that used by the Forest and Fish process.	Noted and will be taken into consideration as we move forward.