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January 22, 2024

Submitted Via Email: sonja.cady@co.thurston.wa.us
Thurston County Hearing Examiner
3000 Pacific Ave SE, Suite 100
Olympia, WA 98501

Re: Project No.: 2022103702
Taylor Manzanti Geoduck Farm
Closing Argument for Taylor Shellfish Company, Inc.

Dear Hearing Examiner:

I am submitting this letter on behalf of Taylor Shellfish Company to provide closing argument with respect to Taylor Shellfish' request for a shoreline substantial development permit ("SDDP") to operate an intertidal geoduck farm on Thurston County Parcel No. 93000100000 pursuant to project number 2022103702 ("Project").

Attached to this letter are the following documents, which Taylor Shellfish is submitting as part of its response in this matter and in support of its SSDP request:

- Attachment 1: Applicant Taylor Shellfish Farms' Response to Public Comments. This document provides a response to public comments submitted on the SSDP application. It also provides information in response to Examiner Rice's questions regarding labelling of Taylor Shellfish's gear. This document was prepared by Taylor Shellfish's Director of Regulatory Affairs with assistance from technical advisors. It groups comments by topic, identifies commenters on each topic, and provides responses with appropriate citations. Additional supporting documents are appended to Attachment 1.

- Attachment 2: Confluence Environmental company, Response to Comments on Thurston County Taylor Shellfish Farms Project No.: 2022103702. This document provides a technical response by an expert in marine biology to public comments submitted regarding the Project's potential impacts on the natural environment. This document was prepared by Chriz Cziesla, Senior Principal Marine/Fisheries Biologist and CEO of Confluence Environmental Company. Mr. Cziesla also provided testimony regarding the Project's environmental impacts during the January 9, 2024 hearing in this matter.

- Attachment 3: Ramboll, Responses to Comments on Microplastics: Mazanti Farm Hearing. This document provides responses to comments regarding the Project's potential to generate marine debris and microplastics. It was prepared by Dr. Rosalind A. Schoof, who is a is a board-certified toxicologist with more than 35 years' experience assessing human health effects and exposures from chemical substances. Dr. Schoof has extensive experience analyzing the potential effects associated with plastics in shellfish aquaculture, and the Shorelines Hearings Board ("SHB") has relied on her testimony in numerous hearings in concluding that plastics used in geoduck aquaculture would not have unacceptable adverse impacts. Attachment 3 supplements Dr. Schoof's testimony and prior written submittals in the record that demonstrate the Project's plastic gear would not contribute measurable microplastics or chemicals to the aquatic environment. See e.g., Hearing Exhibits 14, 18.

- Attachment 4: Taylor Shellfish Company Mazanti Shellfish Farm Project No. 2022103702 October 27, 2023. This document is an analysis submitted on October 27, 2023, to Thurston County staff on behalf of Taylor Shellfish Company addressing the Project's compliance with permit issuance criteria. Attachments E-I and K are included; the remaining attachments to the consistency analysis are included elsewhere in the record.

Taylor Shellfish's closing argument in support of the Project's SSDP is provided in section B below. Section A provides response to questions posed by Examiner Rice regarding Taylor Shellfish's requested revisions to permit conditions and the extent to which commenters' criticisms of the Washington Sea Grant geoduck research program have been previously analyzed and rejected by the SHB.

A. Responses to Examiner Rice Requests

A. Recommended Permit Conditions

During the January 9 hearing, Ms. Ewald discussed the following four recommended conditions of approval in the staff report: 4, 5, 17, and 22. Taylor Shellfish has considered these recommended conditions further after the hearing and is only requesting a modification to condition 22, as follows (additional language is in underline):

> Sand dollars populations shall not be significantly negatively impacted by preparation or planting of Geoduck.

As discussed during that January 9 hearing and in *Coalition to Protect Puget Sound Habitat v. Pierce County*, SHB No. 14-024, Findings of Fact, Conclusion of Law, and Order (May 15, 2015), Taylor Shellfish takes care to avoid impacts to sand dollars to the maximum extent possible. Crew members push sand dollars aside by hand as necessary a few inches to insert the tubes, and even if sand dollars are overturned during planting, they are able to aggregate and right themselves. Hearing Exhibit 20 at Finding of Fact 13. Some sand dollars may be impacted, and a zero-impact standard would not be possible for geoduck aquaculture or any other activity

on intertidal beaches to satisfy. Nonetheless, "geoduck aquaculture does not have a significant impact on sand dollars." *Id*. See also Hearing Exhibit 19. Condition #22 should be revised to avoid an infeasible zero-impact standard. Taylor Shellfish intends to, and is comfortable with, a condition ensuring it takes measures to ensure sand dollar populations are not significantly impacted by the farm.

With respect to the other three conditions discussed during the January 9 hearing, modifications are not necessary, but Taylor Shellfish will take this opportunity to clarify the company's understanding of these conditions and planned compliance approach.

- Condition 4: This condition requires an unobtrusive but visible sign to be placed at the aquaculture bed. Neither Taylor Shellfish, nor its lessor for this farm, own uplands adjacent to this project area. Therefore, the sign would need to be installed on the tidelands. A sign protruding above the tidelands would quickly become fouled and unreadable, and it could present an obstacle to navigation if it sticks up multiple feet from the substrate. Therefore, Taylor Shellfish will comply with this condition by including contact information on buoys or corner markers. The buoys can be maintained, and a clear marker at corners will be as visible as possible.

- Condition 5: This condition requires shellfish culturing to not occur within 10 horizontal feet of eelgrass (Zostera marina) or kelp. Taylor Shellfish is planning to operate the Project in full compliance with the terms, conditions, and conservation measures of the programmatic consultation for shellfish activities in Washington State inland marine waters. New farms under the programmatic consultation maintain at least 16-foot horizontal buffers from native eelgrass and protected kelp species. See programmatic consultation measure 6.[1] Taylor Shellfish plans to maintain this buffer, rather than the smaller 10-foot buffer in the staff report's recommended condition.[2] Protected kelp are rooted/attached brown algae in the order Laminariales. There are also some species of kelp that are not rooted or attached and drift in the water. It is not possible to ensure floating kelp does not come near the farm, nor is there any ecological reason to prohibit this occurrence.

- Condition 17: This condition states that no seeding, culture or other operations are to be done in biologically sensitive areas of the beach such as herring or smelt spawning grounds. As just discussed, Taylor Shellfish plans to comply with the programmatic consultation, which contains measures to avoid adverse impacts to forage fish spawning areas and spawn. See programmatic consultation measures 7-10. The Project will be located well below surf smelt and sand lance spawning elevations. Herring opportunistically spawn on vegetation and structured habitat such as rocks and cobbles. There is no vegetation or structured habitat currently at the Project site, and therefore

[1] Available at: https://www.nws.usace.army.mil/Portals/27/docs/regulatory/NewsUpdates/20181128%20Verification%20Enclosure%201.pdf?ver=wEEviExfV5z-aA3uEPh1Uw%3d%3d
[2] As discussed in the staff report, application documents, and at hearing, there is no eelgrass at or near the Project.

Taylor Shellfish will be in compliance with condition 17. Herring may opportunistically spawn on the Project's nursery tubes. If this occurs, there will be no adverse impacts to herring eggs because Taylor will survey for herring spawn during spawning periods and avoid activities until the eggs have hatched and herring spawn is no longer present, consistent with the programmatic consultation measure 10.

B. Washington Sea Grant Research

Some commenters oppose the Project's SSDP and argue it should be denied because the Project will significantly impact benthic organisms and other aquatic species. Commenters do not support these claims with empirical studies demonstrating that geoduck aquaculture has such impacts.[3] Rather, their attempt to support this claim is largely limited to critiquing an empirical research program conducted by Washington Sea Grant evaluating the impacts associated with geoduck grow-out and harvest activities.

Examiner Rice requested information regarding the extent to which commenters' criticisms have been rejected in earlier decisions. In response to that request, one commenter submitted post-hearing argument on this point. Exhibit 21. The commenter recognized that the SHB has issued numerous decisions relying on the Sea Grant research program for evaluating the environmental impacts of geoduck aquaculture. Those decisions include the following: *Coalition to Protect Puget Sound Habitat v. Pierce County*, SHB No. 11-019 (July 13, 2012); *Coalition to Protect Puget Sound Habitat v. Thurston County*, SHB No. 13-006c (October 11, 2013); *Coalition to Protect Puget Sound Habitat v. Pierce County*, SHB No. 13-016c (January 22, 2014); and *Coalition to Protect Puget Sound Habitat v. Pierce County*, SHB No. 14-024 (May 15, 2015).

The commenter contends these decisions "are basically irrelevant" because, among other things, "scientific knowledge changes over time" and "[t]he neighbors have provided evidence that simply was not presented or even available during prior proceedings, e.g., new critiques of old studies . . ." Exhibit 21, p. 6. This is inaccurate. Not only has the SHB heard extensive testimony and carefully evaluated the findings and conclusions of the Sea Grant research program on several occasions, but it has considered and rejected the very same arguments that commenters offer here regarding the thoroughness and rigor of that research program. Specifically, in SHB No. 14-024, the petitioner called a witness, James Brennan, to support its contention that the geoduck farm at issue in that case would cause unacceptable impacts to aquatic species. A large

[3] Some commenters contend a modelling study and titled: "Evaluating trophic and non-trophic effects of shellfish aquaculture in a coastal estuarine foodweb" provides evidence of such impacts. As discussed by Chris Cziesla during the hearing and as documented in Hearing Exhibits, however, this model was intended to serve as a guide for potential future areas of research "rather than a predictive tool" and "should not be used for regulatory decisions[.]" Hearing Exhibit 13 at p. 3 of 4 of Nov. 28, 2016 memorandum. *See also* Attachment 2. Commenters also mischaracterizes a federal court decision addressing a general Corps permit (Nationwide Permit 48) as evidence that the Project or Taylor Shellfish's activities more generally cause significant impacts. The decision at issue critiqued the thoroughness of the Corps' 2017 decision document that formed the foundation for issuance of that permit; it did not hold that shellfish aquaculture operations, as conditioned, in fact have significant impacts. *Coal. to Protect Puget Sound Habitat v. U.S. Army Corps. of Engineers*, 417 F. Supp. 3d 1354 (W.D. Wash. 2019).

portion of Mr. Brennan's presentation was dedicated to characterizing and critiquing the Sea Grant research program. Like the commenters here, Mr. Brennan critiqued the scale and scope of the research program and the number of species that were evaluated under it. Attachment 1, Appendix 1, pp. 73-80.[4] Mr. Brennan also argued the various statements included within the Sea Grant studies regarding the limits of the research program indicated that further studies must be performed until additional permits are issued authorizing geoduck aquaculture. Unlike the commenters here, Mr. Brennan has significant professional experience in the marine environment, and the SHB carefully considered his critiques. The SHB also considered opposing testimony from the applicants' witnesses, who argued the Sea Grant research program is robust and supports the position that geoduck aquaculture does not have unacceptable environmental impacts. *See also* Attachment 2 at 9. The SHB agreed with the applicants' witnesses, acknowledging that while the Sea Grant research program had limitations and contained recommendations for future research, it "is the most specific and relevant scientific information currently available on this subject." Hearing Exhibit 20, p. 11.

The SHB is a quasi-judicial administrative body "with specialized skills in hearing shoreline cases," and even courts are obligated to give due deference to the SHB's "specialized knowledge and expertise." *Buechel v. State Dep't of Ecology*, 125 Wn.2d 196, 204, 202-03, 884 P.2d 910, 916 (1994). Commenters on this Project are raising the same critiques regarding the Sea Grant research program that have been previously considered and rejected by the SHB. Moreover, these critiques are offered by individuals who do not have professional experience designing, undertaking, interpreting, or applying research studies in the marine environment. The expert witness offered by Taylor Shellfish, on the other hand, has extensive experience and expertise in such matters and has provided evidence that it is "extremely rare" to have a research program as specific and thorough as Sea Grant's "directly assessing potential impacts associated with the topic at hand, namely geoduck aquaculture." Attachment 2 at 9. Commenters have provided no basis for the Hearing Examiner to reject the deference owed to the SHB's evaluation of the Sea Grant research program, *Buechel*, 125 Wn.2d at 203, including the SHB's determination that this research program is the most specific and relevant to geoduck aquaculture and should be utilized when evaluating geoduck permit decisions.

Commenters also contend that earlier decisions on geoduck permit applications are irrelevant because the Project must be based on the record in this case. Hearing Exhibit 21 at 6. They also mischaracterize Thurston County staff as arguing that the Project should be approved simply because prior geoduck projects were approved or of rubber-stamping the Project's SSDP. *Id*. at 4; January 9, 2024 hearing testimony.[5] While the SHB has appropriately upheld prior SSDPs

[4] Attachment 1, Appendix 1 is excerpts of Mr. Brennan's presentation to the SHB in Case No. 14-024. This presentation was entered as Petitioner's Exhibit 135 in the case.

[5] County staff did not, as commenters claim, state that it lacked necessary information on the Project. County staff did recognize that WDFW has expertise on genetic issues, and nothing in the SMA or SMP requires the County to duplicate WDFW's analysis in this regard. County staff also correctly discussed that federal agencies carefully evaluate microplastics issues. To the extent that the County separately considers this issue, Taylor Shellfish has provided extensive information in the record demonstrating that the Project will not generate measurable amounts of

issued for geoduck aquaculture in Thurston County, SHB No. 13-006c, neither Thurston County nor Taylor Shellfish has argued the Project's SSDP should be issued simply because prior farm permits have been issued and upheld on appeal. Nor is it accurate to say that the Project is being rubber-stamped. The Project's permit application was first submitted in July 2022, and the County issued the MDNS after spending more than 13 months evaluating its anticipated environmental impacts. Hearing Exhibits 1.c, 1. Taylor Shellfish submitted extensive information in support of the SSDP application and provided thoughtful responses to public comments. Thurston County staff scheduled the hearing in this matter and prepared the staff report recommending approval of the Project's SSDP only after carefully evaluating its impacts and assessing it for compliance with the SMP and SMA. Taylor Shellfish presented extensive information at the hearing regarding the Project's operations and anticipated environmental impacts; in fact, some commenters complained that Taylor spent significant time during the hearing fully explaining the Project to Examiner Rice. Finally, Taylor Shellfish welcomed additional post-hearing comments from the public, is providing extensive responses to those comments, and has agreed to extending the typical timeline for making permit decisions to ensure the Hearing Examiner has ample time to make a well-informed and thorough decision. Claims that Taylor Shellfish has not provided sufficient evidence in the record to support its SSDP application or that the County is rubber-stamping this decision are simply not credible.

B. The Project Is Consistent with SSDP Issuance Criteria

Taylor Shellfish respectfully requests that Hearing Examiner issue the Project's SSDP pursuant to the recommended conditions of approval in the Staff Report, along with the recommended revision to condition 22 set forth above.

The Project is consistent with the SSDP issuance criteria for reasons set forth in the Staff Report and Taylor Shellfish's consistency analysis (Attachment 4). For brevity, Taylor Shellfish incorporates by reference rather than repeats these earlier analyses. The discussion below provides supplemental analysis of the Project's consistency with the SMA and the SMP in response to public comments.

<u>The Project is Consistent with the SMA.</u>

Commenters incorrectly argue the Project is inconsistent with the Policy of the SMA, with one commenter contending Thurston County is "fixated on aquaculture's preferred use status" and that this status should not be "overblown." Exhibit 21 at 5. This argument is meritless. No specific example of this alleged "fixation" or "overblown reliance" on aquaculture's specific use status is provided. Further, the legal authority offered in support of this argument is not on point. These cited cases reject the contention that private property rights should be elevated above or placed on the same footing as protection of ecological resources. *Samson v. City of Bainbridge*

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microplastics. And while commenters expressed incredulity over County staff not visiting the Project site, they provided no information demonstrating that a site visit was necessary. The Project site lacks eelgrass or protected kelp species, nor are there other sensitive habitats within the Project area that would warrant a site visit.

Island, 149 Wn. App. 33, 49 (2009) (ban on single family docks—despite "preferred" status of single family uses); *Olympic Stewardship Found. v. Growth Mgmt. Hearings Bd.*, 199 Wn. App. 668, 690 (2017). In fact, the commenter expressly misstates the holding of one of these cases, contending Samson upheld a ban on private docks "despite 'preferred' status of single family uses." Hearing Exhibit 21 at 5. In fact, the *Samson* court held private docks in the area at issue "are not a preferred use[.]" *Samson*, 149 Wash. App. at 39.

Nor is it accurate to contend that the SMA was enacted for the singular purpose of preserving the status quo or preventing further shoreline use and development. Rather, the SMA was enacted in recognition of the need "for a planned, rational, and concerted effort, jointly performed by federal, state, and local governments, to prevent the inherent harm in an uncoordinated and piecemeal development of the state's shorelines." RCW 90.58.020. Thus, "[t]he SMA does not prohibit development of the state's shorelines, but calls instead for 'coordinated planning ... recognizing and protecting private property rights consistent with the public interest.'" *Nisqually Delta Ass'n v. City of DuPont*, 103 Wn.2d 720, 726, 696 P.2d 1222 (1985) (quoting RCW 90.58.020). *See also May v. Robertson*, 153 Wn. App. 57, 92, 218 P.3d 211 (2009); *Biggers v. City of Bainbridge Island*, 162 Wn.2d 683, 697, 169 P.3d 14 (2007).

The SMA declares "[i]t is the policy of the state to provide for the management of the shorelines of the state by planning for and fostering all reasonable and appropriate uses." RCW 90.58.020. Further, while all reasonable and appropriate uses are to be fostered, the SMA identifies a subset that are preferred—those, like the Project, that "are consistent with control of pollution and prevention of damage to the natural environment, or are unique to or dependent upon use of the state's shoreline." *Id.* Accordingly, the SMA guidelines identify several general policy goals of the SMA, the first of which is: "The utilization of shorelines for economically productive uses that are particularly dependent on shoreline location or use." WAC 173-26- 176(3)(a). The guidelines expressly recognize aquaculture is a water-dependent, preferred shoreline use that is of statewide interest and, when properly managed, can result in long-term benefits and protect the resources and ecology of the shoreline. WAC 173-26-241(3)(b)(i)(A). Additionally, all shellfish beds, including commercial beds, are classified as critical saltwater habitat due to the important ecological functions they provide. WAC 173-26-221(2)(c)(iii)(A). No other type of use is specifically recognized in the guidelines as being in the statewide interest, capable of producing environmental benefits, and creating critical saltwater habitat.

Unlike the private single-family development discussed in *Sampson*, shellfish aquaculture is indisputably a preferred use, and County staff appropriately recognized as such in the Staff Report. Further, while it is not located on shorelines of statewide significance, it advances many of the priorities for such locations, including protection of the statewide interest; providing long-term benefits, and protecting the resources and ecology of the shoreline. RCW 90.5.020. As discussed above, County staff did not rubber-stamp or give a free pass to the Project; it spent well over one year carefully scrutinizing and developing conditions to the Project to ensure it would not have unacceptable impacts to the natural or built environment. Commenters' contention that the Project is inconsistent with the SMA is premised on their mistaken positions that the Project would have significant or otherwise impermissible environmental impacts, and it should be rejected on that basis.

No Net Loss

Commenters claim that the Project is subject to, and inconsistent with, a no net loss standard. One commenter contends that WAC 186-26-186 "acknowledges that the no net loss concept is embodied in the SMA." Hearing Exhibit 21 at 3. But the guideline does not state as such; it simply provides that the SMA "makes protection of the shoreline environment an essential statewide goal consistent with the other policy goals of the act." In other words, protection of the shoreline environment is one of the SMA's multiple policy goals. WAC 186-26-186 further provides that comprehensively-updated SMPs must includes policies and regulations designed to achieve no net loss of ecological functions, but neither it nor any other provision cited by the commenters states that a "no net loss" standard must be read into Thurston County's current SMP and constitute a criterion of permit issuance.

Even if a no net loss standard were to apply, the Project would satisfy it for reasons discussed at hearing and elsewhere in the record. The Project is located outside of sensitive habitat, is incorporating all conservation measures and best management practices to avoid and minimize potential adverse impacts, and it will have beneficial environmental impacts. In fact, this Project will result in the creation of a new critical saltwater habitat. WAC 173-26-221(2)(c)(iii)(A). Similar to their argument regarding SMA non-compliance, commenters' no net loss argument is premised on the factually incorrect assertion that the Project will have unacceptable adverse environmental impacts.

Shoreline Master Program

Commenters provide relatively scant argument or analysis attempting to demonstrate the Project is inconsistent with the SMP. Much of the argument that is offered in this regard addresses consistency with the County's proposed update to its SMP. *E.g.*, Hearing Exhibit 4n. Because the proposed SMP update has not even completed formal review by the Department of Ecology—let alone approval—Taylor Shellfish also will not address the Project's consistency with it here.[6]

One commenter contends that the Project is inconsistent with the policies in the SMP addressing considerations of views and aesthetics. Hearing Exhibit 4.n, p. 2. The Aquaculture policies and regulations are set forth in pages 39-43 of the SMP. Policy 5 states: "Aquacultural development should consider and minimize the detrimental impact it might have on views from upland property." SMP p. 39. The Project is consistent with this policy. The Project's geoduck tubes will only be present for a portion of the crop cycle and will not be visible for most time of the year when they are present. They will have neutral colors and be arranged in an orderly manner to minimize aesthetic impacts. Commenters fail to identify any additional measures that can or should be undertaken to further minimize aesthetic impacts.

[6] Taylor Shellfish believes that the Project is fully consistent with the proposed SMP update.

Contrary to public comments, the Project is also consistent with policy 4, which states "[a]quacultural enterprises should be operated in a manner that allows navigational access of shoreline owners and commercial traffic." SMP p. 39. See Hearing Exhibit 4.n, p. 7. The Project is located outside of commercial navigation areas, will only protrude a few inches above the substrate, and is vertically separated from neighboring shoreline owners by approximately 10 feet. It will have no adverse impact on public navigation or recreation.

C. Conclusion

State and local governments have determined that geoduck aquaculture is not only a permissible, but a preferred, use of the shoreline. The Project is located outside of sensitive habitats including submerged aquatic vegetation beds and forage fish spawning habitats, and it is following all conservation measures and best management practices to avoid and minimize potential adverse impacts to the natural environment. The Project will result in environmental benefits by improving water quality and providing structured habitat, and it will advance long-term and state-wide interests. Some residential property owners in the area oppose the Project, but they have not demonstrated that it fails to comply with the SMA or SMP. Their continued opposition to the Project does not provide a basis for denying or further conditioning the SSDP.

For the reasons set forth above and at hearing, Taylor Shellfish respectfully requests that the Hearing Examiner issue the Project's SSDP.

Sincerely,

Jesse DeNike

JGD:am
Enclosures
Cc: Client

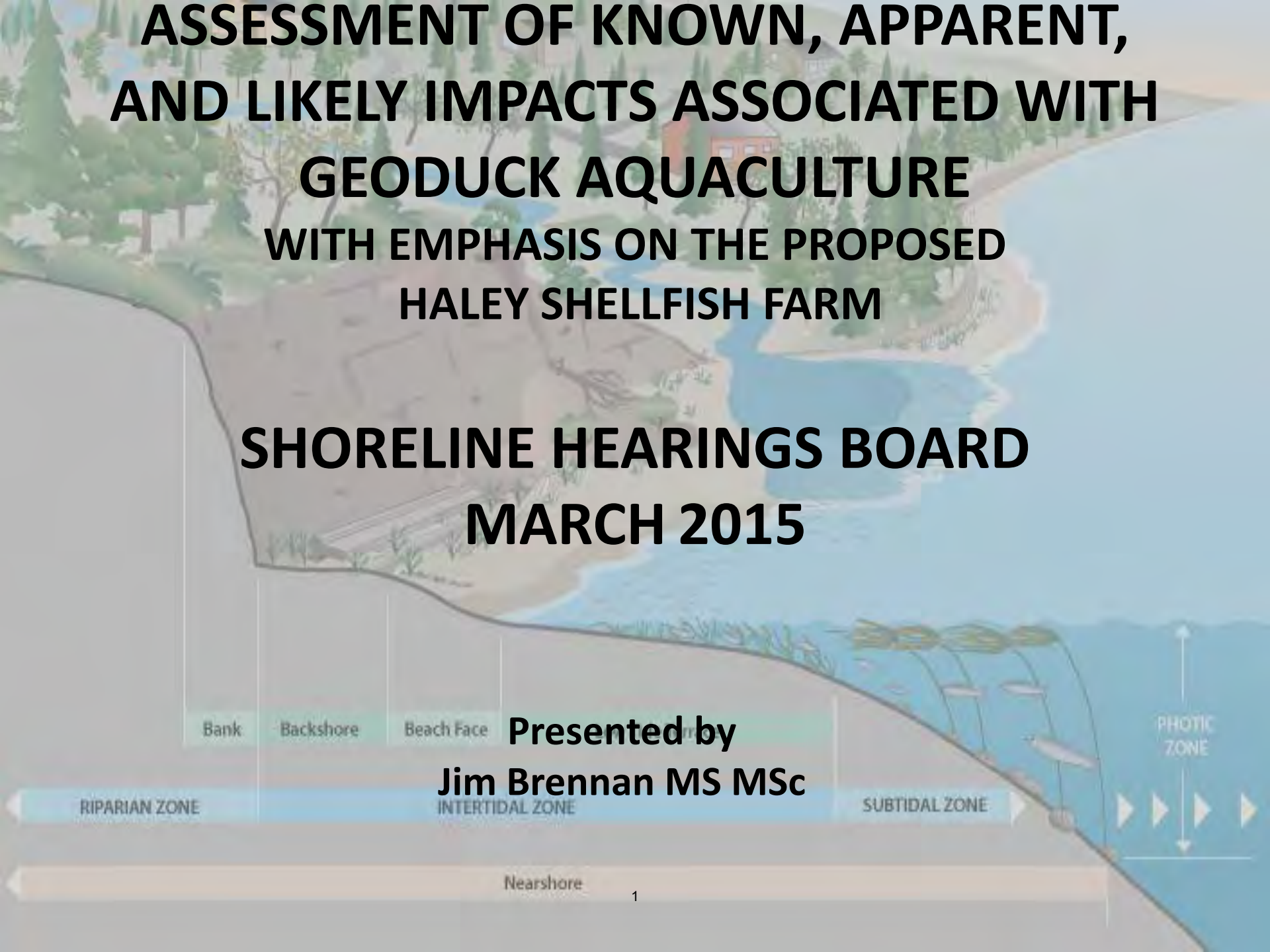
Appendix 1

ASSESSMENT OF KNOWN, APPARENT, AND LIKELY IMPACTS ASSOCIATED WITH GEODUCK AQUACULTURE

WITH EMPHASIS ON THE PROPOSED HALEY SHELLFISH FARM

SHORELINE HEARINGS BOARD MARCH 2015

Presented by
Jim Brennan MS MSc



OUTLINE PART I
BACKGROUND

- PERSONAL/PROFESSIONAL BACKGROUND
- BASICS OF NEARSHORE ECOLOGY
- REVIEW THREATS/CHALLENGES
- REVIEW PROTECTION AND RESTORATION MEASURES

BACKGROUND
Professional Qualifications

- **Education: MS MSc Moss Landing Marine Labs**
- **33 years work experience/24 yrs in Puget Sound**
- **Puget Sound Nearshore**
  - **Research**
  - **Education**
  - **Environmental Assessment**
  - **Regulatory**
  - **Policy and Management**
  - **Restoration**

BACKGROUND
Professional Qualifications

- Nearshore Technical Committees
  - KC sponsored NTC (Chair)(Local, State, Federal)
  - PSNERP NST (State, Federal)
  - SRFB TRP (State/Federal)
  - Regulatory Effectiveness TAG (State/Federal)
  - WDFW & WADNR HCP TAC (State)
  - ETAC/TAGs (Local)
  - Development, Regulatory, Restoration, Monitoring TACs
- Publications (empirical research and technical reports, guidance documents, education materials.)
- Editorial/Research Review (journals, funding) (State/Federal)
- Training/workshops (local, state, federal)

Part III
Additional Review and Comments

- **Geoduck research: What it tells us, and what it doesn't**
- **Hearing Examiner's decision**
- **Summary and Conclusions**

Harvest Impacts

Van Blaricom et al.

Results

Only modest effects on infaunal communities from harvest

Some species showed reduction in abundance

Some species showed increases, while other showed decreases in different plots at different times.

VanBlaricom et al. Caveats

- Caution that the projection of results to larger spatial or temporal scales may be inappropriate, including surface areas larger than a single plot
- Data may not provide sufficient basis for extrapolation to series of successive aquaculture cycles

Additionally, location, time period, contrasting results with other studies, sampling methods, and attributed differences leaves many gaps and questions.

PVC TUBE and NET IMPACTS

Aquaculture structures are known to cause a modification of habitat and resulting changes to the benthic sediment composition, sediment chemistry, species composition, nutrient exchange, porosity of sediments, permeability, oxygen content, bacterial content, and other effects (Simenstad and Fresh 1995; Spencer et al. 1996; Spencer et al. 1997; Goulletquer et al. 1999; Bendell-Young 2006; Dumbauld et al. 2009; Straus et al. 2011).

McDonald et al.

Tube & Net Impacts

Results:

- **A significant difference in transient fish and macroinvertebrate communities between culture and reference plots.**
- **The structured phase of geoduck aquaculture significantly impacts the abundances and composition of mobile fauna.**
- **Density of resident infauna and epifauna lower on culture plots (contrast w/VB study)**
- **Differences attributed to structure and other possible physical/chemical alterations.**
- **Recovery over time after gear removal.**

McDonald et al.
Caveats

- Not measuring all faunal changes associated with aquaculture gear –therefore not a good measure of community composition.
- Physical and chemical variables (e.g., sediment grain size, pore water nutrients) that may contribute to site-specific differences were not examined in the present study – further study needed.
- The habitat value of unstructured areas to certain taxa cannot be overstated.
- Does not account for repeated, or longer term changes (e.g., cumulative impacts)

McPeek et al.

Staghorn sculpin feeding

Results:

- **The structured phase of geoduck aquaculture initiated some changes to staghorn sculpin ecology**
- **General food web function of sculpin remained unchanged**

McPeek et al. Caveats

- It is important to note that the present study is based on data from one prevalent member of the fish community with a generalized diet. Nearshore fishes with specialized diets may experience more dramatic impacts compared to staghorn sculpin. For example, a specialist feeder seeking corophium amphipods could be more limited in aquaculture areas compared to the opportunistic staghorn sculpin.
- Results cannot be extrapolated to forecast the impacts of geoduck aquaculture operations in close proximity or repeated farming activities in the same location
- Aquaculture structures likely caused a sampling bias
- with increasing density, disturbances from geoduck aquaculture could exceed the natural disturbance regime of the system and significantly impact trophic dynamics
- structures will reduce preferred habitat and foraging efficiency of certain organisms

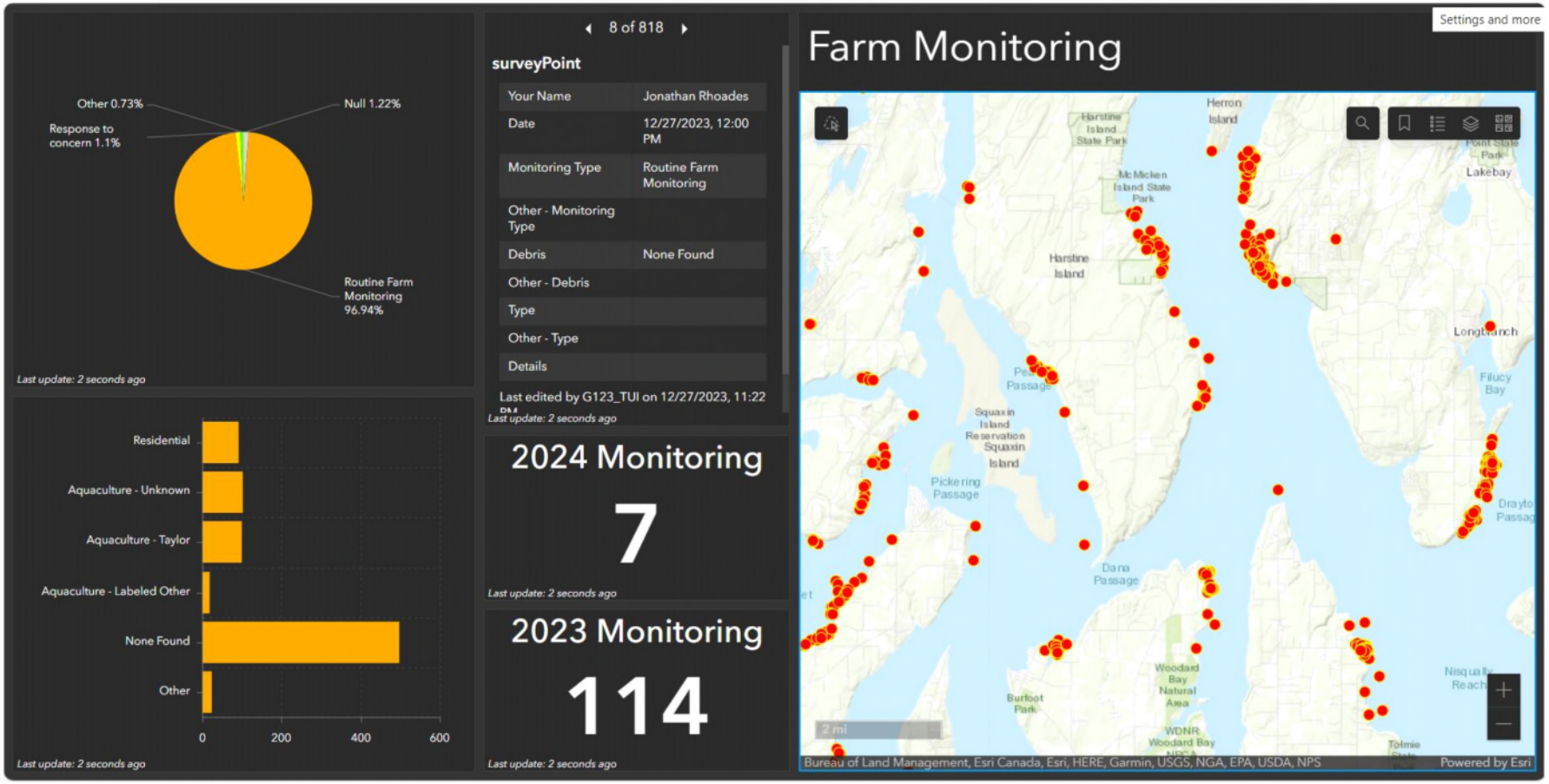
Appendix 2

Your Name	Date	Monitoring Type	Debris	Other - De	Type	Other - Type	Details	x	y
Jonathan Rhoades	1/2/2023	Routine Monitoring	NoneFound					-122.825	47.23182
Jonathan Rhoades	1/2/2023	Routine Monitoring	NoneFound					-122.795	47.29135
Jonathan Rhoades	1/8/2023	Routine Monitoring	other		Float,Nursery_Tube		Haley & Taylor/Seattle4 pieces of a float 1-4in pvc tube not marked	-122.793	47.29331
Jonathan Rhoades	1/8/2023	Routine Monitoring	NoneFound					-122.823	47.22954
Jonathan Rhoades	1/9/2023	Routine Monitoring	NoneFound					-122.839	47.15803
Jonathan Rhoades	1/3/2023	Routine Monitoring	NoneFound					-122.748	47.18559
Jonathan Rhoades	1/9/2023	Routine Monitoring	Residential		Other		Chambers Bay1/2 bag of trashBroken piece of plastic about 3ft long	-122.584	47.20034
Jonathan Rhoades	1/17/2023	Routine Monitoring	NoneFound					-122.821	47.22987
Jonathan Rhoades	1/17/2023	Routine Monitoring	NoneFound					-122.795	47.29083
Nyle	1/22/2023	Routine Monitoring	Aquculture - Unknown				4 Geoduck rubber bands	-122.809	47.36609
Nyle	1/22/2023	Routine Monitoring	Residential		Other	Oyster cage	Likely from a shellfish garden	-122.809	47.3659
Nyle	1/20/2023	Routine Monitoring	Aquculture - Taylor		Nursery_Tube		More 4” PVC coming out of the ground	-122.861	48.067
Nyle	1/18/2023	Routine Monitoring	NoneFound					-122.892	47.70161
Jonathan Rhoades	1/26/2023	Routine Monitoring	NoneFound					-122.795	47.29212
Jonathan Rhoades	1/26/2023	Routine Monitoring	NoneFound					-122.747	47.1861
Jonathan Rhoades	1/26/2023	Routine Monitoring	NoneFound					-122.821	47.22944
Jonathan Rhoades	1/26/2023	Routine Monitoring	NoneFound					-122.841	47.16164
Jonathan Rhoades	1/26/2023	Routine Monitoring	NoneFound					-122.839	47.15798
Jonathan Rhoades	1/26/2023	Routine Monitoring	Aquculture - Taylor		Residential,Nursery_Tube		1, 2in seattle nursery tube1/2 bag if trash	-122.584	47.20153
Jonathan Rhoades	1/31/2023	Routine Monitoring	Residential		Grow_/_Flip_Bag		A bundle of 10 oyster grow bags un marked	-122.822	47.23001
Jonathan Rhoades	2/1/2023	Routine Monitoring	NoneFound					-122.796	47.31972
Jonathan Rhoades	2/5/2023	Routine Monitoring	NoneFound					-122.839	47.15803
taylor brickner	2/15/2023	Routine Monitoring	Residential		Nursery_Tube		3 unmarked mesh tubes	-122.822	47.22999
taylor brickner	2/15/2023	Routine Monitoring	NoneFound					-122.747	47.1904
Jonathan Rhoades	2/16/2023	Routine Monitoring	NoneFound					-122.789	47.14468
Jonathan Rhoades	2/18/2023	Routine Monitoring	NoneFound					-122.747	47.18671
Jonathan Rhoades	2/21/2023	Routine Monitoring	Residential		Residential		1 pop bottle	-122.842	47.16165
Jonathan Rhoades	2/21/2023	Routine Monitoring	NoneFound					-122.84	47.15767
Jonathan Rhoades	2/21/2023	Routine Monitoring	Residential		Grow_/_Flip_Bag		A bundle of 15 grow bags unmarked	-122.823	47.23084
Jonathan Rhoades	2/21/2023	Routine Monitoring	NoneFound					-122.746	47.18693
Jonathan Rhoades	2/28/2023	Routine Monitoring	NoneFound					-122.748	47.18475
Jonathan Rhoades	2/28/2023	Routine Monitoring	NoneFound					-122.79	47.14433
Jonathan Rhoades	2/28/2023	Routine Monitoring	NoneFound					-122.79	47.14433
Jonathan Rhoades	3/13/2023	Routine Monitoring	Residential		Other	1/3 of a 5gal bucket of trash		-122.584	47.2029
Jonathan Rhoades	3/13/2023	Routine Monitoring	NoneFound					-122.748	47.18443
Jonathan Rhoades	3/13/2023	Routine Monitoring	Aquaculture - Taylor		Nursery_Tube,Other		5 tubes markes TSF17- 2in tunes marked SSLLC2ft of styrofoam10foot of PVC	-122.824	47.23036
Jonathan Rhoades	3/14/2023	Routine Monitoring	NoneFound					-122.794	47.29304
Jonathan Rhoades	3/14/2023	Routine Monitoring	NoneFound					-122.794	47.29304
Jonathan Rhoades	3/17/2023	Routine Monitoring	Residential		Nursery_Tube		1- 4in pvc unmarked	-122.789	47.14479
Jonathan Rhoades	3/24/2023	Routine Monitoring	Residential		Nursery_Tube		7/ 4in pvc nursery tubes unmarked	-122.79	47.14489
Jonathan Rhoades	3/26/2023	Routine Monitoring	NoneFound					-122.79	47.14493
Jonathan Rhoades	3/28/2023	Routine Monitoring	Residential		Residential,Nursery_Tube		4 tubes 6in taylors7tubes 6in unmarked1 tube 2in ssllc5gal bucket of trash	-122.793	47.2931
Jonathan Rhoades	3/28/2023	Routine Monitoring	NoneFound					-122.825	47.23319
Jonathan Rhoades	3/28/2023	Routine Monitoring	NoneFound					-122.84	47.25652
Jonathan Rhoades	4/6/2023	Routine Monitoring	Residential		Residential		3- 5gal buckets of trash.	-122.584	47.20093
Jonathan Rhoades	4/6/2023	Routine Monitoring	NoneFound					-122.822	47.2283

Erin	4/9/2023	other	Residential			Tennis ball, styrofoam	-122.582	47.19401
Erin	4/9/2023	other	Residential	Nursery_Tube,Other	Plastic bags, bottles, styro	1 mesh tube	-122.581	47.20488
Nyle	4/10/2023	Routine Monitoring	Aquculture - Unknowr	Grow_/_Flip_Bag		1 empty bag	-122.636	47.39287
Jonathan Rhoades	4/14/2023	Routine Monitoring	NoneFound				-122.79	47.14452
Jonathan Rhoades	4/22/2023	Routine Monitoring	NoneFound				-122.79	47.14524
Jonathan Rhoades	4/24/2023	Routine Monitoring	Labeled - Other	Nursery_Tube		3- 6in taylor tubes5- 2in unmarked pvc tubes	-122.79	47.1453
Jonathan Rhoades	4/25/2023	Routine Monitoring	NoneFound				-122.823	47.22994
Jonathan Rhoades	4/25/2023	Routine Monitoring	NoneFound				-122.8	47.28917
Jonathan Rhoades	5/4/2023	Routine Monitoring	other	Nursery_Tube,Other,Float,Residential		10 tubes1 bullet float6ft of rope1/2 buck residential trash	-122.825	47.23338
Jonathan Rhoades	5/4/2023	Routine Monitoring	other	Nursery_Tube,Other,Float,Residential		10 tubes1 bullet float6ft of rope1/2 buck residential trash	-122.825	47.23338
Nels Whipple	5/11/2023	Routine Monitoring	Aquculture - Unknowr	Nursery_Tube		5 mesh tubes	-122.868	48.07123
Jonathan Rhoades	5/20/2023	Routine Monitoring	NoneFound				-122.794	47.29347
Jonathan Rhoades	5/24/2023	Routine Monitoring	NoneFound				-122.821	47.22853
Jonathan Rhoades	6/1/2023	Routine Monitoring	NoneFound				-122.821	47.22868
Nyle	6/5/2023	Routine Monitoring	NoneFound				-123.917	46.69087
Nyle	6/4/2023	Routine Monitoring	NoneFound				-122.84	47.15795
Nyle	6/4/2023	Routine Monitoring	NoneFound				-122.789	47.14454
Nyle	6/4/2023	Routine Monitoring	NoneFound				-122.794	47.29318
Nyle	6/2/2023	Routine Monitoring	NoneFound				-123.012	47.07361
Nyle	6/6/2023	Routine Monitoring	NoneFound				-122.795	47.32002
Nyle	6/6/2023	Routine Monitoring	Aquculture - Unknowr	Other	Rebar	3 pieces	-122.856	47.22953
Erin	6/7/2023	Routine Monitoring	Aquculture - Unknowr	Nursery_Tube		26 Taylor mesh geoduck50 Seattle shellfish tubes3 unmarked grow bags1 crab ba	-122.638	48.30715
Nyle	6/7/2023	Routine Monitoring	Aquculture - Unknowr	Other	Geoduck rubber band	1	-122.817	47.37172
Jonathan Rhoades	6/7/2023	Routine Monitoring	NoneFound				-122.821	47.22865
Rebecca	6/8/2023	Routine Monitoring	Aquculture - Unknowr	Nursery_Tube		PVC tube	-122.963	47.15524
Nyle	6/14/2023	Routine Monitoring	NoneFound				-123.037	47.25309
Jonathan Rhoades	6/16/2023	Routine Monitoring	Aquculture - Taylor	Grow_/_Flip_Bag,Nursery_Tube		1- 6in tube 2-6in tubes1- oyster grow bagAll marked Seattle Shelfifh	-122.794	47.29492
Jonathan Rhoades	6/16/2023	Routine Monitoring	Residential	Net,Grow_/_Flip_Bag,Nursery_Tube,Clam_Gear,Other,R		2-pop bottles3-6in tubes marked Seattle Shellfish2-2in tubes marked Seattle Shel	-122.794	47.29382
taylor brickner	6/27/2023	Routine Monitoring	NoneFound				-122.84	47.15808
taylor brickner	6/27/2023	Routine Monitoring	Residential	Other	paint can		-122.842	47.16197
taylor brickner	6/27/2023	Routine Monitoring	Residential	Other	styrofoam, plastic tote		-122.796	47.31937
taylor brickner	6/27/2023	Routine Monitoring	Residential	Other,Nursery_Tube,Resic	1 mesh tube marked tsm. plastic bag		-122.794	47.29344
taylor bricknee	6/27/2023	Routine Monitoring	Residential	Nursery_Tube,Other		3 llc marked tubes, plastic deck panel, plastic bag	-122.825	47.22989
taylpr brickner	6/27/2023	Routine Monitoring	Aquculture - Unknowr	Nursery_Tube		3 umarked mesh tubes	-122.79	47.1445
Rebecca	7/3/2023	Routine Monitoring	Aquculture - Unknowr	Nursery_Tube,Other	Vexar	Residential debris, 2 rigid mesh tubes, one vexar tube	-122.857	48.06277
Taylor brickner	7/8/2023	Routine Monitoring	NoneFound				-122.789	47.14465
Taylor brickner	7/8/2023	Routine Monitoring	NoneFound				-122.823	47.23027
Jonathan Rhoades	7/19/2023	Routine Monitoring	NoneFound				-122.826	47.23385
Jonathan Rhoades	7/19/2023	Routine Monitoring	NoneFound				-122.826	47.23385
Jonathan Rhoades	7/27/2023	Routine Monitoring	NoneFound				-122.841	47.16171
Jonathan Rhoades	7/27/2023	Routine Monitoring	NoneFound				-122.839	47.15815
Jonathan Rhoades	8/3/2023	Routine Monitoring	other	Grow_/_Flip_Bag,Nursery_Tube,Residential		2 oyster grow bags bot marked6/ 2in mesh tubes marked sslcSome residentail tr	-122.793	47.2953
Jonathan Rhoades	7/27/2023	Routine Monitoring	NoneFound				-122.823	47.22961
Jonathan Rhoades	7/30/2023	Routine Monitoring	NoneFound				-122.826	47.23389
Allen	8/5/2023	Routine Monitoring	NoneFound				-122.801	47.29194
Allen	8/5/2023	Routine Monitoring	NoneFound				-122.828	47.23555
Allen	8/5/2023	Routine Monitoring	NoneFound				-122.841	47.16107

Allen	8/10/2023	Routine Monitoring	NoneFound			-122.789	47.14466
Allen	8/10/2023	Routine Monitoring	NoneFound			-122.746	47.1842
Jonathan Rhoades	8/12/2023	Routine Monitoring	NoneFound			-122.839	47.15789
Jonathan Rhoades	8/30/2023	Routine Monitoring	NoneFound			-122.84	47.15812
Jonathan Rhoades	9/22/2023	Routine Monitoring	NoneFound			-122.821	47.22906
Jonathan Rhoades	9/25/2023	Routine Monitoring	NoneFound			-122.821	47.22873
Jonathan Rhoades	9/28/2023	Routine Monitoring	NoneFound			-122.822	47.22907
Jonathan Rhoades	10/3/2023	Routine Monitoring	NoneFound			-122.822	47.22878
Jonathan Rhoades	10/6/2023	Routine Monitoring	NoneFound			-122.842	47.16172
Jonathan Rhoades	10/15/2023	Routine Monitoring	NoneFound			-122.789	47.14453
Jonathan Rhoades	10/15/2023	Routine Monitoring	NoneFound			-122.746	47.18574
Jonathan Rhoades	10/21/2023	Routine Monitoring	NoneFound			-122.789	47.14453
Jonathan Rhoades	10/21/2023	Routine Monitoring	NoneFound			-122.789	47.14453
Nels Whipple	10/12/2023	Response	Aquaculture - Other	Nursery_Tube	7 Taylor 6” tubes3 unknown grower tubes19 TMS 2.5” tubes15 Seattle 2.5” tubes	-122.787	47.34333
Jonathan Rhoades	11/2/2023	Routine Monitoring	NoneFound			-122.788	47.14432
Jonathan Rhoades	11/12/2023	Routine Monitoring	NoneFound			-122.789	47.14397
Jonathan Rhoades	11/18/2023	Routine Monitoring	NoneFound			-122.823	47.22968
Jonathan Rhoades	11/25/2023	Routine Monitoring	NoneFound			-122.823	47.22966
Jonathan Rhoades	12/27/2023	Routine Monitoring	NoneFound			-122.824	47.23065
Taylor brickner	1/10/2024	Routine Monitoring	Residential	Residential,Other	Plastic bottle, 4 unmarked plastic mesh tubes.	-122.827	47.23998
Jonathan Rhoades	1/12/2024	Routine Monitoring	NoneFound			-122.795	47.29283
Jonathan Rhoades	1/11/2024	Routine Monitoring	Labeled-Other	Other		-122.746	47.18645
Jonathan Rhoades	1/14/2024	Routine Monitoring	other	Residential,Nursery_Tube,Clam_Gear	1 shopping bag of residential trash 5 -6in mess tubes taylors3 -6in mess tubes uni	-122.819	47.22676
Jonathan Rhoades	1/15/2024	Routine Monitoring	NoneFound			-122.841	47.16116
Jonathan Rhoades	1/15/2024	Routine Monitoring	NoneFound			-122.79	47.14416

Appendix 3


Other 0.73%
Null 1.22%
Response to concern 1.1%
Routine Farm Monitoring 96.94%
Last update: 2 seconds ago
Residential
Aquaculture - Unknown
Aquaculture - Taylor
Aquaculture - Labeled Other
None Found
Other
0
200
400
600
Last update: 2 seconds ago
8 of 818
surveyPoint
Your Name
Jonathan Rhoades
Date
12/27/2023, 12:00 PM
Monitoring Type
Routine Farm Monitoring
Other - Monitoring Type
Debris
None Found
Other - Debris
Type
Other - Type
Details
Last edited by G123_TUI on 12/27/2023, 11:22
Last update: 2 seconds ago
2024 Monitoring
7
Last update: 2 seconds ago
2023 Monitoring
114
Last update: 2 seconds ago
Settings and more
Farm Monitoring
Herron Island
Harstine Island State Park
McMicken Island State Park
Lakebay
Harstine Island
Longbranch
Filucy Bay
Squaxin Island Reservation Squaxin Island
Pickering Passage
Dana Passage
Woodard Bay Natural Area
Burfoot Park
WDNR Woodard Bay
2 mi
Bureau of Land Management, Esri Canada, Esri, HERE, Garmin, USGS, NGA, EPA, USDA, NPS
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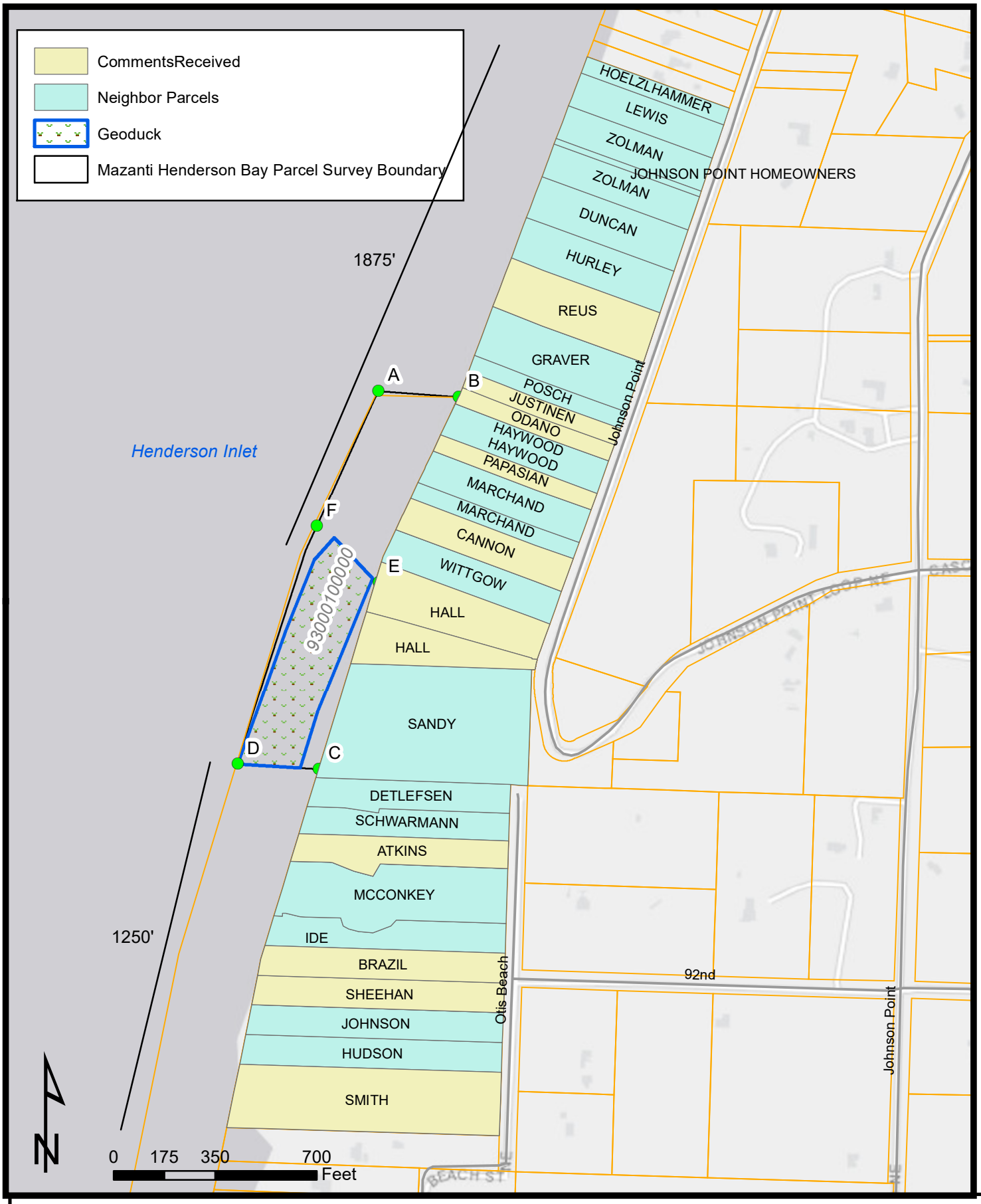
Appendix 4



Document Path: M:\Working\Erin_Working\Map_Projects\Mazanti\Mazanti_Henderson_Neighbors.mxd

PROPOSED PROJECT: Mazanti Tidelands
IN: Henderson Inlet
Near/At: Olympia
County: Thurston
State: WA

Map Created 1/18/2024

Appendix 5

LEA ENNIS
Court Administrator/Clerk

The Court of Appeals
of the
State of Washington

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July 29, 2022

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Case #: 839021
Friends of Guemes Island Shorelines, Petitioner v. Kevin Duncan, Respondent
Skagit County Superior Court No. 21-2-00234-9

Counsel:

The following notation ruling by Commissioner Jennifer Koh of the Court was entered on July 29, 2022 regarding Petitioner's Motion for Discretionary Review:

> The superior court certified a motion for discretionary review under RAP 2.3(b)(4) after it partially denied defendant Kevin Duncan's summary judgment motion and denied the summary judgment motion of plaintiff Friends of Guemes Island Shorelines (FOGIS). FOGIS supports review under that rule and requests review under RAP 2.3(b)(1) and (2) as well. Duncan argues review is not warranted under any rule. For the reasons described below, discretionary review is denied.
>
> In August of 2018, Duncan purchased two adjacent parcels on Guemes Island. One parcel contains his house and road access, and it extends to the ordinary high-water mark (OHWM). The other parcel stretches from the OHWM down to Bellingham Channel and includes second-class tidelands. Guemes Island residents have a history of walking the tidelands around the island, including on Duncan's land.
>
> In 2020, Duncan posted "No Trespassing" signs and began telling walkers to not cross his land. These interactions sometimes became acrimonious.
>
> In April of 2021, some island residents formed FOGIS. They filed a complaint against Duncan, seeking a declaratory judgment that states walkers are allowed to enter his land below the OHWM and an injunction requiring the same.

The parties filed cross-motions for summary judgment. FOGIS argued that both the doctrine of customary use and the public trust doctrine prohibited Duncan from barring walkers from entering his land below the OHWM. Duncan argued that Washington had not adopted the doctrine of customary use and that the public trust doctrine did not extend to the public's ability to access tidelands when the tide was out. Duncan also contended that dozens of declarations and other evidence supporting the custom argument contained inadmissible hearsay.

The superior court granted Duncan's motion in part, denied FOGIS's motion, and declined to rule on the evidentiary objections. The court explained summary judgment was inappropriate on the custom claim because "there's factual issues that I can't resolve under the record as I've seen it," including the reliability of evidence submitted in support of the claim. Despite concluding these issues "need to be resolved at trial, with the judge to hear testimony from witnesses," the court also certified questions for discretionary review under RAP 2.3(b)(4): "the scope and application of the public trust doctrine in Washington, the common law of custom in Washington, and ER 803(a)(20)." The court did not elaborate further on the nature of the questions.

"Interlocutory review is disfavored." Minehart v. Morning Star Boys Ranch, Inc., 156 Wn. App. 457, 462, 232 P.3d 591 (2010). "It is not the function of an appellate court to inject itself into the middle of a lawsuit and undertake to direct the trial judge in the conduct of the case." Maybury v. City of Seattle, 53 Wn.2d 716, 720, 336 P.2d 878 (1959). An appellate court does not find its own facts, Minehart, 156 Wn. App. at 462, and credibility determinations "are peculiarly matters for the trier of fact and may not be second-guessed by an appellate court," id. at 464 (citing Thorndike v. Hesperian Orchards, Inc., 54 Wn.2d 570, 572, 575, 343 P.2d 183 (1959); Quinn v. Cherry Lane Auto Plaza, Inc., 153 Wn. App. 710, 717, 225 P.3d 266 (2009)). Accordingly, the typical function of an appellate court is to review "rulings for legal error and consider [ ] the harm of the alleged error in the context of its impact on the entire trial." Id. at 462.

I. Review under RAP 2.3(b)(4)

Under RAP 2.3(b)(4), this Court may accept review when a superior court certifies that its order "involves a controlling question of law as to which there is substantial ground for a difference of opinion and that immediate review of the order may materially advance the ultimate termination of the litigation." The superior court's certification is not binding on this Court.

A. Public Interest Doctrine

FOGIS contends this Court should accept review to consider "the scope and application of the public trust doctrine" and determine whether it includes walking across second class tidelands when the tide is out. Duncan argues there is not a substantial ground for a difference of opinion on this issue, citing to Wilbour v. Gallagher, 77 Wn.2d 306, 462 P.2d 232 (1969), as "settled precedent."

In Wilbour, the Washington Supreme Court considered whether the public trust doctrine barred a private landowner from blocking public access by preventing navigable waters from covering their land. Id. at 315-16. The levels of Lake Chelan

fluctuated depending upon the release of water from a dam. Id. at 309. For approximately three months of each year, the water level was higher and covered part of the Gallaghers' land. Id. at 307, 309. The Gallaghers began pouring fill on those parts of their land to prevent them from being covered by the rising waters. Id. at 309. To evaluate whether the public trust doctrine barred the Gallaghers from pouring fill and blocking public access, the court analogized to naturally fluctuating bodies of water. Id. at 314-16. As the owner of "periodically submerged" land, they had "the right to prevent any trespass on their land between the high and low marks when not submerged." Id. at 315. But their right was "qualified by the public right of navigation and the state may prevent any use of it that interferes with that right." Id. (citing Stewart v. Turney, 237 N.Y. 117, 142 N.E. 437 (1923)). Accordingly, the court held that the Gallaghers were prohibited from pouring fill because, when their land was submerged, it was "subjected to the rights of navigation, together with its incidental rights of fishing, boating, swimming, water skiing, and other related recreational purposes generally regarded as corollary." Id. at 316 (citing Nelson v. DeLong, 213 Minn. 425, 7 N.W.2d 342 (1942)). But "[w]hen the level of the lake is lowered so that the [Gallaghers'] land is no longer submerged, then they are entitled to keep trespassers off their land." Id. at 316.

FOGIS argues two later cases, Orion Corp. v. State, 109 Wn.2d 621, 747 P.2d 1062 (1987), rev'd in part on other grounds by Yim v. City of Seattle, 194 Wn.2d 682, 451 P.3d 694 (2019), and Caminiti v. Boyle, 107 Wn.2d 662, 732 P.2d 989 (1987), extended the scope of the doctrine such that walking across dry tidelands is within its scope. But, this argument fails to account for our Supreme Court's recent affirmation Wilbour in Chelan Basin Conservancy v. GBI Holding Co. where it relied solely upon Wilbour's reasoning to evaluate a public trust doctrine claim. 190 Wn.2d 249, 261, 413 P.3d 549 (2018). The court explained "the competing rights and interests of the public and private owner rise and fall with the water," id., so "'the rights of the public decrease and the rights of the landowners increase as the waters drain off their land . . . giving them the right to exclusive possession until their lands are again submerged,'" id. (quoting Wilbour, 77 Wn.2d at 315). Thus, contrary to FOGIS's argument, Washington courts hold that the scope of the public trust doctrine is defined by the presence or absence of water. Because Chelan Basin and Wilbour appear to control the question of whether an owner of occasionally submerged land has the right to prevent trespassing when the land is dry, I am not persuaded that there is a "substantial ground for a difference of opinion" on this issue. While I acknowledge the trial court's decision to certify, I am not persuaded review of this issue is warranted under RAP 2.3(b)(4).

B. Customary Use Doctrine

FOGIS contends review is necessary to determine, first, whether the customary use doctrine is part of Washington common law; second, how the doctrine is applied; and, third, whether, as a matter of law, FOGIS is entitled to summary judgment on the basis of customary use.

FOGIS relies heavily on an early Washington Supreme Court decision, Isaacs v. Barber, 10 Wash. 124, 38 P. 871 (1894), and on a territorial Supreme Court decision, Tenem Ditch Co. v. Thorpe, 1 Wash. 566, 20 P. 588 (1889), to argue that Washington has adopted the customary use doctrine generally and applied it without regard to

whether the custom is "ancient." Both cases relied, at least in part, upon customary use to determine a party's right to appropriate groundwater. Isaacs, 10 Wash. at 129-30; Tenem Ditch, 1 Wash. at 568-69. These cases and others relying upon them, e.g., Longmire v. Smith, 26 Wash. 439, 447, 67 P. 246 (1901) (citing Tenem Ditch to evaluate a dispute about groundwater use), demonstrate that Washington has not rejected the customary use doctrine entirely. They do not stand for the proposition, however, that Washington has adopted the doctrine broadly. Indeed, Marincovich v. Tarabochia, 114 Wn.2d 271, 787 P.2d 562 (1990), makes clear that the doctrine's application is limited.

In Marincovich, one group of commercial gillnet fishermen who fished the Columbia River sought an injunction against another such group to prevent them from fishing in certain areas. 114 Wn.2d at 273. The plaintiff fishermen argued customary use was a basis of their right to exclude the defendants and cited both Isaacs and Tenem Ditch for support. Id. at 274, 275. The Supreme Court rejected this argument, explaining "the appropriated use of water is not analogous to the recognition of drift rights for fishing." Id. at 275. It also rejected plaintiffs' reliance upon "customary water appropriation principles" stated in Isaacs and Tenem Ditch. Id.

Here, FOGIS analogizes recreational walking to water appropriation, two activities even more distinct than fishing and water appropriation. Although Marincovich does not expressly reject extension of the customary use doctrine beyond riparian rights, its holding weighs heavily against such an extension. Thus, while there are some grounds for a difference of opinion about application of the doctrine to the instant conflict, those grounds do not appear substantial in light of Marincovich. As Marincovich is binding on this Court, I am not persuaded that advisory opinions of the Office of the Attorney General provide substantial grounds either. Because FOGIS fails to explain why "substantial ground for a difference of opinion" exists about the application of the customary use doctrine, review is not warranted under RAP 2.3(b)(4).

Moreover, granting review at this point in the proceedings is not consistent with this Court's approach to RAP 2.3(b)(4) certifications. To warrant certification for interlocutory review, a party should present a purely legal question that does not require the appellate court to delve into the record to determine the facts or to evaluate alternatives based on disputed factual questions. The superior court denied summary judgment on the basis of customary use because of unresolved factual issues, including a critical credibility determination. Thus, accepting review would not "materially advance the ultimate termination of the litigation," RAP 2.3(b)(4), unless this court wholly rejected FOGIS's position as a matter of law. If FOGIS prevailed, however, then additional pretrial evidentiary proceedings and a full trial would both be required to resolve factual and credibility disputes. Under these circumstances, I am not persuaded that review is warranted under RAP 2.3(b)(4).

C. Hearsay

FOGIS contends review is required to determine the meaning of "customs" in hearsay exception ER 803(a)(20). Duncan argues review would be premature.

Hearsay is generally prohibited except as permitted. State v. Kelly, 19 Wn. App. 2d 434, 448, 496 P.3d 1222 (2021) (citing ER 802). Many witness statements are not hearsay. See, e.g., id. ("a nonassertive statement does not constitute hearsay") (citing State v. Modest, 88 Wn. App. 239, 249, 944 P.2d 417 (1997); State v. Collins, 76 Wn. App. 496, 498-99, 886 P.2d 243 (1995)). Thus, a court must first decide whether a statement is hearsay before considering whether an exception applies. State v. Powell, 126 Wn.2d 244, 265-66, 893 P.2d 615 (1995).

Despite ruling on FOGIS's summary judgment motion, the superior court declined to rule on Duncan's hearsay objections, including the threshold determination of whether the objectionable statements were hearsay. (I note that a "court cannot consider inadmissible evidence when ruling on a motion for summary judgment." Davis v. Fred's Appliance, Inc., 171 Wn. App. 348, 357, 287 P.3d 51 (2012) (citing Charbonneau v. Wilbur Ellis Co., 9 Wn. App. 474, 512 P.2d 1126 (1173)). This too weighs against accepting review because it would require this court to rule on basic evidentiary issues before the trial court has done so.) Whether a statement is hearsay is well-settled and does not allow for a "substantial ground for a difference of opinion." RAP 2.3(b)(4). And because a ruling on ER 803(a)(20) would still require the superior court's threshold determinations, accepting review would not "materially advance the ultimate termination of the litigation." Review is not warranted on this question.

II. Review under RAP 2.3(b)(1) and (2)

FOGIS seeks discretionary review of the evidentiary and customary use doctrine issues under RAP 2.3(b)(1) and (2). It does not seek review of the grant of summary judgment on the public trust doctrine.

Discretionary review may be granted under RAP 2.3(b)(1) if the trial court committed "obvious error which would render further proceedings useless." RAP 2.3(b)(2) requires a showing of "probable error" in a trial court decision that "substantially alters the status quo or substantially limits the freedom of a party to act."

FOGIS fails to satisfy the effects prong of either rule. First, further proceedings are required on the customary use issue to resolve disputed issues of material fact and to make basic evidentiary rulings. Because further proceedings are not useless, review is not warranted under RAP 2.3(b)(1). Second, FOGIS fails to show the trial court's ruling limited the freedom of a party to act or substantially changed the status quo. To do so, "RAP 2.3(b)(2) necessarily requires an immediate effect outside the courtroom." In re Dep. of N.G., -- Wn. 2d. --, 510 P.3d 335, 340 (2022). Although FOGIS asserts the effect prong of RAP 2.3(b)(2) is satisfied because the ruling "allow[s] Duncan to continue intimidating people from exercising their long-cherished rights," as this assertion recognizes, this is a continuation of behavior that predated and prompted this litigation. In sum, because FOGIS fails to satisfy the effect prong of either RAP 2.3(b)(1) or (2), review is not warranted under either rule.

In sum, I am not persuaded that review is appropriate at this stage of the proceedings under RAP 2.3(b)(1)(2) or (4); the motion for discretionary review is denied.

In the event counsel wishes to object, RAP 17.7 provides for review of a ruling of the Commissioner. Please note that a "motion to modify the ruling must be served . . . and filed in the appellate court not later than 30 days after the ruling is filed."

Sincerely,

Lea Ennis
Court Administrator/Clerk

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Attachment 1

Project No.: 2022103702: Applicant Taylor Shellfish Farms' Response to Public Comments In Record		
Comment	Commenter(s)	Response
The Proposal may adversely impact benthic organisms living within the sediment due to harvest activities.	[PHI 3/21/23, 5/30/23, 7/24/23, 7/27/2023], [Ron Smith/PHI 12/5/22], [Tonni Johnson, undated], [Gerald & Janet Sheehan 1/7/24], [FOBL 1/8/24], [Janell McCleary 1/7/24], [Betsy Norton 1/8/24], [PHI 1/8/24], [Ron Smith/PHI 1/12/24]	Taylor Shellfish will fully comply with the Programmatic Consultation, which thoroughly analyzes potential impacts due to harvest activities. Washington Sea Grant and other independent researchers have conducted rigorous studies on impacts to benthic organisms, substrate disturbance and water quality. These studies have been reviewed and supported by third party scientists and repeatedly accepted by decision makers, including the Shoreline Hearings Board as discussed in Hearing Attachment M response to comments Section A, p1. Some commenters have questioned the thoroughness and accuracy of the Washington Sea Grant geoduck research program, but as discussed in Attachment 2 to this response, that research program carefully analyzed the impacts associated with geoduck grow-out and harvest operations. It provides reliable information for decisionmakers, and commenters' criticisms of it are misguided. Commenters also provide no affirmative information or evidence demonstrating that geoduck aquaculture activities would significantly impact benthic organisms.
The Proposal may adversely affect seagrass, including protected eelgrass due to planting and harvest techniques.	[PHI 3/21/23, 7/24/23, 7/27/2023], [Janell McCleary 1/7/24], [Marta Allen 1/12/24], [Ron Smith/PHI 1/12/24]	The proposal area does not support any protected eelgrass (Zostera marina), within the project footprint. The absence of eelgrass is documented by WA DNR on their survey maps, which reference the area from 2003 through 2020. The closest eelgrass is located 2.9 miles north from the Proposal and just south from Joemma Beach State Park. Eelgrass restoration plot experiments began there in 2013, and restoration plantings followed in 2015 and 2016. No reports found have indicated that this planted eelgrass has led to recruitment on any nearby location. Floating brown kelp, from the order Laminariales is also not observed to be present on WA DNR seagrass maps. Additionally, Taylor Shellfish crews are trained to observe site conditions during planting activities and will comply with the proposed restriction against planting within 16' horizontal feet of protected eelgrass or kelp upon farm installation. Given no planting will occur within or near protected eelgrass or kelp species, no impact to these species is expected to occur.
The Proposal may adversely impact native geoduck stocks through genetic influence, parasites, or disease.	[PHI 5/30/23, 7/24/23, 7/27/2023], [Ron Smith/PHI 12/5/22], [Ron Smith & Deb Hall 12/2/22], [Gerald & Janet Sheehan 1/7/24], [FOBL	WDFW is the regulating agency tasked with protecting existing natural stocks through their transfer permit program. Through this process, WDFW reviews health certificates, hatchery management and spawning protocol. The Transfer Permit issued by WDFW for Taylor Shellfish's geoduck seed movement (permit # 24-1004) states: *"WDFW has reviewed and approves of Taylor Shellfish Hatchery Geoduck BMPs to reduce genetic*

	1/8/24], [PHI 1/8/24], [Ron Smith/PHI 1/12/24]	*risk to wild stocks. Collection and use of geoduck broodstock and Olympia oyster broodstock will follow the procedures designed to reduce genetic risk to wild stocks provided by Taylor Shellfish to WDFW on 11/08/23 ("Taylor Shellfish Hatchery Geoduck BMPs" and Taylor Olympia Oyster Hatchery Protocol)."* Commenters provide no information demonstrating that WDFW's regulation of Taylor's hatchery management and spawning protocols is in any way inadequate to protect against potential adverse impacts through genetic influence, parasites, or disease.
The Proposal may adversely impact fish, birds, marine mammals, and other wildlife, along with supporting habitat, and reduce food for other animals.	[PHI 3/21/23, 7/24/23, 7/27/2023], [Ron Smith/PHI 12/5/22], [Laura Hendricks 12/5/22], [Holly Hulst 12/4/22], [Pyke Johnson 12/4/22], [Ron Smith & Deb Hall 12/2/22], [Tristan Atkins 12/1/22], [Pyke Johnson 1/7/24], [FOBL 1/8/24], [Sam Smith 1/8/24], [PHI 1/8/24], [Ron Smith/PHI 1/12/24]	Taylor Shellfish will operate this Proposal in compliance with the Programmatic Endangered Species Act and Essential Fish Habitat consultation for shellfish farming activities in Washington State inland marine waters ("Programmatic Consultation"). The Programmatic Consultation includes over 30 conditions to ensure projects do not have unacceptable impacts to ESA-listed species, designated critical habitat, and essential fish habitat. Hearing Exhibit 2 & 3.
The existing protections in the County SMP are outdated and unfairly favor new geoduck applications.	[Mark Butcher & Pam Meyer 1/7/24], [Darcy Eggeman 1/8/24], [George Johnston 1/8/24]	Both the existing and Draft SMP recently adopted by the County, contain language allowing geoduck aquaculture in the Conservancy shoreline designation through the shoreline permit process. The draft SMP also acknowledges that aquaculture is a preferred, water dependent use and statewide interest. When properly managed, it can result in long-term over short-term benefit, and can protect the resources and ecology of the shoreline.
The Proposal includes use of new type of tube which was not included in the application.	[Michael Mason 1/10/24], [Pyke Johnson 1/12/24]	The Proposal will use a nursery tube formed from the same HDPE material as used by multiple growers for over a decade in rigid nursery tubes and grow bags. This flexible HDPE is also used by aquaculture for other purposes, including clam and cultch bags, which have been used for several decades, are subject to more sunlight and exposure, and have been observed to maintain their integrity for over 10 years. The nursery gear and benefits are more fully reviewed in Hearing Exhibit 12.
The Proposal will attract sea lions.	[Pyke Johnson 1/12/24], [Shelley Gaske 1/12/24], [George Johnston 1/12/24]	While the commentors provide no references on their claims that sea lions are attracted to cultivated shellfish, marine mammal populations, including sea lions, as reported by University of Washington Eyes over Puget Sound 9/20/23 article, are seeing dramatic

		increases in numbers. Sea lions are opportunistic hunters. While they may prey occasionally on geoduck, Taylor Shellfish has not experienced any significant mortality due to their presence on the shoreline.
The Proposal relies on incomplete and inadequate SeaGrant Research for its conclusions and an insufficient review of species impacts.	[PHI 7/20/23, 7/24/23, 7/27/2023], [Tristan Atkins 12/1/22], [William Reus 1/3/24], [William Reus 1/3/24], [Gerald & Janet Sheehan 1/7/24], [Mark Butcher & Pam Meyer 1/7/24], [Sam Smith 1/8/24], [PHI 1/8/24], [Cynthia Sheller 1/12/24], [Ron Smith/PHI 1/12/24]	For reasons discussed in Attachment 2 to Taylor's Shellfish's January 22, 2024 closing argument, the Washington Sea Grant geoduck research program carefully analyzed the impacts associated with geoduck grow-out and harvest operations. It provides reliable information for decisionmakers, and commenters' criticisms of it are misguided. As also discussed in Attachment 2, commentors criticisms have been previously analyzed and rejected by decisionmakers, including the SHB (see also Exhibit 20, pgs. 10-11; Appendix 1).
Additional research contradicting current methodology and research into negative impacts of geoduck aquaculture is prevented by industry. Scientists and researchers are threatened with loss of employment for voicing concerns.	[Ron Smith 1/12/24]	This comment is unsupported, inflammatory, and false. Taylor Shellfish supports continued scientific research into shellfish aquaculture and the marine environment in which it operates. In fact, Taylor Shellfish made one of its largest geoduck farms (the Foss farm) available for research as part of Sea Grant's geoduck research program. The fact that there has been relatively little interest in conducting further research addressing the same issues that were covered as part of the Sea Grant research is strong evidence that the scientific community views that research program as highly credible and the results as reliable for evaluating the impacts of geoduck aquaculture.
The eelgrass delineation completed was limited in its evaluation of the environment and not conducted by a third party and therefore should not be accepted.	[PHI 7/24/23, 7/27/2023], [Tonni Johnston 1/8/24], [Marta Allen 1/12/24]	There are no requirements for eelgrass delineations to be completed by third party consultants. The U.S. Army Corps qualifications outlined in their January 2018 publication '*Components of a Complete Eelgrass Delineation*' state that "eelgrass bed delineations should be performed by someone who has demonstrated the ability to identify eelgrass species present within the project area and conduct ecological surveys." Ms. Lamb was fully qualified to complete a report. She has a master's degree in environmental studies and had been employed by Taylor Shellfish for over three years, during which time she attended eelgrass delineation training, conducted gear experiment studies in eelgrass environments to understand the population and recruitment impacts to eelgrass, and assisted in Biological Evaluations and Eelgrass Delineations with Taylor consultants. The farm was not mapped by the regulating

		authority to contain protected eelgrass or canopy forming kelp species, and the delineation confirmed those conclusions.
The Proposal's plastic gear is formulated with harmful chemicals and will degrade, resulting in leaching and microplastics, negatively impacting human health.	[PHI 3/21/23, 7/24/23, 7/27/2023], [Laura Hendricks 12/5/22], [Holly Hulst 12/4/22], [Ron Smith & Deb Hall 12/2/22], [Gerald & Janet Sheehan 1/7/24], [Jan Odano 1/8/24], [George Johnston 1/8/24], [FOBL 1/8/24], [PHI 1/8/24], [Cynthia Sheller 1/12/24]	The Proposal will utilize gear that is specifically manufactured to withstand environmental conditions without degrading, and it will be routinely monitored to ensure it remains properly deployed and is not experiencing unexpected wear. Concerns regarding the use of plastics in shellfish aquaculture have been exhaustively analyzed in multiple prior permit appeals before the Shorelines Hearings Board. The SHB has appropriately determined that the use of marine-grade gear following best management practices does not cause significant adverse impacts. *E.g.* SHB No. 11-019 (FF 10, 11, and COL 6, 14); SHB No. 13-006c (FF 36-42 and COL 16); SHB No. 14-024 (FF 39-43, 47 and COL 13, 20) [marine debris); SHB No. 11-019 (FF 9); SHB No. 13-006c (FF 41-42 and COL 16); SHB No. 14-024 (FF 44-47 and COL 13, 20) [microplastics and leaching concerns]. The use of aquaculture gear is also exhaustively analyzed in the Programmatic Consultation, which includes several measures to ensure that appropriate gear is deployed and properly managed. Concerns regarding gear degradation are further addressed in Attachment 3 to Taylor Shellfish's 1/22/24 response and Hearing Exhibits 14-16 and 18.
The Proposal will result in gear loss and plastic pollution.	[PHI 3/21/23, 5/30/23, 7/24/23, 7/27/2023], [George Johnston 12/3/22], [Ron Smith/PHI 12/5/22], [Evan Smith 1/7/24], [Laura Westrup 1/8/24], [Jan Odano 1/8/24], [George Johnston 1/8/24], [FOBL 1/8/24], [Sam Smith 1/8/24], [PHI 1/8/24], [Marta Allen 1/12/24]	Taylor Shellfish will follow all conservation measures from the Programmatic Consultation to ensure all gear used for the Proposal will be appropriate for use in the marine environment, properly secured, and responsibly maintained and monitored. Additionally, Taylor Shellfish will conduct even more frequent patrols of the farm than required under the Programmatic Consultation to further respond to concerns regarding potential gear loss. This farm will have a dedicated crew assigned to its maintenance, monitoring and harvest operations. Debris patrols will occur at minimum every tide cycle (approximately 2 weeks), in addition to as soon as safely possible following storm events to look for displaced gear and other debris. Debris patrols shall include expedient response to community concerns. Reviewing the farm debris collection data, this crew has a strong history of patrolling their farms routinely, they participate at each industry cleanup, and respond quickly to reports of lost gear inside and out of their working farm area. In 2023, they conducted 80 patrols, or an average of 2.5 patrols per month on

		farms with gear and 1.5 each month for those without gear. In addition, over 30 compliance checks were completed on the farms or within the area to confirm BMPs. In the first 2 weeks of 2024, the farm crew already conducted at least one patrol on each of their farms. Their report and the dashboard of locations, included as Appendix 2 and 3 document that they found 18 rigid mesh tubes marked Taylor Shellfish, but over 100 pieces of aquaculture gear that were other growers or did not have markings. They also picked up over 19 grocery bags of residential trash, along with paint cans, pvc drain pipe, Styrofoam, a plastic cooler, fish net, and floats. On 53 of the 80 site visits, nothing was found on the beach. Commercial aquaculture gear, including tubes and net are required to be marked or labeled, per Programmatic condition # 18. Taylor has used many methods for gear labeling which are attached to the gear, including zip ties, arrow clips, or labeled lines connected to a row of tubes, which are marked with the name and contact or email for Taylor Shellfish. To comply with permit conditions, Taylor will label tubes and nets used for this farm.
The applicant does not provide sufficient mitigation to offset the impacts of geoduck aquaculture, nor have they funded water quality and other mitigation work.	[PHI 5/30/23], [George Johnston 12/3/22], [Ron Smith & Deb Hall 12/2/22], [Lanny Carpenter 12/1/2022], [Michael Mason 11/30/22], [William & Sherry Reus 11/21/22], [William Reus 1/3/24], [Gerald & Janet Sheehan 1/7/24], [Pyke Johnson 1/7/24], [Jonathan Briggs 1/7/24], [Darcy Eggeman 1/8/24], [George Johnston 1/8/24], [William and Sherry Reus 1/11/24]	Geoduck aquaculture, including planting, gear and harvest methods has been analyzed under the Programmatic Consultation. When appropriately conditioned, the farms have been shown to have minimal to beneficial impact to the environment. No mitigation, other than complying with applicable BMPs is required for new aquaculture by either the Thurston County SMP, or Comprehensive Plan. The commenters provide no concrete information demonstrating that the farm, as proposed and conditioned, would have adverse impacts requiring further mitigation. Taylor Shellfish is a very strong proponent for clean water laws, open space protections and environmental education, and has financially supported efforts to meet water quality goals for Washington State as well as international efforts to combat ocean acidification and climate change.
The Proposal's gear is not maintained to minimize risk of environmental degradation.	[PHI 3/21/23, 7/24/23, 7/27/2023], [George Johnston 1/8/24], [PHI 1/8/24]	Comments regarding gear storage effects focused on PVC. The Proposal will not use PVC for this project. The flexible mesh gear is designed to be compressed. These tubes are received in rolls and stored under cover. Once cut, the tubes are staged compressed onto poles which are also maintained under cover. Tubes removed from a farm are cleaned of any remaining biofouling, inspected for wear or damage, and restrung for

		future use. Due to the significant reduction in volume, these tubes are stored out of direct sunlight to meet the manufacturer's 10 year expected lifespan. Taylor has used this type of HDPE for other purposes, including clam sacks and cultch bags, both of which are exposed to more sunlight and exposure to environmental elements compared to flexible mesh tubes for geoduck culture, and they have proven to maintain their integrity for at minimum 10 years.
The Proposal may impact forage fish and their spawning habitat.	[PHI 7/24/23, 7/27/2023], [Michael Mason 12/2/22], [Tonni Johnson, undated], [Harry Branch 1/1/24], [PHI 1/8/24], [Ron Smith & Deb Hall 1/12/24]	Taylor Shellfish will fully comply with the Programmatic Consultation, which thoroughly analyzes potential impacts to sensitive species and their prey resources. Among other things, the Project will be monitored for forage fish during the seasonal herring spawn monitoring window. This farm is denoted by WA Dept of Fish and Wildlife as containing smelt spawning habitat. Puget Sound smelt are observed to spawn in substrate situated from +7 to mean high water. Taylor will not cultivate above +1, or provide farm support generally above +5' tidal elevation, and all farm access will occur by boat, thereby avoiding smelt spawning habitat. See also Hearing Exhibit 10, p5.
This Proposal is situated at a site which receives more significant wind and wave energy, resulting in increased debris.	[PHI 3/21/23, 7/24/23,7/27/2023], [PHI 1/8/24], [Marta Allen 1/12//24], [Cynthia Sheller 1/12/24]	Taylor Shellfish manages productive farms in dynamic intertidal locations throughout Puget Sound, including near the project location, and those with more regular wind and wave energy than this proposal. Hearing Exhibit 17, p. 25. This proposed farm will be operated in compliance with all conditions of the Programmatic Consultation and Best Management Practices. A seasoned and dedicated crew will monitor and maintain the farm, with crews on site at least once every tidal cycle (approximately every 2 weeks), when gear is present. In addition to regular patrols, Taylor checks on its farms following significant weather events to ensure gear is secure with debris monitoring. Taylor is confident that these steps will prevent gear loss.
Increased traffic from watercraft will cause unsafe recreation along the shoreline.	[PHI 7/24/23, 7/27/2023], [George Johnston 12/3/22], [Ron Smith/PHI 12/5/22]	Taylor Shellfish skippers and boat drivers are all required to carry a valid State boater card, successfully pass through company boating and safety training, and demonstrate continued compliance with USGS navigation rules and Company safety policies. These rules require boat operators to maintain a safe speed and maintain a lookout for obstacles. In more than 100 years of managing farms in Puget Sound, Taylor has never caused harm to individuals recreating in the water.

The Proposal will cause noise, odor, and lighting impacts.	[PHI 7/24/23, 7/27/2023], [Kristen Hearn-Papasian 12/5/22], [George Johnston 12/3/22], [William & Sherry Reus 12/3/22], [Tonni Johnson, undated], [Gerald & Janet Sheehan 1/7/24], [Tonni Johnston 1/8/24], [George Johnston 1/8/24]	Taylor Shellfish will avoid unacceptable noise impacts by operating this Proposal in compliance with the County's noise ordinance, Chapter 10.36 TCC. Taylor Shellfish has multiple farms in Thurston County, including within Henderson Inlet, and has extensive experience successfully meeting the noise ordinance standards. The vessels and equipment used for the Proposal would not cause more noise than generated by current operations.
The Proposal will negatively impact sand dollars.	[Bruce Justinen 12/5/22], [Cynthia Sheller 1/12/24]	As discussed in detail in *Coalition to Protect Puget Sound Habitat v. Pierce County*, SHB No. 14-024, Findings of Fact, Conclusion of Law, and Order (May 15, 2015),[1] Taylor Shellfish takes care to avoid impacts to sand dollars to the maximum extent possible. Crew members push sand dollars aside by hand as necessary a few inches to insert the tubes, and even if sand dollars are overturned during planting, they are able to aggregate and right themselves. *Id*. at Finding of Fact 13. While some sand dollars may be affected, the population will not be negatively impacted. See also Hearing Exhibit 19.
This Proposal does not fall in line with WA DNR's statement that additional information is needed to understand the effect of geoduck aquaculture.	[Michael Mason 12/5/2022], [William Reus 12/5/2022]	WA DNR announced their proposed pilot to lease intertidal aquatic lands for geoduck cultivation in 2003. This was prior to the WA Sea Grant research and report. It is unclear whether pilot projects were eventually leased for intertidal lands. WA DNR and Washington State treaty tribes co-manage the subtidal geoduck resource for the state. Together, they manage over 44,000 acres of geoduck tracks in Puget Sound, allocating harvest for approximately 6,000 acres each year. These harvest determinations are based on scuba surveys of natural recruitment and bed densities. In contrast, farmed geoduck is managed on less than 500 total acres of privately owned intertidal lands, with an estimated average of 100-200 acres harvested and replanted each year. Geoduck aquaculture and any impacts it has on the intertidal environment and species interactions have been analyzed by the Services and found to have minimally adverse to beneficial environmental impacts.

[1] Available at: https://eluho2022.my.site.com/casemanager/s/eluho-document/a0T82000000HHySEAW/findings-of-fact-conclusions-of-law-and-order

WA DNR geoduck leasing pilot program does not allow farms near adjacent residential development.	[Michael Mason 12/5/2022], [William Reus 12/5/2022], [Tonni Johnston 1/8/24]	Aquatic lands managed by WA DNR for wild geoduck harvest under RCW 79.96.080. Under this management structure, WA DNR must also balance various considerations outlined by the Public Lands Act on state owned tidelands and within navigable waterways that are inapplicable in the shoreline permitting context or that are not criteria for permit approval. WA DNR, as the manager of state-owned aquatic lands, may assign its own conditions on tidelands it elects to lease for private cultivation.
The Proposal will limit or adversely impact the ability of upland owners to install or maintain shoreline armoring to manage significant existing shoreline erosion.	[Chris Papasian 12/5/22]	According to the WA DOE Coastal Atlas map, the shoreline of this area is a feeder bluff, meant to feed the beach through natural deposition of upland sediments. While this area is a relatively stable region due to minimal slope and the fact that it is mapped as 100% modified with shoreline armoring and development, there is an active drift cell which continues to move loose sediments to the south. Taylor's aquaculture activities do not have a history of negatively impacting upland armoring above the natural processes, and we do not expect it to occur in this location. Taylor Shellfish appreciates that shoreline armoring is not a permanent fix to beach movement and repairs or replacement of these systems by upland property owners will most likely be required over the life of the lease. Taylor's proposed Project is not located on the commenters' property, and no specific information is provided demonstrating that the Project would preclude the commenters from repairing their bulkhead. Taylor is prepared and willing to work with these landowners should such coordination be necessary in their future permitting efforts.
The Proposal will adversely impact property values.	[Tonni Johnston 1/8/24]	Property values are not a decision criterion for shoreline permit approval. Regardless, no evidence has been provided demonstrating the Proposal would adversely impact property values. Taylor Shellfish farms shellfish in many areas of Washington State that have residential use and development nearby and has never been provided with information demonstrating the presence of shellfish farms adversely impacts property values. Additionally, this claim has been rejected in at least one Shoreline Hearings Board appeal. *Coalition to Protect Puget Sound Habitat v. Pierce County,* SHB No. 14-024 (May 15, 2015) (FF 48-49, 51 and COL 13, 21). Commercial shellfish farmers in Henderson Inlet work hard to ensure water quality remains high in farming areas, benefiting residential and other users. Staff participate in water quality protection district meetings, assist shellfish and water quality sampling efforts for recreation and commercial activities, and contribute to nonprofits including land trusts and others who provide environmental education to youth.

The Proposal will pose a risk to boaters and recreational users, and it will adversely impact public access and use of Henderson Inlet	[Tonni Johnson 9/22/23], [PHI 7/20/23, 7/24/23], [David Hall 12/5/23], [Ron Smith/PHI 12/5/22], [David Hall 12/3/22], [Lon Sullivan 12/3/22] [Stephanie Bishop, 12/1/22], [Tonni Johnson, undated], [Gerald & Janet Sheehan 1/7/24], [Pyke Johnson 1/7/24], [Jonathan Briggs 1/7/24], [Jan Odano 1/8/24], [George Johnston 1/8/24], [PHI 1/8/24], [Bryan Johnston 1/10/24], [David Hall 1/12/24]	This Proposal is located on privately-owned tidelands, and its corner boundaries will be marked. The tidal elevation of the Proposal is from the extreme low tide line on the west side of the farm to +1 mean lower low water on the east side. The privately-owned tidelands on which the Proposal is located extend in an easterly direction to the meander line (approximate Mean High Tide, or + 10 to + 13' elevation in Puget Sound). There is an approximately 15-foot horizontal separation between the Proposal's farm footprint and the closest adjacent parcel and approximately 150' from the proposal to the closest adjacent residence. There is also an approximate 25-foot vertical separation from residential structures to the Proposal. The Proposal's geoduck nursery tubes will be in place for less than half of the cultivation cycle, and they will extend only a few inches above the substrate, with the ability to lay flat on the beach. Given the approximately 10-foot vertical separation of tidelands between the Proposal and adjacent properties, there will be ample room for adjacent property owners to access their properties over the Proposal at high tide. Boaters are required to follow the USCG rules of navigation when operating vessels and therefore should be aware of their surroundings. If boats are damaged, it is due to grounding out in the substrate. Passive recreation including kayaking and paddleboarding over the farm will not see any restrictions on use. Taylor Shellfish encourages neighbors to come into the farm and ask questions when farm managers are present and available. Taylor also regularly invites nonprofit groups, schools, and researchers to come to the farms to learn about shellfish aquaculture. Taylor reached out to one of the groups, South Sound Green, who have historically visited this beach and assured the program manager that this access to the beach would remain. Taylor has worked with and supported the outreach efforts of this group on other activities and events and continues to look for programs which encourage youth environmental engagement and awareness.
Bush Act Tidelands allow the use of private tidelands for oyster cultivation only.	[PHI 7/20/23], [Kristen Hearn-Papasian 12/5/22], [Ron Smith/PHI 12/5/22], [Reus/Smith 11/26/22], [Ron Smith & Deb Hall 11/21/22], [George Johnston 1/8/24]	Bush Act tidelands were state owned aquatic areas that were sold for the purpose of shellfish cultivation in 1895. Based on Bush Act maps, this parcel, as well as all lands to the south and through the head of Henderson Inlet, were purchased and historically used for shellfish cultivation. This parcel has continued to remain under private ownership. The property owner has leased the tidelands to Taylor Shellfish and another grower for the purpose of geoduck and oyster cultivation. The commenters are incorrect that only oyster cultivation is allowed on these tidelands. RCW 79.135.010(1).

The boundary of the Proposal is not clear.	[David Hall 12/3/22], [Lon Sullivan 12/3/22], [Ron Smith & Deb Hall 12/2/22], [Michael Mason 11/30/22], [Lon Sullivan & Virginia Cannon 1/8/24], [Cynthia Sheller 1/12/24]	The Property was formally surveyed and recorded by Thurston County in 2017, and survey markers were installed at that time. The farm application's map package included the parcel outline in relation to neighboring parcels, survey map and approximate farm boundary within the parcel. Taylor has digital files of the property boundary and the tools to affirm the location of the markers. The farm and/or property corners will be marked prior to planting to provide neighbors with clear, visual confirmation. With regards to upper tidal elevation for farm activities, Taylor was originally intending to farm oysters and geoduck. The property owner decided to sign a lease with another grower to cultivate oysters within the parcel boundary north of the planned geoduck footprint. Taylor therefore submitted an amended application to remove oyster cultivation. Taylor did not change where geoduck would be grown and maintained its geoduck cultivation area between +1 and -4.5' on the southern half of the parcel.
Henderson Inlet belongs to the public and should not be used for private aquaculture.	[Tonni Johnson 9/22/23], [Ron Smith/PHI 12/5/22], [Lon Sullivan 12/3/22], [Ron Smith & Deb Hall 12/2/22], [William & Sherry Reus 11/21/22], [Pyke Johnson 1/7/24], [Lon Sullivan & Virginia Cannon 1/8/24]	The Proposed tidelands area is privately owned. Shellfish aquaculture is a preferred, water-dependent use that is in the statewide interest and has significant environmental and economic benefits. RCW 90.58.020; WAC 173-26-241(3)(b);. Shellfish projects such as this are expressly allowed in Henderson Inlet's Conservancy Shoreline Designation pursuant to a shoreline permit. Thurston SMP p. 43.
The Proposal will have unacceptable aesthetic impacts.	[Ron Smith/PHI 12/5/22], [Pyke Johnson 12/4/22], [William & Sherry Reus 12/3/22], [Lon Sullivan 12/3/22], [Ron Smith & Deb Hall 12/2/22], [Ron Smith & Deb Hall 12/2/22], [Michael Mason 11/30/22], [William & Sherry Reus 11/21/22], [Tonni Johnson, undated], [Gerald & Janet Sheehan 1/7/24], [Jonathan Briggs 1/7/24], [Jan Odano 1/8/24], [Darcy Eggeman 1/8/24], [George Johnston	This Proposal will be situated in front of four parcels developed with three existing residential homes. Only one of the commentors lives adjacent to the Proposed farm footprint, with most commentors owning parcels greater than 500' from the project area. Appendix 4. The SMP (along with the SMA and its implementing guidelines) give preference to shellfish aquaculture as a preferred, water-dependent use. The SMP does not prohibit aesthetic impacts but rather states: "Aquacultural development should consider and minimize the detrimental impact it might have on views from upland property." SMP p.39. In response to neighbor concerns regarding aesthetics, plastic, debris, and carbon footprint of mobilizing volumes of tubes to and from its sites, Taylor has invested significant resources to develop, test and convert operations to using flexible mesh to address and minimize concerns regarding its farms. The Proposal is also utilizing general BMPs including neutral colored gear that will blend into the

	1/8/24], [PHI 1/8/24], [William and Sherry Reus 1/11/24]	marine environment and neat and orderly alignment of structures to minimize impacts on views.
The Proposal will cause significant adverse environmental impacts under the State Environmental Policy Act, and an Environmental Impact Statement should be prepared for the Proposal.	[George Johnston 12/3/22], [Tristan Atkins 12/1/22]	The County issued a determination of nonsignificance ("DNS") for the Proposal under SEPA. The DNS was not appealed and is therefore final and determinative.
The Proposal risks environmental harm due to the presence of ongoing pollution in Henderson Inlet	[Holly Hulst 12/4/22], [FOBL 1/8/24], [Betsy Norton 1/8/24]	The Proposal is located in Henderson Inlet. The tidelands, and surrounding area are reviewed annually for any health impacts and it remains open and approved for shellfish harvest by WA DOH, the regulating authority. Other geoduck farms operated by Taylor, are located less than 1 mile west of the subject parcel. No negative impacts to water quality due to resuspension or farm activities has been observed.
The Proposal is inconsistent with the policy of the SMA at RCW 90.58.020.	[Ron Smith/PHI 12/5/22], [Sam Smith 12/5/22], [Holly Hulst 12/4/22], [Pyke Johnson 12/4/22], [Kevin Vandehey 12/3/22], [Ron Smith & Deb Hall 12/2/22], [William Reus 1/3/24], [George Johnston 1/8/24], [PHI 1/8/24]	The Proposal is consistent with the policy of the SMA. RCW 90.58.020 provides: "It is the policy of the state to provide for the management of the shorelines of the state by planning for and fostering all reasonable and appropriate uses." Shellfish aquaculture is not only a reasonable and appropriate use under the SMA—it is a preferred, water-dependent use. RCW 90.58.020. Numerous decisions have confirmed that shellfish farming is a preferred use of the shoreline and that use restrictions must be based on scientific and technical grounds. See Closing Arguments to Taylor Shellfish's January 22, 2024 response. The SMA guidelines and Thurston County SMP also confirm that shellfish aquaculture is a preferred or encouraged use that is in the statewide interests and can have important environmental and economic benefits. WAC 173-26-241(3)(b)(i)(A); Thurston County Comprehensive Plan p. 9.
The Public Trust Doctrine grants the public the right to access private tidelands at low tide and prohibits the Proposal from occupying public waters.	[Ron Smith/PHI 12/5/22], [Gerald & Janet Sheehan 1/7/24], [Darcy Eggeman 1/8/24], [George Johnston 1/8/24], [Lon Sullivan & Virginia Cannon 1/8/24]	The Supreme Court of Washington has held "the requirements of the 'public trust doctrine' are fully met by the legislatively drawn controls imposed by the Shoreline Management Act of 1971." *Caminiti v. Boyle*, 107 Wash. 2d 662, 670, 732 P.2d 989 (1987). As discussed above, the SMA identifies aquaculture as a preferred, water-dependent use. And the Thurston County SMP, which was developed by the County and approved by Ecology under the SMA, expressly allows geoduck aquaculture in the Conservancy environment. SMP p. 43. Further, as discussed in the attached Court of Appeals decision Appendix 5, the Public Trust Doctrine does not grant the right to access privately-owned tidelands at low tide. Accordingly, the Proposal is consistent with the Public Trust Doctrine.

The Proposal will result in the taking of private property.	[David Hall 12/3/22], [Lon Sullivan 12/3/22]	A taking of private property may occur through the physical occupation of private property or by imposing certain severe restrictions on the use of private property. See e.g., *Lingle v. Chevron U.S.A. Inc.*, 544 U.S. 528 (2005); *Yim v. City of Seattle*, 194 Wash. 2d 682, 451 P.3d 694 (2019), *as amended* (Jan. 9, 2020). The Proposal will do neither. It is located on private-owned property.
The Proposal may cause adverse impacts to water circulation, currents, water flow, or erosion.	[Tonni Johnston 1/8/24], [Janell McCleary 1/7/24]	According to WA DOE Coastal Atlas map, the shoreline of this area is a feeder bluff, meant to feed the beach through natural deposition of upland sediments. While this area is a relatively stable region and the fact that it is mapped as 100% modified with shoreline armoring and development, there is an active drift cell which continues to move loose sediments to the north. See Hearing Exhibit 17, slide 5-6.
The Proposal will impact the ability for upland Properties to be assisted with emergency water services for fire.	[Gerald & Janet Sheehan 1/7/24]	This farm will be operated within the lower tidal elevation, below +1'. Gear is flexible, allowing emergency boats to mobilize on top of the farm, if necessary.
The Proposal will not help support jobs or result in economic benefits. The cultivated shellfish will be sold in foreign markets.	[PHI 7/20/23, 7/24/23], [George Johnston 12/3/22], [Ron Smith/PHI 12/5/22], [Sam Smith 12/5/22], [Evan Smith 12/4/22], [Holly Hulst 12/4/22], [William & Sherry Reus 12/3/22], [David Hall 12/3/22], [Lon Sullivan 12/3/22], [Ron Smith & Deb Hall 12/2/22], [Tonni Johnson, undated], [William Reus 1/3/24], [Gerald & Janet Sheehan 1/7/24], [Jonathan Briggs 1/7/24], [William and Sherry Reus 1/11/24]	This farm will support farm crew, divers, farm manager and processors. Taylor employees are paid livable wages and benefits. Wages are regularly reviewed and corrected to ensure cost of living adjustments are reflected. The SMP confirm that shellfish farming strengthens and diversifies the local economy, and it is encouraged use for this reason. SMP p. 39, Thurston County Comp Plan p. 9. Cultivated shellfish from the Proposal will be sold in domestic and international markets. During the COVID pandemic, Taylor invested significantly to expand its domestic market. Foreign sales will help combat our nation's $20 billion seafood trade deficit and trade imbalances.
Thurston County does not have programs in place to verify compliance with permit conditions	[PHI 5/30/23], [George Johnston 1/8/24]	Thurston County has code enforcement within the Planning Department. These officials have been out to other Taylor farms to follow up on community complaints and to ensure the farm was being managed within code compliance. Taylor also regularly brings regulators from other agencies (U.S. Army Corps, WA Dept of Ecology, WA Dept. of Health, WA Dept. of Fish and Wildlife) onto farms for requested compliance checks, either as a result of general compliance, or to follow up on specific questions or

		compliance condition. Finally, Taylor employs a full-time farm compliance manager who is directed to visit farms to review compliance with permit conditions and codes of practice. These site visits are documented, and the results shared with Directors and Executives.
The farm, as described, will operate within the requirements of the Thurston County Sanitary Code	[Thurston Co. Env Health 6/5/23]	Noted.
The Nisqually Tribe has no specific concerns regarding the application.	[Nisqually Indian Tribe, 11/10/22]	Noted.

Attachment 2

CONFLUENCE
ENVIRONMENTAL COMPANY

To: Jesse DeNike, Plauche & Carr
cc: Erin Ewald, Taylor Shellfish

From: Chris Cziesla

Chris Czish

Date: January 22, 2024

Re: Response to Comments on Thurston County Taylor Shellfish Farms Project No.: 2022103702

The following table provides responses by topic to comments received related to environmental impacts of Taylor Shellfish's proposed aquaculture farm in Thurston County (Project No.: 2022103702). The relevant comment letters for each of the topics are listed in the second column. Where necessary, references are provided to support the responses. A complete list of references is included after the table.

Table 1. Responses to Comments on Taylor Shellfish Farms Project No.: 2022103702

Topic	Relevant Comment Letters	Response	References
1.The Proposal may adversely impact benthic organisms living within the sediment due to harvest activities.	[PHI 3/21/23, 5/30/23, 7/24/23, 7/27/2023], [Ron Smith/PHI 12/5/22], [Tonni Johnson, undated], [Gerald & Janet Sheehan 1/7/24], [FOBL 1/8/24], [Janell McCleary 1/7/24], [Betsy Norton 1/8/24], [PHI 1/8/24]	Commentors provided numerous statements about the SeaGrant research, however, did not provide any evidence, data, or supporting information for their claims related to potential impacts to benthic invertebrates. Conversely, this topic has been thoroughly studied in multiple locations, over multiple seasons, and multiple years. The extent and robustness of these studies is unparalleled in terms of directly assessing potential impacts and the close proximity to the proposed farm site in Henderson Inlet (i.e., one study site located ~2.5 miles north). The studies specifically set out to "determine if geoduck aquaculture harvest operations alter benthic infaunal invertebrate assemblages of intertidal sand flats in southern Puget Sound". The results and conclusions of the studies are unambiguous and indicate that "Our perMANOVA analyses identified a number of significant differences based on site, date, or treatment in contrasts within and between plots. However, none of the three assessments of the interaction term [harvest state]*[treatment] were found to be significant…….Because the interaction term was not significant in any case, significant differences between plots at Foss and Manke were likely the result of factors other than harvest-related disturbances. Results for homogeneity of multivariate dispersion (HMD) analyses for cultured and reference plots at the three study sites likewise did not fit expectations consistent with geoduck harvesting as a primary source of disturbance." The study authors sum this up by stating "Our study revealed only modest effects on infaunal communities from the harvest phase of geoduck aquaculture operations. Multivariate analyses indicated an absence of significant shifts in community composition (both means and variability) at any of the three study sites as a result of harvesting activities. Similarly, we found little evidence of a significant "spillover" effect of cultured geoduck harvest operations on resident infaunal communities." The authors go on to hypothesize that the results are likely explained by the natural disturbance regime associated with study sites (i.e., intertidal sand flats) which includes small and large waves, thermal stress, freshwater (from rain events), among others, to which the benthic infaunal communities are adapted. These natural disturbance events occur much more frequently than the disturbance resulting from geoduck harvest, and thus the community structure is controlled by the natural disturbance regime and not significantly altered by geoduck harvest. As the commentors have noted, the authors of the studies do identify several caveats, additional questions, and opportunities for further research at the end of the "discussion" sections of their reports. However, these questions and further research recommendations are a demonstration of the scientific	Washington Seagrant, 2013, VanBlaricom et al., 2015

Topic	Relevant Comment Letters	Response	References
		process, where each new step in research leads to additional questions and new hypotheses to test, and in no way call into question the veracity of their reported results and conclusions.	

Topic	Relevant Comment Letters	Response	References
2. The Proposal may adversely impact fish, birds, marine mammals and other wildlife, along with supporting habitat, and reduce food for other animals.	PHI 3/21/23, 7/24/23, 7/27/2023], [Ron Smith/PHI 12/5/22], [Laura Hendricks 12/5/22], [Holly Hulst 12/4/22], [Pyke Johnson 12/4/22], [Ron Smith & Deb Hall 12/2/22], [Tristan Atkins 12/1/22], [Pyke Johnson 1/7/24], [FOBL 1/8/24], [Sam Smith 1/8/24], [PHI 1/8/24] [	Commentors expressed concern that the proposed geoduck farm would adversely affect fish, birds, marine mammals, and other wildlife and their supporting habitat. There are numerous studies and analyses which refute these claims. Specifically, the US Army Corps of Engineers (Corps) conducted a Biological Assessment and the National Marine Fisheries Service (NMFS) and US Fish and Wildlife Service (USFWS) issued two Programmatic Biological Opinions which included extensive analysis of the relevant scientific literature related to ongoing and future shellfish aquaculture activities in Washington State, including geoduck aquaculture, and any potential effects to Endangered Species Act listed species and their habitats. This included analysis for numerous listed fish species (salmon, rockfish, eulachon, steelhead, green sturgeon, bull trout), marine mammals including whales, and birds (snowy plover, marbled murrelet) as well as the habitats and prey they rely on. Furthermore, the NMFS analysis also included an assessment of potential impact to Essential Fish Habitat (EFH) for salmon (3 species; coho, chinook, pink), ground fish (87 species of flatfish, roundfish, rockfish, and elasmobrachs), and coastal pelagic species (5 species: northern anchovy, market squid, Pacific sardine, Pacific mackerel, and jack mackerel). EFH is defined as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity”. The analyses of these species are an excellent representation and integration of potential ecological effects associated with aquaculture. All of these species rely on a diverse suite of habitats and prey resources and the conclusions reached in these analyses support the limited effects of geoduck aquaculture on fish, birds, marine mammals, and supporting prey resources and habitats. The USFWS Biological Opinion stated “The Service has reviewed the current rangewide status of the bull trout, the environmental baseline for the action area, the direct and indirect effects of the proposed action, the effects of interrelated and interdependent actions, and the cumulative effects that are reasonably certain to occur in the action area. It is the Service’s Biological Opinion that the action, as proposed, will not appreciably reduce the likelihood of survival and recovery of the bull trout in the wild. The action, as proposed, is not likely to jeopardize the continued existence of the bull trout. It is the Service’s Biological Opinion that the action, as proposed, will not destroy or adversely modify designated bull trout critical habitat.” Additionally for marbled murrelet “The Service has reviewed the current rangewide status of the marbled murrelet, the environmental baseline for the action area, the direct and indirect effects of the proposed action, the effects of interrelated and interdependent actions, and the cumulative effects that are reasonably certain to occur in the action area. It is the Service’s Biological Opinion that the action, as proposed, will not appreciably reduce the likelihood of survival and recovery of the marbled murrelet in the wild. The action, as proposed, is not likely to jeopardize the continued existence of the marbled murrelet.” The NMFS Biological Opinion concluded “After reviewing the current status of the listed species, the environmental baseline within the action area, the effects of the proposed action, any effects of	Brown and Theusen, 2011. Corps, 2015. McDonald et al., 2015. NMFS 2016, Washington Seagrant, 2013, USFWS 2016

Topic	Relevant Comment Letters	Response	References
		interrelated and interdependent actions, and cumulative effects, it is NMFS' opinion that the proposed action is not likely to jeopardize the continued existence of Puget Sound Chinook salmon, HCSR chum salmon, green sturgeon, or Puget Sound/Georgia Basin canary rockfish, and will not destroy or adversely modify critical habitat of any of these species." Specific conclusions reached by NMFS in the EFH analyses include: "Despite interaction with the bottom environment over hundreds or thousands of acres in each sub-region, there is no evidence that such disturbance interferes with benthic productivity or decreases the availability of forage for EFH species on such a temporal to allow for a determinant conclusion of the effects." "Based on the currently available evidence, the level of benthic disturbance from existing shellfish aquaculture in Washington State is well within the range of normal sediment-disturbing processes (e.g. storm/wave activity) and that adverse effects are likely to be quite limited in space (the footprint of the shellfish bed plus some buffer to account for current) and duration (from a few hours to a few days to a few months depending on the benthic assemblages in question). Therefore, we believe that the effects of these existing, new, and expanded aquaculture activities on benthic communities unlikely to cause large scale impacts to EFH. Impacts to prey resources of EFH species would be quite limited in time and space." While the Opinions concluded no jeopardy for the species they did acknowledge and allow a limited amount of incidental "take" of a few individuals related to aquaculture activities. Specifically, over the projected 20 years, NMFS and USFWS anticipated 5 combined total chinook salmon, chum salmon, green sturgeon, canary rockfish and 8 bull trout (2 in South Puget Sound). It should be noted that these analyses considered all existing aquaculture activities as well as future new aquaculture for a 20-year term (2015-2035). This included existing aquaculture and new aquaculture on 38,715 acres in Washington state. Specifically for South Puget Sound, the analyses considered a total of 3,746 acres, which included 2,351 acres of continued aquaculture, 780 acres of fallow aquaculture, 41 acres of new recreational aquaculture, 126 acres of new restoration aquaculture, and 448 acres of new commercial aquaculture. The proposed farm fall within the 448 of new aquaculture analyzed for South Puget Sound. As part of these analyses, NMFS, USFWS and the Corps developed conservation recommendations to avoid and minimize any potential effects. The project includes the implementation of all these conservation recommendations.	

Topic	Relevant Comment Letters	Response	References
		The fact that NMFS and USFWWS reached the conclusion of "no jeopardy" and issued an extremely limited amount of "take" (2 individuals in South Puget Sound) for activities occurring on thousands of acres of intertidal lands, confirms how well shellfish aquaculture interacts with the ecosystem, listed species, prey resources, and the habitats that support them. In contrast, in 2020, NMFS issued a "jeopardy" opinion (i.e., would jeopardize the continued existence of the species and adversely modify designated critical habitat) for a series of 18 projects in Puget Sound that included residential bulkheads, residentials commercial piers, marinas, and other small projects in the nearshore environment that occurred in less than 100 acres of total area. While these projects are vastly different than shellfish aquaculture, this jeopardy biological opinion demonstrates that NMFS understands the value of intertidal shorelines to listed species, has identified types of projects considered harmful, and does not consider shellfish aquaculture as a negative influence on the species, prey resources and habitats that support them.	

Topic	Relevant Comment Letters	Response	References
3. The Proposal may adversely seagrass, including protected eelgrass due to planting and harvest techniques.	[PHI 3/21/23, 7/24/23, 7/27/2023], [Janell McCleary 1/7/24]	As documented by the eelgrass survey conducted at the project site, there is no eelgrass present in the project area. This is consistent with past and ongoing marine vegetation mapping conducted by Washington Department of Natural Resources, which also confirms the lack of eelgrass at the project site (7 surveys) and in the entirety of Henderson Inlet (6-7 surveys). The closest mapped areas of eelgrass occur on the shoreline of Key Peninsula, south of Joemma Beach State Park, approximately 2.9 miles away and south of Tolmie State Park approximately 6 miles away. Due to the lack of current and historical presence of eelgrass in the project area and larger surrounding vicinity, the proposed project has no potential to have adverse effects to this habitat type. In the commentors' critique of the SeaGrant studies, several statements of concern were included from the work of Reusnik and Rowell 2012, and Horwith 2013. The commentors stated that the studies indicate geoduck harvest "kills eelgrass" and that "whatever had killed the eelgrass had a more widespread negative impacts and recommended further study". These statements are an oversimplification of the results and discussion in the studies. First, it is important to note that the Horwith study is in Samish Bay, a large deltaic setting (i.e., river mouth sediment deposition zone) in Northern Puget Sound with very large eelgrass beds (100+ acres). This is a fundamentally different setting than the relatively narrow intertidal setting of the project area completely lacking eelgrass. In looking in detail at the study results and discussion, while it is true that geoduck harvest and predator netting resulted in a reduction in eelgrass, there were numerous other findings related to the interactions of eelgrass and geoduck aquaculture. For example, the study site, a natural sand bar, where eelgrass was absent, but present in adjacent areas, was planted with geoduck in 2002. Eelgrass colonized the farm area between 2002 and 2008, potentially facilitated by the geoduck tubes allowing eelgrass seeds to establish. The study showed a 44% reduction in density immediately following geoduck harvest, however eelgrass recovery began 1 year after harvest. The author states "Thus, the current geoduck aquaculture practices do not appear to have made this site unsuitable for later recolonization by eelgrass". Furthermore, follow up with study author revealed that, after the initial loss in eelgrass, a full recovery of eelgrass 2 years after the nets were removed and while nursery tubes were in place to help stabilize and shelter eelgrass in the culture bed (Horwith, pers. comm., 2014). In the SeaGrant study, Horwith observed a change in infaunal communities and also stated "On Fisk Bar, however, infaunal abundance, richness, and diversity were poorly predicted by quadrat-specific *Z. marina* biomass, suggesting that the effects of geoduck aquaculture on infauna were not mediated solely through eelgrass". However, in the next paragraph Horwith, contextualizes his statement by	Taylor 2019 Washington SeaGrant 2013

Topic	Relevant Comment Letters	Response	References
		saying "To provide but one example of the capricious nature of infaunal response, aquaculture of a single bivalve species (*Mytilus edulis*) has been found to have a negative effect (Chamberlain et al. 2001), no effect (Danovaro et al. 2004), or a positive effect (Callier et al. 2008) on infaunal diversity." Therefore, while Horwith indicates that eelgrass biomass alone did not predict observed changes in infaunal community characteristics, he acknowledges that there are numerous factors contributing to and affecting species communities. The applicability of the Horwith study results to the project area are limited, due to the lack of eelgrass at the project area and the dramatically different ecological setting (i.e., sand bar in a river delta). Commentors' characterization of the study as indicating that the proposed geoduck aquaculture project would adversely impact eelgrass or could be relevant to the project area is erroneous.	

Topic	Relevant Comment Letters	Response	References
4. The Proposal relies on incomplete and inadequate SeaGrant Research for its conclusions. (insufficient review of species impacts)	[PHI 7/20/23, 7/24/23, 7/27/2023], [Tristan Atkins 12/1/22], [William Reus 1/3/24], [William Reus 1/3/24], [Gerald & Janet Sheehan 1/7/24], [Mark Butcher & Pam Meyer 1/7/24], [Sam Smith 1/8/24], [PHI 1/8/24]	Please see the response to comment 1 above. I have been professionally working in marine sciences in the Pacific Northwest in regulatory review, impact analyses, and designing and implementing associated research studies for over 25 years. I have extensive experience in the design, review, and interpretation of ecological studies and how to apply their results to new questions and locations. It is extremely rare in the environmental/regulatory setting to have a >1.5 million dollar 6-year research program, involving dozens of researchers from universities and academic institutions, spending thousands of hours, directly assessing potential impacts associated with the topic at hand, namely geoduck aquaculture. The fact that three of the four study sites were located in South Puget Sound and in close proximity to the proposed farm site in Henderson Inlet (i.e, one study site located ~2.5 miles northwest), and in similar intertidal shoreline settings makes the applicability of the study results even more accurate. Proposed geoduck aquaculture project approvals have been challenged numerous times including review by the Shoreline Hearings Board (SHB). The SHB has affirmed the interpretation of the SeaGrant results as indicating limited and/or short-term effects from geoduck aquaculture on intertidal habitats and the species that utilize these settings and has consistently approved the projects under review. In making these decisions, the SHB reviewed extensive amounts of material including expert reports, presentations, and testimony. For example, during SHB 14-024 (Exhibit 20), Mr. Jim Brennan raised concerns on the same topics raised by the commentors on this project including: harvest impacts on benthic communities; predator tube and net impacts; impacts to sand dollars, fish, and other species; caveats by the SeaGrant researchers about limitations of their results. I provided expert testimony at this hearing and was part of the team that responded to concerns raised by Mr. Brennan and others. Ultimately the SHB affirmed the decision to issue the approval for the geoduck aquaculture farm. The SHB has acknowledged that the SeaGrant studies had limits—all studies do—but that they provided reliable information for decision-making and represent the best science available on the subject. Commentors acknowledged that the SeaGrant work described the adaptation of Puget Sound beaches to natural disturbance and the resultant resiliency to the effects of geoduck harvest by stating "The GARP report does *suggest* that in a general sense, Puget Sound beaches are pretty resilient, and that the constant need to adapt to the harsh marine environment allows the inhabitants of the beach to bounce back a er insults like the harvest phase of geoduck aquaculture." However, commentors then go on to selectively pull out SeaGrant author statements where study limitations or areas of future research potential exist.	Confluence 2015 McDonald et al., 2015. NMFS 2016 USFWS 2016 VanBlaricom et al., 2015 Washington SeaGrant 2013

Topic	Relevant Comment Letters	Response	References
		Specifically, commentors misrepresent or misunderstood the concept that recovery of infaunal organisms from disturbance resulting during harvest occurs during the growout phase in the culture cycle 4-6 years. Instead commentors state that eelgrass recovery is 5 years, and that recovery of other organisms is "simply unknown". These statements are irrelevant and incorrect respectively. Eelgrass recovery from impacts associated with geoduck harvest is irrelevant to this project given that there is no eelgrass present in the project area or larger vicinity (See response to comment 3). Furthermore, the Seagrant studies specifically reported on the recovery of the benthic communities present in the geoduck culture areas demonstrating rapid recovery from harvest impacts likely due to the species adaptations to repeated natural disturbances occurring at much more frequent intervals (i.e., many time per year versus 1 harvest event every 4-6 years). The commentors also suggest the Seagrant studies are "extremely limited" because they assess only a subset of the totality of species present in the intertidal settings. This comment likely comes from a lack of familiarity with ecological study design (versus human medical study design). In ecological studies, standard study design includes evaluating total species present in the samples and focusing detailed analytical effort on representative species from the various taxonomic groups present. This use of representative species has both statistical, ecological, and practical rationale. From a statistical perspective, the numbers of replicate samples required to produce valid analyses and conclusions is defined by the statistical tests being applied and the resulting confidence intervals, correlation coefficients, and other metrics of significance being reported. That is to say, you need a certain number of samples to develop meaningful conclusions. Ecologically, representative species or genera are used, instead of all identified species, because they exhibit similar life history traits, have similar environmental requirements, and play a similar role in food webs and trophic structure. While practically, representative or grouping of species are used because detailed identification of benthic infaunal organisms (to the species level versus family or genus) is incredibly labor intensive and time-consuming work done via dissecting microscope and requiring a high degree of taxonomic expertise. Therefore, given the similar ecological role of multiple individual species, the need to produce valid statistically defensible results, and the practical limitations of detailed identifications, the SeaGrant studies appropriately focused their efforts on a limited subset of species to reach their conclusions. Commentors also noted that the SeaGrant studies did not evaluate sand dollars and suggests that they would be eliminated from the project site. This concern has been raised in the past related to other geoduck farms (SHB 14-024; Hearing Exhibit 20). To investigate this concern, Confluence conducted an investigation looking at sand dollar presence and abundance at an active geoduck farm (~4.5 miles north of proposed project site) in comparison to an adjacent control site. The results indicated that sand dollar abundance was similar between the active farm site and control area	

Topic	Relevant Comment Letters	Response	References
		demonstrating that geoduck farming did not result in decreased sand dollar populations and certainly did not eliminate sand dollars from the farm area (Hearing Exhibit 19). Comments also call out the SeaGrant Final Report Research Priorities and Monitoring Recommendations focusing on cumulative impacts and repeated cycles on culture plots. As common in all research programs, areas of further exploration and additional research recommendations are made. That is the definition of the scientific method, namely – ask a question, make observations, establish a hypothesis, experimentally test the hypothesis, formulate a conclusion, identify further questions to ask. The identification of additional research opportunities does not negate the results and conclusion reached from the completed research. Specifically considering multiple cycles of planting and harvesting, it stands to reason that if, as the study authors conclude, the community structure in intertidal locations is adapted to and controlled by frequent (multiple times per year) high levels of disturb5ance from natural events (i.e., wind waves, storms, thermal stress, etc.) and that geoduck harvest and subsequent recovery is similar to one of those natural events, that repeated harvest (once every 4-6 years) would not result in a change to the community structure. Similarly. considering cumulative impacts from additional and/or nearby geoduck farms, the SeaGrant studies did not find "spill over" effect to adjacent areas, so there is no mechanism for cumulative site-specific effects to occur from adjacent sites. Additionally, the potential for cumulative effects from additional geoduck farms within South Puget Sound was accounted for and analyzed in detail in the Programmatic Biological Opinions conducted by NMFS and USFWS where hundreds of additional acres of new shellfish aquaculture were added to existing shellfish aquaculture when reaching their conclusions (See response to comment 2). Commentors also express concern about genetic interactions of commercial geoduck with wildstock geoduck. Taylor Shellfish has a robust program in its geoduck hatchery to ensure appropriate management of genetic issues. They work closely with researchers and the Washington Department of Fish and Wildlife (WDFW) to maintain appropriate practices related to genetic diversity and compatibility with wild stock geoduck. WDFW, the agency charged with approving transfers of shellfish, has approved Taylors process and procedures related to genetic concerns. Many of the findings reached by the Washington Sea Grant geoduck research program have been published in peer-reviewed journals, including the following articles: Glenn R. VanBlaricom et. al, *Ecological effects of the harvest phase of geoduck (Panopea 11enerosa Gould, 1850) aquaculture on infaunal communities in southern Puget Sound*, Washington, Journal of Shellfish Research Vol. 34, No. 1, pp. 171-87 (2015); P. Sean McDonald et. al, *Effects of geoduck (Panopea 11enerosa Gould, 1850) aquaculture gear on resident and transient macrofauna communities of Puget Sound*,	

Topic	Relevant Comment Letters	Response	References
		Washington, Journal of Shellfish Research Vol. 34, No. 1, pp. 189-202 (2015); McPeek et. al, *Aquaculture Disturbance Impacts the Diet but not Ecological Linkages of a Iniquitous Predatory Fish*, Estuaries and Coasts (Nov. 8, 2014).	

Topic	Relevant Comment Letters	Response	References
5. The Ferriss et al. (2015) paper identified the potential for a 20% or greater change in some animals due to 120% increases in geoduck aquaculture.	[William Reus 1/3/24], [Ron Smith 1/12/24]	Commentors raised concerns about potential impacts to certain species based on EcoPath with EcoSim (EwE) modelling efforts including a 120% increase in geoduck aquaculture in central Puget Sound. The model projected increases in biomass densities of surfperch, nearshore demersal fish, and small crabs, and decreases in great blue herons, bald eagles, seabirds, flatfish, and certain invertebrates (e.g. predatory gastropods and small crustaceans). The conclusions presented in the Ferriss et al. (2015) article were reported in the media at the time of its publication and are being raised by the commentors on this project in a manner which suggests an unfamiliarity with the appropriate application and constraints of models such as EwE. Because of these inappropriate characterizations, Confluence reached out to the study authors to discuss the study results and produced a summary memorandum for the authors review to ensure accuracy (Exhibit 19). Highlights from this memorandum specific to the commentors concerns include: • The objective of this modeling effort was not to identify a "cap" on geoduck aquaculture. In fact, the primary objective was to provide guidance for monitoring and to identify areas for future research. In particular, we [the authors] use the model to identify a short list of species that would be prime candidates for additional monitoring and study. • This is a model and thus represents "model reality". We don't focus on exact quantities of increase or decrease. Instead, we focus on general patterns and relative increase/decrease to identify sensitivities. For example, small crabs are sensitive to changes in geoduck aquaculture in the model because their response is strongly positive. • The model should not be used predictively. It would be inappropriate for anyone to make a statement like "a 120% increase in aquaculture will result in a XX% decrease in eagles, herons, or salmon". The results only suggest that these species are sensitive within the model framework such that we need more information about them. Thus these species should be targeted for monitoring and additional study. One commentor also indicated at the hearing that the Ferriss study authors were somehow "bullied" or otherwise maligned by Confluence. Clearly in reviewing the memorandum, which was provided to the authors for approval and agreement, this was not the case. Instead, these discussions were respectful and clarified the results, interpretations, and appropriate use of the Ferriss et al. study.	Confluence 2016. (Exhibit 19) Ferriss et al. 2015

Topic	Relevant Comment Letters	Response	References
6. The eelgrass delineation completed was limited in its evaluation of the environment and not conducted by a third party and therefore should not be accepted.	[PHI 7/24/23, 7/27/2023], [Tonni Johnston 1/8/24]	The eelgrass survey conducted at the site was appropriate for the site conditions, especially given that this site and the surrounding vicinity does not contain eelgrass, nor has it historically. Confluence Environmental Company has conducted 100's of eelgrass surveys in Puget Sound and would have used a similar approach as what was completed by Taylor Shellfish staff, namely photo documentation at low tide. Detailed methodology provided by the Corps and WDFW often suggest evaluating transects and placing randomly spaced quadrats to count eelgrass shoots. While these methods are appropriate for sites with eelgrass present and when eelgrass density needs to be determined, transects and quadrats are not necessary when eelgrass is absent. In fact, photo documentation of the project area provide a complete representation of eelgrass absence and actually provides more information on the entirety of the site versus a transect/quadrat approach. The Corps routinely recommends applicants use the methods used by Taylor Shellfish in areas where eelgass is not expected to occur like the project site. The agencies who routinely require eelgrass surveys (Corps, WDFW, and NFMS) have no limitation on applicants conducting eelgrass surveys themselves, provided they have the ability to identify eelgrass. Taylor staff Audrey Lamb is fully qualified to conduct such surveys.	

Topic	Relevant Comment Letters	Response	References
7. The Proposal may impact forage fish and their spawning habitat.	[PHI 7/24/23, 7/27/2023], [Michael Mason 12/2/22], [Tonni Johnson, undated], [Harry Branch 1/1/24], [PHI 1/8/24]	Commentors suggested that the project might negatively affect forage fish spawning habitat and may ingest forage fish juveniles or larvae. The only forage fish which spawn near the site are surf smelt on sands and small gravel in the high intertidal at +7 feet mean lower low water (MLLW). The closest areas where other forage fish spawn (sand lance and herring) are miles away. The proposed geoduck farm is located in the intertidal nearshore between +1 and -4.5 feet MLLW, thereby providing substantial horizontal and vertical separation from the areas where surf smelt spawn (+ 7 ft MLLW). Geoduck aquaculture activities would occur within the farm footprint and access to and from the farm would occur via boat from the waterward side of the farm, again well away from surf smelt spawning areas. Harvest activities, which have the potential to generate turbidity typically occur in the dry at low tide or during tidal stages when water is below the surf smelt spawning areas, thereby preventing any fine sediment from reaching the spawning areas. The topic of geoduck ingestion of juvenile or larval forage fish has been raised as part of the review of other geoduck farms and detailed review has occurred during permit approvals and subsequent SHB hearings SHB No. 11-019 (FF 7, 8, and COL 6); SHB No. 13-006c (FF 29 and COL 13); SHB No. 13-016c (FF 67)). In all cases the reviews found this issue to be of limited to negligible concern. These conclusions are supported by the simple fact that geoduck are selective filter feeders that typically ingest food particles that range from 1-15 microns, while larval and juvenile forage fish are typically much larger than this at 3 millimeters (3000 microns). So, while it is theoretically possible for larval fish to fit into a geoduck siphon, this would be a rare occurrence. Furthermore, geoduck filter water located within a few centimeters of its siphon located at the sediment water interface (+1 to -4.5 ft MLLW). When surf smelt eggs hatch in the upper intertidal, the larval fish are entering the water at +7 ft MLLW or greater. Thus, the smallest newly hatched larval fish are separated by 6 or more feet of the water column as well as the horizontal distance to the cultured geoduck. Both the size mismatch and the spatial separation make the risk of geoduck ingestion of larval or juvenile forage fish negligible and inconsequential.	*Coalition to Protect Puget Sound Habitat v. Pierce County*, SHB No. 11-019 (July 13, 2012); *Coalition to Protect Puget Sound Habitat v. Thurston County*, SHB No. 13-006c (October 11, 2013); *Coalition to Protect Puget Sound Habitat v. Pierce County*, SHB No. 13-016c (January 22, 2014).

Topic	Relevant Comment Letters	Response	References
8.The Proposal will negatively impact sand dollars.	[Bruce Justinen 12/5/22]	See response to comment 4. This concern has been raised in the past related to other geoduck farms (SHB 14-024). To investigate this concern, Confluence conducted an investigation looking at sand dollar presence and abundance at an active geoduck farm (~4.5 miles north of proposed project site) in comparison to an adjacent control site. The results indicated that sand dollar abundance was similar between the active farm site and control area demonstrating that geoduck farming did not result in decreased sand dollar populations and certainly did not eliminate sand dollars from the farm area.	

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Attachment 3

RAMBOLL

ENVIRONMENT
& HEALTH

MEMO

Responses to Comments on Microplastics:
Manzanti Farm Hearing

Client **Plauché & Carr LLP**
To **Jesse DeNike**
From **Rosalind A. Schoof, Ph.D.**

Date January 19, 2024

This memorandum provides responses to some of the comments made during the Manzanti farm hearing or submitted before and after the hearing about the use of plastic aquaculture gear and possible release of microplastics. These responses are intended to augment but not replace my testimony during the hearing and my memorandum titled "Microplastics Literature Update", dated and submitted on January 9, 2024.

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In my memorandum and my testimony, I noted that land-based sources are the predominant source of marine plastic debris. In one slide, I showed data from several older surveys from 2007 and 2009. The 2007 survey was a survey of the west coast of the U.S., with a focus on California beaches. One commentor suggested these surveys were too dated to be currently relevant. While these surveys are quite old, and I did not find a more recent survey of the U.S. west coast, Taylor Shellfish has documented the plastic debris found in their numerous Burley Lagoon surveys.

Taylor staff activities and findings are documented in an email to me January 12th, 2024 from Erin Ewald. Last year Taylor Shellfish staff "*conducted at least 67 patrols, throughout the Burley farm area. During which they found: 6 grow bags and approximately 20 clam sacks, all within the farm boundary. They also found approximately 5 pieces of recreational shellfish gear (untagged). They also found several dozen plastic grocery bags, paint cans, 5-gallon buckets, many dozen plastic bottles and cans, open cell float debris, and aluminum boat, canoe, dinghy, foam insulation, drainpipe, a mattress, life ring, roofing material, spent fireworks, foam filled tires, plastic lawn chairs, and a garbage can full of golf balls. The Burley farm crew participates in every industry beach cleanup. In April 2021, they collected over 3 totes of residential debris which was then recycled and disposed of*."

These findings illustrate the magnitude of land-based plastic pollution even in a protected area such as Burley lagoon. This recent information is consistent with the earlier survey results and the opinions and conclusions provided in my presentation, specifically showing that shellfish operations in the Salish Sea are not a major source of marine debris and that, in contrast, these operations may be responsible for a net reduction of marine debris.

In addition to studies of macroplastic pollution, ongoing research shows that land-based sources are significant contributors of microplastics to surface water with a positive correlation between microplastic concentration in rivers and urbanization (Watkins et al. 2019). Multiple studies show that fibers are the

predominant form of microplastics in rivers (Watkins et al. 2019). Microplastics in rivers are, in turn, a significant contributor to microplastics in nearshore marine waters.

Commentors also stated concerns about microplastics being a source of exposure to chemical additives or to persistent chemicals adsorbed to the microplastic particles. This issue is examined in a recent guidance document from the Interstate Technology & Regulatory Council (ITRC 2023). ITRC is a consortium of state regulators and other participants who draft and issue guidance documents on emerging environmental topics. With regard to the question of whether ingested microplastics serve as a vector for the transport of persistent pollutants into biota and humans, they conclude that "*[T]he more conclusive laboratory and field studies generally provided evidence for the absence of the vector effect.*" They conclude "*the available evidence does not support the assertion that MP play a major role in the bioaccumulation of POPs* [aka persistent organic pollutants] *when compared to other exposure pathways under environmentally realistic conditions.*"

At least one commenter suggested that microplastics bioaccumulate in the food chain. This assertion is not supported by a recent review by Gouin (2020) who states that microplastics "*do not bioaccumulate and do not appear to be subject to biomagnification as a result of trophic transfer through food webs*". Furthermore, most of the small number of microplastic particles found in organisms were located in the gastrointestinal tract. Shumway et al. (2023) also examine this issue and conclude that "*given the extremely low levels of MP in bivalves under field conditions, it is considered highly unlikely that transfer and amplification of levels will be prevalent.*"

In addition to these specific comments, much of the information that was presented by commenters was related to marine debris or microplastics generally and did not demonstrate that this proposed farm, or more broadly, responsibly operated shellfish aquaculture activities in the Salish Sea, generate significant amounts of marine debris or microplastics. My earlier memorandum (Exhibit 14) and presentation (Exhibit 18) address these concerns in detail; and none of the information or comments presented during the hearing altered my conclusion that the Manzanti farm will not result in the release of microplastics that would be detectable or have any adverse effects on biota or human health.

1 References

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Attachment 4

Taylor Shellfish Company
Mazanti Shellfish Farm
Project No. 2022103702
October 27, 2023

Executive Summary

This memorandum analyzes the consistency of Taylor Shellfish Company's proposed geoduck aquaculture farm ("Proposal") under Project #2022103702 with the Shoreline Management Act ("SMA") and the Shoreline Master Program for the Thurston Region ("SMPTR").

As set forth below, the Proposal fully complies with shoreline substantial development permit ("SSDP") review criteria and will not have significant adverse environmental impacts. The Proposal is not only an allowed, but a preferred use of the shoreline under the SMA, its implementing guidelines, and the SMPTR.

The Proposal is further supported by numerous laws and policies that encourage shellfish aquaculture in recognition of the important environmental, economic, and cultural benefits this use provides. The United States imports the vast majority of its seafood and suffers from a growing, annual seafood trade deficit of over $17 billion (as of 2020).[1] Authorizing new shellfish farms, such as this Proposal, is critical if we are to reverse this alarming trend. Commercial geoduck aquaculture has been extensively studied in recent years, including legislatively-directed research performed through Washington Sea Grant. These studies indicate that the environmental impacts associated with geoduck aquaculture are insignificant, temporary in nature, and within the scale of natural disturbances in Puget Sound.

The Washington Shorelines Hearings Board ("SHB") has issued numerous recent decisions confirming shellfish aquaculture is a preferred use that has insignificant environmental impacts. Most of these cases have addressed geoduck aquaculture. For example, the SHB has issued four decisions in recent years addressing challenges to permits issued by local governments for new geoduck farms. *Coalition to Protect Puget Sound Habitat v. Pierce County*, SHB No. 11-019 (July 13, 2012); *Coalition to Protect Puget Sound Habitat v. Thurston County*, SHB No. 13-006c (October 11, 2013); *Coalition to Protect Puget Sound Habitat v. Pierce County*, SHB No. 13-016c (January 22, 2014); and *Coalition to Protect Puget Sound Habitat v. Pierce County*, SHB No. 14-024 (May 15, 2015).

Appellants have raised numerous claims in contending permits should be denied or reversed for new geoduck farms. With one limited exception,[2] the SHB has consistently rejected these claims,

[1] https://www.fisheries.noaa.gov/national/aquaculture/us-aquaculture

[2] SHB No. 13-016c. The permit at issue in this case was for a proposed farm along shorelines of statewide significance and allowed for alternating 10- and 25-foot eelgrass buffers, along with monitoring and adaptive management. The SHB specifically found "a lack of complete and/or reliable scientific evidence in the record to support a buffer of this size at this Site given the scale and density of the commercial geoduck farming proposed in both intertidal and subtidal zones, and the conditions found at this Site." Finding of Fact 51. As indicated in this finding, the SHB did not find that evidence was presented proving that the farm would harm eelgrass, only that insufficient evidence was presented to support the buffers in the shoreline permit. The SHB also expressed concerns

holding impacts from geoduck farms would be insignificant and minimized through reasonable permit conditions.

Geoduck aquaculture—along with all other common forms of shellfish aquaculture—have also recently been comprehensively analyzed by the U.S. Army Corps of Engineers ("Corps") the U.S. Fish and Wildlife Service ("USFWS"), and the National Marine Fisheries Service ("NMFS") in a programmatic Endangered Species Act and Essential Fish Habitat consultation ("Programmatic Consultation"). The Programmatic Consultation cover continuing and new aquaculture projects in Washington State over an intended 20-year period.

The PBA and PBOs comprehensively analyze continuing and new aquaculture operations in Washington State, including geoduck aquaculture in South Puget Sound. The agencies' analyses focused on impacts to listed species, critical habitat, and essential fish habitat (including eelgrass and forage fish) based on current baseline conditions and projected future shellfish activities in Washington waters. Effects regarding water quality, substrate and sediments, vegetation, benthic community, fish and birds, contaminants, and noise were examined. The Programmatic Consultation documents include a programmatic biological assessment ("PBA") by the Corps, programmatic biological opinions ("PBOs") from both NMFS and USFWS, and a revised incidental take statement prepared by NMFS.[3] *See* Attachments A-D. The PBA and PBOs include over 30 terms, conditions, and conservation measures that effectively avoid and minimize potential adverse impacts to listed species, critical habitat, and essential fish habitat.[4] Attachment E.

Provided an applicant's proposal meet the following three criteria, the PBA and PBOs function as the applicant's biological evaluation:

(1) the proposed activities fall within the scope of activities described in the PBA and PBOs,
(2) the applicant can and will meet the Programmatic Consultations conservation measures, and
(3) the proposed site occurs within the geographic area considered by the Programmatic Consultation.

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with the permit's monitoring and adaptive management plan. In contrast, there is no eelgrass on or near the site of the Proposal.

[3] These documents are available at the following links, respectively, and they are also being provided to the County in support of the Proposal's application.
https://www.nws.usace.army.mil/Portals/27/docs/regulatory/NewsUpdates/Shellfish_PBA_30_Oct_2015.pdf?ver=2016-09-07-185805-287
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https://www.nws.usace.army.mil/Portals/27/docs/regulatory/160907/USFWS_Final%20BiOp_AQ%2020160826.pdf
https://www.nws.usace.army.mil/Portals/27/docs/regulatory/NewsUpdates/NMFSBiOpErrataMemoRevisedITS.pdf?ver=2016-10-03-164208-180

[4] These measures are listed in the Programmatic Consultation verification enclosure, which accompanies Corps permit decisions for projects that proceed under the Programmatic Consultation. The verification enclosure is available here:
https://www.nws.usace.army.mil/Portals/27/docs/regulatory/NewsUpdates/20181128%20Verification%20Enclosure%201.pdf?ver=wEEviExfV5z-aA3uEPh1Uw%3d%3d

The Proposal meets all three of these criteria, and thus the PBA and PBOs function as a habitat assessment report for the Proposal. Additionally, Taylor Shellfish has provided supplemental information as part of its application materials that contain site-specific information pertaining to the Project and the subject property, including an eelgrass survey that documented no eelgrass is present at or near the location of the Proposal.

As set forth in the Proposal's application materials, and as confirmed by the County's issuance of a mitigated determination of nonsignificance for the Proposal, the Proposal has insignificant impacts under the State Environmental Policy Act ("SEPA") and satisfies all permit issuance requirements. Thus, Taylor Shellfish respectfully requests the County approve the Proposal's SSDP.

The Proposal

The Proposal consists of cultivating 3.6 acres of geoduck clams on portions of parcel 93000100000 ("Site"), which is 8.5 acres in size. All farming activities would occur on privately-owned tideland within an area defined by ≤+1.0' Mean Lower Low Water ("MLLW") tidal elevation and the outer boundary at approximately ~-4.5' MLLW tidal elevation, Extreme Low Water ("ELW") MLLW tidal elevation. The size of the proposed geoduck farm is approximately 3.6 acres. Geoduck cultivation activities include seeding and planting, maintenance and growout, and harvest, as described directly below.

Seeding and Planting

Geoduck nursery gear consists of flexible HDPE mesh tubes into the substrate on approximately 15 inch centers. Hatchery-produced geoduck seed clams are placed in each tube where they burrow into the substrate. The tubes extend from the substrate approximately 9 inches, however the material is flexible and can lay flat on the substrate. Area nets are not placed over flexible mesh tubes,

Maintenance and Growout

Tubes are removed after approximately two years, and grow-out continues for approximately four to seven years. During this period, securely staked predator exclusion nets may be placed on top of the geoduck crop, or there may be no gear present. Crews conduct frequent site inspections during the grow-out period to ensure that any gear present remains properly secured and to retrieve any gear that may become loose. Activities during grow-out are limited to site inspections and monitoring of cultured organisms.

Harvest

Cultivated geoducks may take eight years after planting to reach market size or when they reach approximately one to two pounds. Animals may also remain in the ground if markets are not open and available for sale.

Geoducks are harvested using a hand-operated water wand. Typically, a wand is a pipe about 18 to 24 inches long with a nozzle on the end that releases surface-supplied seawater from a hose at a pressure of approximately 40 pounds per square inch (about the same pressure as that from a standard garden hose) and a flow of 20-30 gallons per minute.

Geoducks may be harvested during low tide or with divers when the harvest area is submerged under water. Multiple divers may work in an area at one time. Harvest occurs until all harvestable-sized geoduck are removed from the harvest area. Harvesters may make several sweeps of a tract to ensure all harvestable-sized geoduck are removed. Intakes for supplying water to the onboard pumps are positioned several feet below the water surface. The water intake hose includes a mesh screen covering the intake to prevent fish entrainment in the low-pressure pump.

Harvested geoducks are placed in baskets for transport by boat to Taylor Shellfish's processing plant in Shelton.

The Proposal is Consistent with Applicable Approval Criteria

The sections below discuss the consistency of the Proposal with SSDP approval criteria. Regulatory language is provided in normal font and descriptions as to the Proposal's compliance follow in *italics*.

I. Substantial Development Permit (SMPTR, Section One, II.A)

State law provides that permits shall be granted when a proposal is consistent with the policy of the Shoreline Management Act, the state shoreline regulations (WACs) and the local Master Program (refer to WAC 173-14).[5] SMPTR, Section One, II.A.

A. Consistency with the Policies and Procedures of the Shoreline Management Act (chapter 90.58 RCW) ("SMA").

The Proposal is consistent with the policies and procedures of the SMA. The policy of the SMA is "to provide for the management of the shorelines of the state by planning for and fostering all reasonable and appropriate uses." RCW 90.58.020. To achieve this policy, the SMA expresses a preference for uses that "are consistent with control of pollution and prevention of damage to the natural environment, or are unique to or dependent upon use of the state's shorelines." Id. The Proposal is unique to and dependent upon use of the state's shorelines. It is for the cultivation of geoduck clams in marine waters. Geoduck clams are filter feeders and depend on nutrient-rich marine waters for food. The Proposal "cannot logically exist in any other location and is dependent on the water by reason of the intrinsic nature of its operation." SMPTR,

[5] At the time the 1990 SMPTR was adopted, the criteria for SSDP approval were codified at WAC 173-14-100. The SSDP approval criteria have since been recodified at WAC 173-27-150. The criteria at WAC 173-14-100 and WAC 173-27-150 are virtually identical, although the latter regulation adds a provision granting the local government authority to attach conditions to the approval of permits as necessary to assure consistency with the SMA and the local SMP.

Section Four. See also WAC 173-26-020. Thus, the Proposal is a preferred, water-dependent use that implements the policies of the SMA.

The Proposal is also designed to minimize potential damage to the ecology and environment of the shoreline area consistent with the policies of the SMA. RCW 90.58.020. The Proposal will comply with all terms and conditions of the Programmatic Consultation. As discussed above, that consultation evaluates potential impacts to listed species, critical habitat, and essential fish habitat for shellfish activities throughout Washington State marine waters, including all potential mechanisms of effect including impacts to water quality, prey resources, and migration. The Programmatic Consultation resulted in approximately 30 terms and conditions that are recognized as effectively avoiding and minimizing potential adverse impacts. The Proposal will comply with all of these measures. As such, the Proposal is not anticipated to have a significant adverse impact on water quality, sediment, forage fish, benthic infauna or epifauna, or aquatic vegetation. The Proposal will also follow Environmental Codes of Practice to ensure all activities meet environmental standards. Additional operational measures include: (1) routine mapping, or documentation of critical areas, including identified submerged aquatic vegetation; (2) documented farm site surveys of project areas; and (3) employee training to ensure compliance with conservation measures.

Further, the Proposal is expected to have beneficial environmental impacts. For example, filter feeders such as geoducks can remove nitrogen and phosphorus from the water column, and these nutrients are ultimately removed from the ecosystem via harvest. Ass'n to Protect Hammersley, Eld, & Totten Inlets v. Taylor Res., Inc., 299 F.3d 1007, 1010 (9th Cir. 2002) ("But it must also be recognized that the mussels act as filters and are considered by many to enhance water quality by filtering excess nutrients or other matter in the water that can be destructive to marine environments"). Bioextraction of nutrients during shellfish harvest is one of the only methods available that removes nutrients after they have entered a system, which can then make that system more resilient to nutrient loading. In addition, as the Shorelines Hearings Board has recognized, "[t]he aquaculture gear used to culture geoducks, particularly the PVC tubes, creates artificial hard substrate, resulting, temporarily, in increased habitat diversity. This increased habitat diversity augments the presence of certain species at the farm site, including species important to juvenile salmon foraging along the nearshore." SHB No. 11-019, at FF 5.

Consistent with the SMA's expressed preference of aquaculture as a shoreline use, Washington State Governor Chris Gregoire unveiled the Washington Shellfish Initiative in 2011 – an agreement among federal and state government, tribes, and the shellfish industry to restore and expand Washington's shellfish resources to promote clean-water commerce and create family wage jobs. This initiative calls for:

- *Expanding, promoting and improving shellfish aquaculture in Washington;*
- *Increasing opportunities for and improving access to public tidelands for recreational shellfish harvesting;*
- *Restoring native shellfish habitat and populations such as the Olympia oyster and pinto abalone; and*
- *Improving and protecting water quality to help ensure healthy and safe shellfish for consumers.*

See Attachment F.

Following up on these initial efforts, Governor Jay Inslee launched Phase II of the Washington Shellfish Initiative in 2016 "to promote critical clean-water commerce, elevate the role that shellfish play in keeping our marine waters healthy and create family wage jobs." Attachment G, p. 1. Washington State leads the country in the production of farmed clams, oysters, and mussels (10,500 metric tons in 2013) with an estimated total economic contribution of $184 million in 2010. Id. Washington shellfish growers directly and indirectly employed over 2,700 people in the State in 2010, and are among the largest private employers in some counties. Id. A key goal of Phase II is to improve permitting processes to maintain and increase sustainable aquaculture. Attachment H. Streamlining permitting requirements is critical to increasing shellfish production in Washington State, as shellfish farmers are subject to numerous federal, state, and local permitting requirements that can be extremely costly and difficult to navigate.

The Washington State Shellfish Initiative is in line with the National Oceanic and Atmospheric Administration's ("NOAA") National Shellfish Initiative, which also seeks to stimulate coastal economies and improve the health of ailing estuaries through increasing commercial shellfish production. Attachment I.

The Proposal, therefore, advances the policies of the SMA, as well as state and federal policies that recognize shellfish aquaculture as a beneficial use that should be expanded.

B. Consistency with State Shoreline Regulations.

WAC 173-27-140 provides review criteria for all development and states:

> (1) No authorization to undertake use or development on shorelines of the state shall be granted by the local government unless upon review the use or development is determined to be consistent with the policy and provisions of the Shoreline Management Act and the master program.
> (2) No permit shall be issued for any new or expanded building or structure of more than thirty-five feet above average grade level on shorelines of the state that will obstruct the view of a substantial number of residences on areas adjoining such shorelines except where a master program does not prohibit the same and then only when overriding considerations of the public interest will be served.

The Proposal satisfies WAC 173-27-140. With respect to subsection (1), as discussed above and below, the Proposal is consistent with the policy and provisions of the SMA and the SMPTR. With respect to subsection (2), no building or other such structure is proposed, and the Proposal's gear will only protrude inches above the substrate.

WAC 173-27-150 provides review criteria for SSDPs and states:

> (1) A substantial development permit shall be granted only when the development proposed is consistent with:

(a) The policies and procedures of the act;
(b) The provisions of this regulation; and
(c) The applicable master program adopted or approved for the area. Provided, that where no master program has been approved for an area, the development shall be reviewed for consistency with the provisions of chapter 173-26 WAC, and to the extent feasible, any draft or approved master program which can be reasonably ascertained as representing the policy of the local government.
(2) Local government may attach conditions to the approval of permits as necessary to assure consistency of the project with the act and the local master program.

The Proposal satisfies WAC 173-27-150. As discussed above and below, the Proposal is consistent with the SMA and the SMPTR.

State shoreline regulations also express a preference for water-dependent uses that utilize the shoreline for economically productive uses and protect the ecological functions of shorelines. WAC 173-26-176(3). The Proposal is consistent with these regulations as it is water-dependent, economically productive, and protects the ecological functions of shorelines. Further, state regulations acknowledge aquaculture is an activity of statewide interest and when properly managed, can result in long-term over short-term benefit and protect the resources and ecology of the shoreline. WAC 173-26-241(3)(b). State shoreline regulations also identify commercial shellfish beds as critical saltwater habitat—a designation that no other commercial activity enjoys. WAC 173-26-221(2)(c)(iii)(A).

C. Consistency with the SMPTR.

As described below, the Proposal is consistent with the SMPTR. Therefore, the SSDP for the Proposal should be approved.

II. Regional Criteria (SMPTR, Section Two, V)

All development within the jurisdiction of this Master Program shall demonstrate compliance with the following policies:

A. Public access to shorelines shall be permitted only in a manner which preserves or enhances the characteristics of the shoreline which existed prior to establishment of public access.

No new public shoreline access is included with the Proposal, nor will the Proposal alter existing means of public access.

B. Protection of water quality and aquatic habitat is recognized as a primary goal. All applications for development of shorelines and use of public waters shall be closely analyzed for their effect on the aquatic environment. Of particular concern will be the preservation of the larger ecological system when a change is proposed to a lesser part of the system, like a marshland or tideland.

The Proposal is supported by the extensive analysis in the Programmatic Consultation, which function as a habitat assessment report for the Proposal. Additional project-specific assessment for the Proposal have been conducted and supplied to the County, including an eelgrass survey that documented no eelgrass present at the Site. As discussed above, the Proposal will comply with the Programmatic Consultation, and thus it is expected to protect water quality and habitat.

These conclusions are supported by the findings of Washington Sea Grant's geoduck research program. In 2007, the Legislature directed Washington Sea Grant to review existing scientific information and commission research studies related to geoduck aquaculture according to six priorities. Washington Sea Grant issued its final report associated with this research program in November 2013, concluding geoduck aquaculture has limited disruptions within the range of natural variation experienced by benthic communities in Puget Sound. Highlights include:

- *Geoduck harvest practices have minimal impacts on benthic communities of infaunal invertebrates, with no observed "spillover effect" in habitats adjacent to cultured plots, suggesting that disturbance is within the range of natural variation experienced by benthic communities in Puget Sound.*
- *Differences in the structure of mobile macrofauna communities between planted areas with nets and tubes and nearby reference beaches do not persist once nets and tubes are removed during the grow-out culture phase.*
- *Nutrients released from a typical commercial geoduck operation are low and localized effects are likely to be negligible.*
- *Geoduck aquaculture practices do not make culture sites unsuitable for later colonization by eelgrass.*

See Attachment J. See also Attachment K [Liu et al. 2015. Assessing Potential Benthic Impacts of Harvesting the Pacific Geoduck Clam Panopea generosa in Intertidal and Subtidal Sites in British Columbia, Canada, Journal of Shellfish Research, 34(3): 757-775 (finding no significant impacts to sediment characteristics, the infaunal community, or eelgrass plant parameters at intertidal and subtidal areas associated with harvesting activities)].

This research demonstrates that, similar to other forms of shellfish aquaculture, geoduck farming does not have significant environmental impacts when properly managed. The SHB has recognized Washington Sea Grant as the authority on the environmental impacts of geoduck farms. Specifically, in finding that the aquaculture gear and harvesting activities of a newly permitted geoduck farm will not likely cause adverse environmental impacts, the SHB relied on Washington Sea Grant, acknowledging "it is the most specific and relevant scientific information currently available on this subject." SHB No. 14-024 (FF 17).

In addition, Taylor Shellfish will comply with the most current version of the Washington State Environmental Codes of Practice for Pacific Coast Shellfish Aquaculture, which include routine inspections of aquaculture gear and locating geoduck aquaculture activities away from eelgrass, kelp, and documented forage fish spawning habitat. These conditions, in conjunction with the research and documentation discussed above regarding the impacts of geoduck aquaculture, confirm the Proposal will protect water quality and aquatic habitat.

C. Future water-dependent or water-related industrial uses shall be channeled into shoreline areas already so utilized or into those shoreline areas which lend themselves to suitable industrial development. Where industry is now located in shoreline areas that are more suited to other uses, it is the policy of this Master Program to minimize expansion of such industry.

No industrial uses are proposed.

D. Residential development shall be undertaken in a manner that will maintain existing public access to the publicly-owned shorelines and not interfere with the public use of water areas fronting such shorelines, nor shall it adversely affect aquatic habitat.

No residential development is proposed.

E. Governmental units shall be bound by the same requirements as private interests.

This is a private proposal, not a proposal by a governmental unit.

F. Applicants for permits shall have the burden of proving that a proposed substantial development is consistent with the criteria which must be met before a Permit is granted. In any review of the granting or denial of an application for a permit as provided in RCW 90.58.18.180 (1), the person requesting the review shall have the burden of proof.

As described in this consistency analysis and the Staff Report, the Proposal is consistent with all applicable criteria for SSDP approval.

G. Shorelines of this Region which are notable for their aesthetic, scenic, historic or ecological qualities shall be preserved. Any private or public development which would degrade such shoreline qualities shall be discouraged. Inappropriate shoreline uses and poor quality shoreline conditions shall be eliminated when a new shoreline development or activity is authorized.

The Property is not notable for its aesthetic, scenic, historic or ecological qualities, and it does not contain any native eelgrass, rooted kelp or cultural resources. As discussed above, the Proposal will have minimal environmental impacts, including to aesthetic, scenic, historic, and ecological qualities. The Proposal's geoduck tubes and netting will only be present for a limited portion of the cultivation cycle and will only be visible for a small percentage of daylight hours. Geoduck nets and tubes will be secured in place to prevent them from escaping. No permanent lighting will be used, and temporary lighting will be directed to minimize off-site glare. The Proposal will fully comply with the terms and conditions of the Programmatic Consultation and Environmental Codes of Practice for geoduck cultivation.

Because the Property does not have notable aesthetic, scenic, historic, or ecological qualities, and the Proposal is designed to protect existing conditions, it is consistent with this policy.

H. Protection of public health is recognized as a primary goal. All applications for development or use of shorelines shall be closely analyzed for their effect on the public health.

Nutritionists encourage Americans to increase their seafood consumption for heart health. The goal of the Proposal is to cultivate geoduck clams for harvest, sale, and distribution in local, national, and international markets. Market studies indicate a high demand for additional geoduck clams grown in Washington State, and the Proposal will help meet this demand. Further, the Proposal will have beneficial ecological impacts by improving water quality and providing artificial hard substrate allowing for increased habitat diversity.

III. Aquacultural Activities (SMPTR, Section Three, II)

A. Scope and Definition

Aquaculture involves the culture and farming of food fish, shellfish, and other aquatic plants and animals in lakes, streams, inlets, bays and estuaries. Aquacultural practices include the hatching, cultivating, planting, feeding, raising, harvesting and processing of aquatic plants and animals, and the maintenance and construction of necessary equipment, buildings and growing areas. Methods of aquaculture include but are not limited to fish hatcheries, fish pens, shellfish rafts, racks and longlines, seaweed floats and the culture of clams and oysters on tidelands and subtidal areas.

The Proposal qualifies as aquaculture, as it involves the culture and farming of geoduck clams on tidelands.

B. Policies

1. The Region should strengthen and diversify the local economy by encouraging aquacultural uses.

As discussed above, the Proposal advances this goal. It strengthens and diversifies the local economy by helping to support a local shellfish farming company, providing revenue for upland property owners, and increasing tax revenue. It also helps reduce our nation's overreliance on foreign aquaculture products and combats the +$17 billion seafood trade deficit in furtherance of national and state aquaculture policies. See also RCW 15.85.010 (encouraging promotion of aquaculture activities throughout Washington State).

2. Aquacultural use of areas with high aquacultural potential should be encouraged.

The Property has high aquaculture potential. The beach characteristics meet the necessary biophysical requirements for successful geoduck aquaculture. Water quality is good at this location.

3. Flexibility to experiment with new aquaculture techniques should be allowed.

The Proposal will utilize aquacultural techniques that have proven to be effective and ecologically beneficial.

4. Aquacultural enterprises should be operated in a manner that allows navigational access of shoreline owners and commercial traffic.

The Proposal is designed and conditioned to minimize impacts to views from upland property. The Proposal does not include permanent lighting, and any temporary lighting will be directed to minimize off-site glare. Taylor Shellfish will regularly patrol the Property and nearby beaches for escaped gear, and the company will comply with the Environmental Codes of Practice for shellfish aquaculture. Geoduck aquaculture gear will only be in place on the beach for a portion of each cultivation cycle, and even when it is present it will only be visible for a small percentage of daylight hours.

5. Aquacultural development should consider and minimize the detrimental impact it might have on views from upland property.

The Proposal has been designed and mitigated to minimize views from upland property. The MDNS prohibits permanent lighting and requires temporary lighting to be directed in a manner to minimize off-site glare. It further requires the Applicant to patrol the Property and nearby beaches for escaped debris on a regular basis and after each severe storm event, and it mandates compliance with the Environmental Codes of Practice for shellfish aquaculture. Geoduck aquaculture gear will only be in place on the beach for a limited portion of each cultivation cycle, and it will only be visible for a small percentage of daylight hours when it is present. The netting over PVC tubes serves to reduce the visual impact of the farm and prevent the escapement of tubes, as well as protect the juvenile geoduck from predation.

6. Proposed surface installations should be reviewed for conflicts with other uses in areas that are utilized for moorage, recreational boating, sport fishing, commercial fishing or commercial navigation. Such surface installations should incorporate features to reduce use conflicts. Unlimited recreational boating should not be construed as normal public use.

The Proposal has minimal potential for use conflicts. It is located on private tidelands, utilizes gear for a limited period of the cultivation cycle, and the gear will protrude inches above the substrate. There are no established commercial navigation channels over the Property and there are no established public recreational uses in the immediate vicinity. Finally, the geoduck tubes will be submerged for the vast majority of the time they are present on the beach, causing no obstruction to use of the waters over which the geoduck bed will be located.

7. Areas with high potential for aquacultural activities should be protected from degradation by other types of uses which may locate on the adjacent upland.

The adjacent upland property does not threaten or endanger the Proposal. The area is approved for shellfish harvesting by the Washington State Department of Health. If approved, the Proposal will help ensure actions are taken in the future to ensure water quality remains high.

8. Proposed aquacultural activities should be reviewed for impacts on the existing plants, animals and physical characteristics of the shorelines.

Taylor Shellfish has provided the County with information to thoroughly review the Proposal's impacts on existing plants, animals, and physical characteristics of the shorelines, including environmental report prepared specifically for the Proposal (such as the eelgrass survey, which found no eelgrass present at the Property), the findings of the Washington Sea Grant geoduck research program, the most recent decisions of the Shorelines Hearings Board, state law, and public policy supporting this ecologically and economically important use.

9. Proposed uses located adjacent to existing aquaculture areas which are found to be incompatible should not be allowed.

There are no known development proposals that would be incompatible with Taylor Shellfish's proposed geoduck farm. The Proposal would be consistent and compatible with existing shellfish farms in the area.

C. <u>General Regulations</u>

1. Aquaculture development shall not cause extensive erosion or accretion along adjacent shorelines.

The issue of sediment erosion and accretion has been addressed and resolved in multiple hearings addressing geoduck aquaculture, including SHB No. 11-019 (FF 6, 14, 16, and COL 6, 14); SHB No. 13-006c (FF 24-26, 30-32 and COL 13, 15); SHB No. 14-024 (FF 32-38 and COL 13, 19). As discussed in these decisions, geoduck aquaculture does not cause extensive erosion or accretion along adjacent shorelines. Geoduck harvest or the presence of culture tubes and/or predator exclusion nets does not significantly impact sediment transport or bathymetry. Minor changes in elevation may persist for limited periods, but these effects are temporary and insignificant compared to the dynamic nature of sediment distribution potential along the shoreline.

2. Aquacultural structures and activities that are not shoreline dependent (e.g., warehouses for storage of products, parking lots) shall be located to minimize the detrimental impact to the shoreline.

The Proposal is shoreline dependent.

3. Proposed aquaculture processing plants shall provide adequate buffers to screen operations from adjacent residential uses.

No new processing plants are proposed. All processing of geoduck clams from the Proposal will occur off-site.

4. Proposed residential and other developments in the vicinity of aquaculture operations shall install drainage and waste water treatment facilities to prevent any adverse water quality impacts to aquaculture operations.

No residential or other developments are proposed.

5. Land clearing in the vicinity of aquaculture operations shall not result in offsite erosion, siltation or other reductions in water quality.

No land clearing is proposed.

6. For nonaquacultural development or uses proposed within or adjacent to an Aquacultural District, or which may be adversely affected by the aquaculture operation, restrictive covenants shall be filed which will inform prospective buyers of the proximity of the Aquacultural District.

No nonaquacultural development or uses are proposed.

7. Establishment of an Aquacultural District. Due to the importance of aquaculture to the Thurston County economy and the unique physical characteristics required to initiate or continue an operation, this section allows for the establishment of an Aquacultural District. The permit for an Aquacultural District will be issued for a specific area. Development authorized within the District will be generally described and located to provide for the range of development associated with the aquaculture operation. The applicant for a District will provide the boundaries of the use area, location and size of upland structures, maximum size, height and surface area coverage of in-water structures, and a description of activities in sufficient detail to determine possible impacts. The activities within an Aquacultural District shall be reviewed on a periodic basis to assure compliance with the permit. If the Administrator finds that an activity or environmental impact is substantially different than that considered in the permit approval then action shall be taken to bring the operation into compliance with the permit. The applicant must be the lessee or owner of the property proposed for inclusion within an Aquacultural District.

The Proposal does not include the establishment of an Aquacultural District.

D. Environmental Designations and Regulations

1. Urban, Suburban, Rural, Conservancy and Natural-Aquatic Environments. All types of aquaculture are allowed, provided the operation is consistent with the policies and regulations of this program and chapter.

The Proposal is located in the Conservancy Environment. As described in this memorandum and the Staff Report, the Proposal is a type of aquaculture and is consistent with the policies and regulations of the SMPTR. Therefore, the Proposal is an allowed use in the Conservancy Environment and should be approved pursuant to an SSDP.

Taylor Shellfish Company, Mazanti Shellfish Farm
Project No. 2022103702
Consistency Analysis

Attachment E

Enclosure 1: Conservation Measures and applicable terms and conditions from the Programmatic Biological Opinions for Shellfish Activities in Washington State Inland Marine Waters (U.S. Fish and Wildlife Service (USFWS) Reference Number 01EWFW00-2016-F-0121, National Marine Fisheries Service (NMFS) Reference Number WCR-2014-1502).

1. Gravel and shell shall be washed prior to use for substrate enhancement (e.g., frosting, shellfish bed restoration) and applied in minimal amounts using methods which result in **less than 1 inch** depth on the substrate annually. Shell material shall be procured from clean sources that do not deplete the existing supply of shell bottom. Shells shall be cleaned or left on dry land for a minimum of one month, or both, before placement in the marine environment. Shells from the local area shall be used whenever possible. Shell or gravel material shall not be placed so that it creates piles on the substrate. Use of a split-hull (e.g., hopper-type) barge to place material is prohibited.

2. The placement of gravel or shell directly into the water column (i.e., graveling or frosting) shall not be conducted between February 1 and March 15 in designated critical habitat for Hood Canal summer chum salmon.

3. For 'new[1] ' activities only, gravel or shell material shall not be applied to enhance substrate for shellfish activities where native eelgrass (*Zostera marina*) or kelp (rooted/attached brown algae in the order *Laminariales*) is present.

4. Turbidity resulting from oyster dredge harvest shall be minimized by adjusting dredge bags to "skim" the surface of the substrate during harvest.

5. Unsuitable material (e.g., trash, debris, car bodies, asphalt, tires) shall not be discharged or used as fill (e.g., used to secure nets, create nurseries, etc.).

6. For 'new' activities only, shellfish activities (e.g., racks, stakes, tubes, nets, bags, long-lines, on bottom cultivation) shall not occur within 16 horizontal feet of native eelgrass (*Zostera marina*) or kelp (rooted/attached brown algae in the order *Laminariales*). If eelgrass is present in the vicinity of an area new to shellfish activities, the eelgrass shall be delineated[2] and a map or sketch prepared and submitted to the Corps. Surveys to determine presence and location of eelgrass shall be done during times of peak above-ground biomass: June 1 – September 30. The following information must be included to scale: parcel boundaries, eelgrass locations and on-site dimensions, shellfish activity locations and dimensions.

7. For 'new' activities only, activities shall not occur above the tidal elevation of +7 feet (MLLW) if the area is listed as **documented** surf smelt (*Hypomesus pretiosus*) spawning habitat

[1] 'New' activities are those activities that were initiated after 18 March 2007. Expansion of activities into a new geographic footprint that had not previously been in commercial aquaculture is treated as a new footprint for the purpose of this programmatic ESA.

[2] For guidance see Corps' Seattle District *Components of a Complete Eelgrass Delineation and Characterization Report (May 2016).*

by WDFW. A map showing the location of documented surf smelt spawning habitat is available at the WDFW website.

8. For 'new' activities only, activities shall not occur above the tidal elevation of +5 feet (MLLW) if the area is **documented** as Pacific sand lance (*Ammodytes hexapterus*) spawning habitat by the WDFW. A map showing the location of documented Pacific sand lance spawning habitat is available at the WDFW website.

9. If conducting 1) mechanical dredge harvesting, 2) raking, 3) harrowing, 4) tilling, leveling or other bed preparation activities, 5) frosting or applying gravel or shell on beds, or 6) removing equipment or material (nets, tubes, bags) within a **documented or potential** spawning area for Pacific herring (*Clupea pallasi*) outside the approved work window[3], the work area shall be surveyed for the presence of herring spawn prior to the activity occurring. Vegetation, substrate, and materials (nets, tubes, etc.) shall be inspected. If herring spawn is present, these activities are prohibited in the areas where spawning has occurred until such time as the eggs have hatched and herring spawn is no longer present. A record shall be maintained of spawn surveys including the date and time of surveys; the area, materials, and equipment surveyed; results of the survey, etc. The Corps and the Services shall be notified if spawn is detected during a survey. The record of spawn surveys shall be made available upon request to the Corps and the Services.

10. For 'new' activities only, activities occurring in or adjacent to **potential** spawning habitat for sand lance, or surf smelt shall have a spawn survey completed in the work area by an approved biologist[4] prior to undertaking bed preparation, maintenance, and harvest activities if work will occur outside approved work windows[3] for these species. If eggs are present, these activities are prohibited in the areas where spawning has occurred until such time as the eggs have hatched and spawn is no longer present. If eggs are not present, work can occur for two weeks. After two weeks, a new forage fish spawn survey shall be completed if still outside the approved work windows. A record shall be maintained of spawn surveys including the date and time of surveys; the area, materials, and equipment surveyed; results of the survey, etc. The Corps and the Services shall be notified if spawn is detected during a survey. The record of spawn surveys shall be made available upon request to the Corps and the Services.

11. All shellfish gear (e.g., socks, bags, racks, marker stakes, rebar, nets, and tubes) that is not immediately needed or is not firmly secured to the substrate will be moved to a storage area landward of MHHW prior to the next high tide. Gear that is firmly secured to the substrate may remain on the tidelands for a consecutive period of time up to 7 days. Note: This is not meant to apply to the wet storage of harvested shellfish.

12. All pump intakes (e.g., for washing down gear) that use seawater shall be screened in accordance with NMFS and WDFW criteria. Note: This does not apply to work boat motor intakes (jet pumps) or through-hull intakes.

13. Land vehicles (e.g., all-terrain, trucks) shall be washed in an upland area such that wash water is not allowed to enter any stream, waterbody, or wetland. Wash water shall be disposed of

[3] See Seattle District website for work window http://www.nws.usace.army.mil/Missions/Civil-Works/Regulatory/
[4] For information on how to become an "approved biologist" for conducting forage fish surveys contact WDFW

upland in a location where all water is infiltrated into the ground (i.e., no flow into a waterbody or wetland).

14. Land vehicles shall be stored, fueled, and maintained in a vehicle staging area located 150 feet or more from any stream, waterbody, or wetland. Where this is not possible, documentation must be provided to the Corps as to why compliance is not possible, written approval from the Corps must be obtained, and the operators shall have a spill prevention plan and maintain a readily-available spill prevention and clean-up kit.

15. For boats and other gas-powered vehicles or power equipment that cannot be fueled in a staging area 150 feet away from a waterbody or at a fuel dock, fuels shall be transferred in Environmental Protection Agency (EPA)-compliant portable fuel containers during refilling. A polypropylene pad or other appropriate spill protection and a funnel or spill-proof spout shall be used when refueling to prevent possible contamination of waters. A spill kit shall be available and used in the event of a spill. All spills shall be reported to the Washington Emergency Management Office at (800) 258-5990. All waste oil or other clean-up materials contaminated with petroleum products will be properly disposed of off-site.

16. All vehicles operated within 150 feet of any stream, waterbody, or wetland shall be inspected daily for fluid leaks before leaving the vehicle staging area. Any leaks detected shall be repaired in the vehicle staging area before the vehicle resumes operation and the leak and repair documented in a record that is available for review on request by the Corps and Services.

17. The direct or indirect contact of toxic compounds including creosote, wood preservatives, paint, etc. within the marine environment shall be prevented. [This does not apply to boats]

18. All tubes, mesh bags and area nets shall be clearly, indelibly, and permanently marked to identify the permittee name and contact information (e.g., telephone number, email address, mailing address). On the nets, identification markers shall be placed with a minimum of one identification marker for each 50 feet of net.

19. All equipment and gear including anti-predator nets, stakes, and tubes shall be tightly secured to prevent them from breaking free.

20. All foam material (whether used for floatation of for any other purpose) must be encapsulated within a shell that prevents breakup or loss of foam material into the water and is not readily subject to damage by ultraviolet radiation or abrasion. Un-encapsulated foam material used for current on-going activities shall be removed or replaced with the encapsulated type.

21. Tires shall not be used as part of above and below structures or where tires could potentially come in contact with the water (e.g., floatation, fenders, hinges). Tires used for floatation currently shall be replaced with inert or encapsulated materials, such as plastic or encased foam, during maintenance or repair of the structure.

22. At least once every three months, beaches in the project vicinity will be patrolled by crews who will retrieve debris (e.g., anti-predator nets, bags, stakes, disks, tubes) that escape from the

project area. Within the project vicinity, locations will be identified where debris tends to accumulate due to wave, current, or wind action, and after weather events these locations shall be patrolled by crews who will remove and dispose of shellfish related debris appropriately. A record shall be maintained with the following information and the record will be made available upon request to the Corps, NMFS, and USFWS: date of patrol, location of areas patrolled, description of the type and amount of retrieved debris, other pertinent information.

23. When performing other activities on-site, the grower shall routinely inspect for and document any fish or wildlife found entangled in nets or other shellfish equipment. In the event that fish, bird, or mammal is found entangled, the grower shall: 1) provide immediate notice (within 24 hours) to WDFW (all species), USFWS/NMFS (all species) or Marine Mammal Stranding Network (marine mammals), 2) attempt to release the individual(s) without harm, and 3) provide a written and photographic record of the event, including dates, species identification, number of individuals, and final disposition, to the Corps and Services. Contact the U.S. Fish and Wildlife Service Law Enforcement Office at (425) 883-8122 with any questions about the preservation of specimens.

25. Vehicles (e.g., ATVs, tractors) shall not be used within native eelgrass (*Zostera marina*). If there is no other alternative for site access, a plan will be developed describing specific measures and/or best management practices that will be undertaken to minimize negative effects to eelgrass from vehicle operation. The access plan shall include the following components: (a) frequency of access at each location, (b) use of only the minimum vehicles needed to conduct the work and a description of the minimum number of vehicles needed at each visit, and (c) consistency in anchoring/grounding in the same location and/or traveling on the same path to restrict eelgrass disturbance to a very small footprint.

26. Vessels shall not ground or anchor in native eelgrass (*Zostera marina*) or kelp (rooted/attached brown algae in the order *Laminariales*) and paths through native eelgrass or kelp shall not be established. If there is no other access to the site or the special condition cannot be met due to human safety considerations, a site-specific plan shall be developed describing specific measures and/or best management practices that will be undertaken to minimize negative effects to eelgrass and kelp from vessel operation and accessing the shellfish areas. The access plan shall include the following components: (a) frequency of access at each location, (b) use of only the minimum number of boats and/or crew members needed to conduct the work and a description of the minimum number of boats and crewmembers needed at each visit, and (c) consistency in disturbance to a very small footprint.

27. Unless prohibited by substrate or other specific site conditions, floats and rafts shall use embedded anchors and midline floats to prevent dragging of anchors or lines. Floats and rafts that are not in compliance with this standard shall be updated to meet this standard during scheduled maintenance, repair, or replacement or before the end of the term of the next renewed authorization. [Any alternative to using an embedded anchor must be approved by the NMFS.]

28. Activities that are directly associated with shellfish activities (e.g., access roads, wet storage) shall not result in removal of native riparian vegetation extending landward 150 feet horizontally

from MHHW (includes both wetland and upland vegetation) and disturbance shall be limited to the minimum necessary to access or engage in shellfish activities.

29. Native salt marsh vegetation shall not be removed and disturbance shall be limited to the minimum necessary to access or engage in shellfish activities.

30. Ensure clam and other shellfish cover nets are secured to the extent practicable. If fish are entangled, record and report species, time, and location of entanglement. Collected specimens of fish entangled shall be preserved in a freezer, and reporting shall be to the NMFS' Lacey Office in order to determine appropriate steps to ascertain the entangled species. Contact the NMFS Central Puget Sound Branch Chief by telephone or email.

31. Only oyster long lines (with flip bags ok) spaced laterally at 10 feet intervals shall be used in **fallow**[5] areas that have been colonized by eelgrass in greater **Puget Sound and Hood Canal**. Flip bags must be suspended above the substrate so they do not rest on substrate at low tide. No other culture methods shall be used in fallow areas colonized by eelgrass. Further, with the exception of mechanical longline harvest, no mechanized activities shall occur in fallow areas colonized by eelgrass. This Term and Condition does not apply to fallow areas in Willapa Bay or Grays Harbor.

32. In **Hood Canal** summer-run chum salmon designated critical habitat[6]: Between February 1 and April 30, shellfish planting and harvesting shall not occur within 15 feet waterward of the waterline (tideline) to protect juvenile chum salmon. In addition, shellfish activities which increase turbidity in the nearshore water (e.g., geoduck harvest) shall not occur at all during this timeframe

[5] Fallow refers to areas that are periodically allowed to lie fallow as part of normal operations.
[6] Critical habitat for Hood Canal summer-run chum salmon occur in Hood Canal and the Strait of Juan de Fuca marine areas in Clallam, Jefferson, Kitsap, and Mason Counties. Exact locations and excluded areas are described at: http://www.westcoast.fisheries.noaa.gov/publications/frn/2005/70fr52739.pdf

Taylor Shellfish Company, Mazanti Shellfish Farm
Project No. 2022103702
Consistency Analysis

Attachment F

WASHINGTON SHELLFISH INITIATIVE

The Washington State Shellfish Initiative is a convergence of the National Oceanic and Atmospheric Administration's (NOAA) National Shellfish Initiative and the State's interest in promoting a critical clean water industry. While the initiative supports Governor Gregoire's goal of a "dig-able" Puget Sound by 2020, it also encompasses the extraordinary value of shellfish resources on the coast. As envisioned, the initiative will protect and enhance a resource that is important for jobs, industry, citizens and tribes.

Overview

Washington State is taking additional action to protect and enhance shellfish resources. This effort supports the long-term goal of abundant shellfish resources for Washington's residents and Native American tribes, as well as a thriving and healthy shellfish aquaculture industry. As an outcome of the 2007 treaty rights settlement, many Puget Sound tribes are undertaking shellfish aquaculture as a means of enhancing shellfish resources for cultural and economic gain.

We recognize and respect that shellfish aquaculture and commercial and tribal harvest of wild shellfish resources are water-dependent uses that rely on excellent water quality. Shellfish also can help filter and improve the quality of our marine waters thereby being part of the solution to restore and preserve the health of endangered waters. We can have healthy marine waters and productive shellfish beds for a growing industry, Native American tribes and for all the citizens of Washington.

The Puget Sound Partnership has targeted a net increase from 2007 to 2020 of 10,800 harvestable shellfish acres, which includes 7,000 acres where harvest is currently prohibited in Puget Sound. However, the recent shellfish downgrade in Samish Bay is a reminder of the constant vigilance needed by landowners, businesses and local, state, federal and tribal governments to protect and restore shellfish beds. Such efforts also are required on the coast where there is considerable opportunity to enhance shellfish resources.

To restore and expand shellfish resources, Washington must renew its protection, restoration and enhancement efforts. These efforts will pay off in increased recreation, additional clean water jobs, and a healthier Puget Sound and coastal marine waters.

Shellfish: Jobs and Economic Opportunity

Shellfish are critical to the health of Washington's marine waters and the state's economy. Washington leads the country in production of farmed clams, oysters and mussels with an annual value of over $107 million. Washington shellfish growers directly and indirectly employ over 3,200 people and provide an estimated total economic contribution of $270 million. Surveys from the early 2000's indicate shellfish growers are the largest private employer in Pacific County and the second largest in Mason County. In just those two counties, they generate over $27 million annually in payroll. In addition, there is ceremonial and subsistence harvest in Puget Sound and coastal waters that tribes consider invaluable and unquantifiable.

Bivalves coming from Washington's cool clean waters are prized as some of the best in the world. This reputation has ensured that domestic and international demand for them has long exceeded

supply. This strong demand has fostered continued growth of shellfish production and hiring even during the current economic downturn. Implementation of the NOAA's National Shellfish Initiative in Washington will enable shellfish aquaculture in the state to expand to meet the demand for quality shellfish providing critical new jobs in rural Western Washington.

Annually, tourists and residents purchase over 300,000 licenses to harvest clams and oysters from Washington waters, providing more than $3.3 million in state revenues. WDFW conservatively estimates that the 125,000 shellfish harvesting trips made each year to Puget Sound beaches provide a net economic value of $5.4 million to the region. On Washington's coast, an average of 244,000 digger trips are made each season to harvest razor clams contributing an estimated $22 million value to the coastal economies.

Shellfish Initiative

1. Create a Public/Private Partnership for Shellfish Aquaculture

Federal, state and local model permitting program. Provide unified state leadership from state natural resource agencies by identifying a shellfish aquaculture coordinating lead for the state and a lead in each agency. Use the Governor's Office of Regulatory Assistance (ORA) to facilitate the state team. Formalize clear and efficient coordination among state and federal agencies, tribes and local governments for permitting and licensing. Develop and implement a Model Permitting Program that ensures early and continued coordination from all parties, with an operational agreement that commits all parties to see each project through from beginning to end. The goal of the program is to develop a consistent process for improved timeliness of permit decisions while ensuring regulatory compliance. The process will address tribal notification and consultation protocols. The process also will address opportunities for early and ongoing dialogue with permittees and others. The Model Permitting Program will be based on existing, successful programs like the MAP Team (Multi-Agency Permitting) which has a proven record of promoting coordinated decision making. The permitting team has initiated work on a draft operational agreement.

Continue vital shellfish aquaculture research. Sustain research on key issues related to aquaculture management and planning. Seek opportunities to partner with NOAA, Washington Sea Grant, USGS and others to build on existing programs and to build our understanding of shellfish and aquaculture in the Pacific Northwest. Priority should be given to research on geoduck aquaculture, the role of shellfish in nutrient cycling and other aspects of ecosystem services provided by shellfish. New research projects include:

- The Jamestown S'Klallam Tribe recently received their state 401 Water Quality Certification for a new geoduck farm which includes a significant monitoring component for evaluating potential impacts to adjacent eelgrass beds. The data from this monitoring will help improve understanding of the relationship between farms and eelgrass.
- Washington Sea Grant will provide $79,198 over two years to support development of a model that will serve as an innovative tool to assess the risk of toxic blooms in Puget Sound. WSG-funded research will study the cyst stage of the toxic algae Alexandrium catenella, responsible for paralytic shellfish poisoning, and evaluate the effectiveness of using cyst mapping as a tool for early warning of bloom events in Puget Sound.
- Washington Sea Grant will host a public symposium to share latest scientific research findings on shellfish production effects on the environment. The meeting will explore the scientific

basis for management decisions to balance competing land use interests, environmental protection and coastal development needs

Implement pilots. Implement pilot projects and use the Model Permitting Program to determine permitting efficiency, practicality and regulatory compliance (e.g., habitat protection). Potential pilots include a Washington Department of Natural Resources (DNR) lease site and North Sound restoration projects in bays like Sequim, Similk and Fidalgo.

Improve guidance for local shoreline master programs. Increase local government and public understanding and application of the new shellfish provisions in State Shoreline Guidelines (Chapter 173-26 WAC). The Department of Ecology (Ecology) will publish an aquaculture Shoreline Master Program Handbook section with special emphasis on geoduck aquaculture and net pen operations, update its aquaculture web resources to make them more comprehensive, and provide direct technical assistance and training to local governments. The guidance will address regulatory and technical assistance to protect against habitat impacts and planning to minimize conflicts with adjoining shoreline owners and other marine water users.

Review of shellfish ecosystem services. U.S. Geological Survey will conduct a review of available filter feeding models to quantitatively evaluate the capacity of cultivated shellfish to mitigate nitrogen pollution in Puget Sound. This work will be informed by NOAA research. If appropriate and feasible, Ecology will explore the possibility of implementing a nitrogen credit system using shellfish for pollution reduction. The credit system could stimulate new shellfish culture and jobs as well as identifying the role of shellfish in reducing nitrogen discharges.

2. Promote Native Shellfish Restoration and Recreational Shellfish Harvest

Restore native shellfish. Native shellfish restoration efforts will focus on two species: native Olympia oysters and pinto abalone.

Olympia oysters:

- Restore 19 historic, large, Puget Sound natural oyster beds and associated local ecosystems by 2022.
- Direct a $200,000 NOAA grant to the Northwest Straits Commission for Olympia oyster restoration in the North Sound.
- Revise and update Washington Department of Fish and Wildlife's (WDFW) 1998 Native Oyster Rebuilding Plan by December 31, 2011. Share the revised plan with NOAA for inclusion in the national Oyster Restoration Plan. WDFW's standardized metrics will be used to determine success.
- Increase collaboration with NOAA for assistance in funding and facilitating Olympia oyster research and restoration efforts conducted by WDFW, Puget Sound Restoration Fund (PSRF), tribal co-managers, shellfish growers and other partners.
- NOAA is planning to host a hatchery breeding program for native oysters to increase seed production that meets established genetic conservation guidelines.

Pinto abalone:

- Use a $560,000 federal grant awarded by NOAA to WDFW in September to bolster the number of pinto abalone. The program aims to re-establish a self-sustaining population of pinto abalone without ESA protections. The NOAA-funded research, coupled with

continued state funding, will advance abalone restoration efforts by developing hatchery and nursery programs for captive propagation and rearing. Priority abalone actions will be conducted by WDFW, Puget Sound Restoration Fund, University of Washington and non-profit organizations.

Enhance recreational shellfish harvest. Improve and increase public access to shellfish on public tidelands for tribal and recreational harvest through signage, maps, acquisition and other efforts.

Create public support for shellfish initiative. Leverage Washington State Parks to engage the public in the initiative.

- Washington Sea Grant will lead the state agencies and partners through a simple planning process to develop shellfish-related messages, publicize events, and otherwise develop materials to make connections between clean water, our region's shellfish resources and jobs.
- State Parks will conduct shellfish interpretive programs and events to help forge personal connections between clean, productive Puget Sound waters, the shellfish we eat, and the iconic role shellfish occupy in Washington's cultural and culinary identity. State Parks will collaborate with other public/tribal/private interests and help promote support of public lands and the Discover Pass program.

3. Ensure Clean Water to Protect and Enhance Shellfish Beds

Direct $4.5 million in Environmental Protection Agency funding to protect and improve water quality to meet state standards in commercial, recreational and tribal shellfish growing areas. Funds will be used to help reach the Puget Sound Partnership's shellfish indicator target of upgrading 10,800 acres of harvestable shellfish beds by 2020. The Department of Health (DOH) and Ecology are managing this new funding, which includes the following:

- More than $2 million to help local governments create sustainable pollution identification and correction (PIC) programs. These programs will be designed to identify and address pathogen and nutrient pollution from a variety of nonpoint sources, including on-site sewage systems, farm animals, pets, sewage from boats and stormwater runoff. Counties being offered funding pending negotiations are San Juan, Thurston, Pierce, Skagit and Kitsap, as well as the Hood Canal Coordinating Council, the consortium of counties and tribes that encompass the Hood Canal.
- More than $1 million to help local health jurisdictions carry out onsite sewage system management plans that inventory, inspect, and fix failing on-site sewage systems in Marine Recovery Areas and other areas sensitive to pathogen pollution.
- $1.5 million to reduce pathogen and nutrient loading by improving manure management in those areas with PIC programs. The fund will pay for eligible agricultural best management practices, including livestock exclusion fencing, off-stream watering, and livestock feeding. Interested land owners must work through a conservation district local government, tribe or other governmental entity. Some of this work can be implemented by putting the newly created Sound Corps to work.
- Increase local government understanding and application of practices for controlling pathogens, consistent with Chapter 173-201 WAC. Ecology will provide guidance on nonpoint source BMPs consistent with state water quality standards as well as training to local governments to ensure that PIC programs and federal funding implement these standards.

- Develop economically viable strategies to address impacts from stormwater and wastewater treatment outfalls, which are a significant factor for shellfish bed prohibitions.

Improve shellfish growing area protection and restoration efforts. Additional efforts are needed at all levels of government to improve water quality protections for shellfish growing areas. Two immediate steps are to:

- Form an EPA and state (i.e., Ecology, DOH, Washington State Department of Agriculture) "pollution action team" to respond quickly when water quality problems are identified that threaten to shellfish areas. The team will focus in priority areas and support PIC programs where established. The team will work with technical staff from affected tribes with treaty reserved rights. Services provided by the team include pollution identification, inspections, enforcement, flyovers and technical assistance, consistent with guidance provided for use of federal funds. The team will focus initially in Drayton Harbor and Portage Bay. There has been a long struggle to protect the community shellfish beds in Drayton Harbor, and there are growing concerns over tribal resources in Portage Bay. The Whatcom Conservation District will be a key local partner in working with the state and federal pollution action team.

Take steps to address ocean acidification. Conduct research and develop recommendations to understand, monitor, mitigate and adapt to acidification in Puget Sound and Washington waters.

- Convene a Blue Ribbon Panel on Ocean Acidification including scientific experts, the relevant agencies and stakeholders to develop clear, actionable recommendations on understanding, monitoring, adapting and mitigating ocean acidification in Puget Sound and Washington waters.
- A new Washington Sea Grant research project will investigate the effects on Pacific oysters of exposure to natural water seawater that contains a high level of carbon dioxide. It will also explore new breeding programs for enhancing the tolerance of farmed Pacific oysters to higher CO2 seawater. Washington Sea Grant will provide $112,693 over two years (2012–14) for the project, building on 2010–13 funding of $478,082 and a total four-year investment of $590,785 to address ocean acidification impacts on shellfish resources.

Work with boaters to address potential pollution impacts.

- Strategically administer the Clean Vessel Program. The State Parks and Recreation Commission will target Clean Vessel Act grants toward marinas where significant recreational, commercial and tribal shellfish resources are harvested. These grants will fund the construction, renovation, operations and maintenance of boat pump-out stations and waste reception facilities for recreational boaters. State Parks will partner with the Washington Sea Grant, DNR and other entities on educational outreach to marinas and boaters that will publicize these pump-out locations and the need for their use.
- Complete No Discharge Zone Assessment. Ecology will complete an assessment needed to establish a No Discharge Zone, which would ban sewage disposal from commercial and recreational vessels for all or parts of Puget Sound.

Taylor Shellfish Company, Mazanti Shellfish Farm
Project No. 2022103702
Consistency Analysis

Attachment G

WASHINGTON SHELLFISH INITIATIVE

January 2016

Washingtonians make hundreds of thousands of trips each year to the coast to harvest razor clams. Tribes have harvested shellfish for generations upon generations, feeding their communities with healthy protein from Puget Sound and coastal shores. The shellfish industry is a foundation of Western Washington's rural economy and an integral part of our state's heritage.

Indeed, Washington leads the nation in farmed shellfish production, with approximately 10,500 metric tons of oysters, clams and mussels harvested in 2013. In recent years, this yield contributed $184 million in economic benefits. Washington shellfish growers employed more than 1,900 employees and created 810 indirect and induced jobs across the state.

Our shellfish — a well-deserved source of pride for local growers — are sought by consumers around the world. Shellfish are also a key part of our marine ecosystems, providing habitat and helping filter and cleanse water. For all these reasons, shellfish are an extraordinary state resource.

The Washington Shellfish Initiative

Thousands of acres of shellfish beds that are closed due to pollution need to be cleaned up, and at least two native shellfish species that are either significantly diminished (Olympia oysters) or imperiled (pinto abalone) need to be restored.

To accomplish these actions, Washington must renew its protection, restoration and enhancement work as well as expand public education on the importance of our shellfish resources. These efforts will pay off in more recreation opportunities, additional clean water jobs, and healthier coastal marine waters and Puget Sound.

The Washington Shellfish Initiative is an innovative partnership among state government, federal government, tribes, the shellfish industry and nonprofit organizations to promote clean water commerce, create family-wage jobs and elevate the role that shellfish play in keeping our marine waters healthy.

Launched originally in 2011 following the National Oceanic and Atmospheric Administration's National Shellfish Initiative, Governor Jay Inslee is launching the second phase of the initiative in January 2016.

Jay Inslee
Governor

A history of accomplishments

Through solving water pollution problems, 2,429 acres of commercial shellfish beds have been opened in Oakland Bay (Mason County), Quartermaster Harbor (King County), Belfair (Mason County), Kingston (Kitsap County) and Dungeness Bay (Clallam County) in just the past four years.

In May 2014, NOAA and the Puget Sound Restoration Fund opened a native shellfish restoration hatchery to grow baby Olympia oysters and pinto abalone. This hatchery sets the stage for larger-scale restoration of native species.

The Washington State Blue Ribbon Panel on Ocean Acidification created a comprehensive strategy for addressing ocean acidification in Washington's marine waters.

Governor Inslee and the Legislature created the Marine Resource Advisory Council and the Washington Ocean Acidification Center to advance this strategy. Washington is leading the nation — and garnering international attention — in addressing ocean acidification.

The Shellfish Interagency Permitting team developed

instructions for permit applications and mapped out the permitting steps to assist applicants and permit reviewers in navigating the permitting process.

The Clean Vessel Program paid for the replacement and installation of sewage pumpouts for boaters at 31 locations around Puget Sound and on the coast, which prevents sewage from polluting our waters.

Washington State Parks, along with a number of community partners, hosted six ShellFest events, which connected communities with the unique shellfish resources on their shorelines.

Phase II goals

The Washington Shellfish Initiative advances our goals of healthy, abundant shellfish resources for a thriving shellfish aquaculture industry, tribal ceremonial and subsistence harvest, and recreational harvest. By cleaning our waters, improving permitting processes and restoring native shellfish, we strengthen local economies and create more resilient, healthier coastal communities. Among the initiative's goals are:

- Ensuring clean water.
- Embracing strategies to address ocean acidification's effects on shellfish.
- Advancing shellfish research topics.
- Improving the permitting process to maintain and grow sustainable aquaculture.
- Restoring native shellfish.
- Enhancing recreational shellfish harvest.
- Educating the next generation about shellfish.

Working together through this initiative, we can grow nutritious food, clean up Puget Sound and promote this irreplaceable resource to local communities and world markets.

The Washington State Shellfish Initiative, led by Governor Jay Inslee, is a convergence of the National Oceanic and Atmospheric Administration's National Shellfish Initiative and the state's interest in promoting the environmental, economic and cultural importance of shellfish.

For more information visit, http://bit.ly/WAshellfishinitiative.

Taylor Shellfish Company, Mazanti Shellfish Farm
Project No. 2022103702
Consistency Analysis

Attachment H

Washington Shellfish Initiative – Phase II Work Plan

Washingtonians make hundreds of thousands of trips each year to harvest razor clams on the coast. Tribal governments and their people have harvested shellfish for generations upon generations, feeding their communities with healthy protein from Puget Sound and coastal shores. The shellfish industry is a foundation of Western Washington's rural economy and an important part of our state's heritage. Washington leads the nation in farmed shellfish production with approximately 10,500 metric tons of oysters, clams and mussels in 2013, which generated approximately $184 million in total economic contribution, of which almost $92 million was direct revenue from the industry. Washington shellfish growers also directly employed more than 1,900 employees and created more than 810 indirect and induced jobs across the state. Our shellfish are sought by consumers around the world and are a well-deserved source of pride for local growers. Shellfish are also a key part of our marine ecosystems, providing habitat and helping filter and cleanse water. For all of these reasons, shellfish are an extraordinary resource to Washington state.

The Washington Shellfish Initiative began in late 2011. The first state initiative in the nation, it was launched on the heels of the National Oceanic and Atmospheric Administration's National Shellfish Initiative. This effort supports the long-term goal of enhancing shellfish resources in coastal waters. Much has been accomplished through the Washington Shellfish Initiative, including water quality improvements to support recreational, tribal ceremonial, subsistence, commercial and nontribal commercial harvest, a new native shellfish restoration hatchery, cutting-edge science to monitor ocean acidification and an assessment of the state aquaculture permitting process.

The goals laid out in the Washington Shellfish Initiative from 2011 are ambitious and vital to the long-term and sustained health of shellfish resources and the marine ecosystem. While important steps have been taken in the past four years, we need to continue advancing these goals to ensure clean water; address ocean acidification; establish predictable, timely and protective permitting processes; restore native shellfish to the nearshore habitat; and educate and engage communities about shellfish resources and protecting water quality.

The following work plan describes the next steps in advancing toward these Washington Shellfish Initiative goals. It outlines plans, partners and timelines to map our future.

GOAL 1: ENSURE CLEAN WATER TO PROTECT AND RESTORE SHELLFISH GROWING AREAS IN PUGET SOUND AND ON THE COAST[1].

1.1 Support sustainable local nonpoint source pollution control programs and strategies. (DOH, ECY, WSCC, WSDA)

Protect shellfish beds in counties with significant shellfish resources. Recognize the extensive economic and tribal cultural importance of the state's shellfish harvest and that it is more cost effective to protect healthy resources than to restore them once they are polluted.

Restore shellfish beds where there is a significant number of shellfish acres that have been downgraded due to pollution originating in contributing watersheds and that need to be recovered for commercial, ceremonial, subsistence and recreational purposes. (DOH National Estuary Program Pathogen Grant Implementation Strategy provides a framework for protecting and restoring shellfish growing areas. See Page 38 for a table of restoration efforts by growing area. Note that growing areas downgraded after 2012, such as Portage Bay, are not listed.) Advance the goals of protecting and restoring shellfish growing areas through the Results Washington[2] goals and processes, in addition to a broad range of local, state, federal, tribal, nonprofit and citizen-based efforts.

[1] Throughout this document, the term "coast," in the context of locations, refers to Willapa Bay, Grays Harbor and the outer coast –Washington's Pacific shoreline.

a) Support comprehensive, sustainable pollution identification and correction (PIC) programs in the 14 counties[3] that have shellfish growing areas. Evaluate PIC programs by identifying what it takes for effective coordination, identifying best practices for source identification, correcting the pollution problems identified as necessary to meet water quality standards, including National Shellfish Sanitation Program (NSSP)[4] standards over shellfish growing areas, identifying sources of sustainable and supplemental grant funding, and addressing barriers that reduce the effectiveness of local and multi-agency efforts. (DOH)

b) Develop and implement effective total maximum daily load water cleanup plans (TMDLs) or a straight to implementation (STI) plans for fecal coliform bacteria in watersheds with shellfish growing areas. (ECY)
   - Identify and implement strategies to address outer coast beach bacterial sources along North Beach in Grays Harbor County, including: 1) outreach and education to improve understanding of water quality problems; 2) increase capacity of local jurisdiction to address wastewater infrastructure improvements; and 3) implement appropriate best management practices.
   - Revisit TMDLs in the watersheds such as the Lower Nooksack River and Samish and update implementation plans based on new information and data.

c) Support the development of strong sustainable, on-site sewage management programs in Puget Sound and on the coast by implementing the Puget Sound Septic Financing Advisory Committee's recommendations to:
   - Pursue agency request legislation to provide a sustainable funding source for local on-site sewage management programs, which may include PIC work for the Puget Sound. (DOH)
   - DOH, Ecology and local health jurisdictions will work together to create a regional, low-interest loan program to help system owners repair and replace failing systems for the Puget Sound and the coast through Ecology's water quality combined funding program. (DOH, ECY)
   - Pursue other recommendations of the advisory committee when alternative approaches are needed.

d) Implement agricultural land use pollution reduction strategies to maximize implementation and maintenance of best management practices (BMPs) to meet water quality standards, including National Shellfish Sanitation Program (NSSP) standards at shellfish growing areas. (WSCC, WSDA, ECY, DOH) Use the Results Washington process to open shellfish acreage by conducting analyses of current efforts and addressing barriers to develop strategic, effective approaches that result in meeting water quality standards, including the achievement of NSSP standards in shellfish growing areas.

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[2] Results Washington is Governor Inslee's data-driven continuous improvement system for state government. Using Lean tools, Results Washington works to make government more efficient, effective and transparent. The Shellfish Coordination Group was formed as part of the Sustainable Energy & Clean Environment goal. This group focuses on the Governor's goal of restoring and protecting approved shellfish growing areas by 1) assessing what's truly going on; 2) identifying barriers towards progress; and 3) bringing state agencies together to address those barriers.

[3] Counties with shellfish growing areas are Clallam, Grays Harbor, Island, Jefferson, King, Kitsap, Mason, Pacific, Pierce, San Juan Skagit, Snohomish, Thurston and Whatcom.

[4] The National Shellfish Sanitation Program (NSSP) is the federal/state cooperative program recognized by the U. S. Food and Drug Administration and the Interstate Shellfish Sanitation Conference for the sanitary control of shellfish produced and sold for human consumption. The NSSP water quality standard for approved shellfish growing waters is a fecal coliform geometric mean not greater than 14 organisms/100 mL with an estimated 90th percentile not greater than 43 organisms/100 mL.

- Each agency providing funding to implement agriculture BMPs to protect water quality affecting shellfish beds will, consistent with Results Washington process outcomes, a) report on the BMPs implemented and funds spent in Puget Sound and coastal communities, and b) collaborate to maximize landowner participation in programs to gain broad compliance with water quality standards including NSSP standards in shellfish growing areas.
- Seek funding for additional technical assistance and implementation costs.
- Evaluate current and past pollution reduction strategies and funding programs to determine what is effective, what is not effective and why. Coordinate across federal, tribal, state and local partners. Use results to inform future strategies.
  - › Efforts will focus initially on the Samish and Nooksack watersheds as long-term water quality efforts have not resulted in sufficient and sustained water quality improvements.
- Identify an agreed-upon approach to develop PIC guidance on nonpoint source BMPs that prevent pollution, achieve water quality standards and maximize landowner participation. Washington needs agreed-upon agricultural BMPs that are designed and implemented to achieve compliance with the state water quality standards. Since 2009, state agencies and stakeholders have worked to reach agreement on a set of BMPS that will meet state water quality standards and ensure that NSSP standards are achieved in shellfish growing areas. It is important for those dependent on shellfish resources in this state that the state's natural resource agencies, in coordination with stakeholders, resolve this issue.
- Ecology is starting a process to develop guidance that identifies BMPs and combinations of BMPs that, if implemented by an agricultural producer and operated and maintained correctly, can provide certainty that it is protecting water quality and meeting the state's water quality standards. (ECY)
- Conduct a detailed survey on the coast to identify where agricultural activities are occurring, evaluate resource impacts, assess where nonpoint source pollution programs are working effectively and where not, and then develop and implement outreach. (WSCC)
- Implement the Voluntary Stewardship Program (VSP) in the opt-in counties of Grays Harbor, Mason, Pacific, San Juan, Skagit and Thurston and encourage counties to address nonpoint sources of pollution while addressing critical areas under VSP to assist with shellfish/water quality protection. (WSCC)
- Seek input from Ecology's Agriculture Water Quality Committee on strategies developed under this section.

1.2 Advance efforts to ensure manure land-application practices do not negatively impact water quality. (WSDA, WSCC, ECY, EPA)

a) Develop and advance options to eliminate unplanned and improper application of manure to agricultural lands. (WSDA, WSCC, ECY)

b) Develop more economic opportunities for dairies and other livestock owners to manage manure as a commodity. (WSDA)

c) Issue an updated concentrated animal feeding operation permit in 2016 to meet water quality standards and expedite the permit process. (ECY)

d) Coordinate state agency efforts to enhance the ability of operators and applicators to get real-time weather information. (WSCC, CDs)

e) Develop a targeted, coordinated education and outreach program for small-acreage livestock property owners. (WSCC, ECY, WSDA)

f) Develop an education and certification program for all land applicators of manure (operators and third-party applicators) and provide incentives for operators to become certified and/or to only use certified applicators. (WSDA)

g) Deploy advance technologies that can continuously detect and measure bacteria in flowing surface waters in watersheds where shellfish beds are impacted by water quality. (EPA)

h) Collaborate with local watershed partnerships to monitor water quality and identify manure land application practices that threaten surface water. Follow up with land applicators to provide education and technical assistance and, when necessary, take appropriate enforcement actions. (WSDA)

1.3 Develop a proactive approach to limit preventable pollution sources from vessels and recreational activities. (ECY, Parks)

a) Evaluate the appropriateness and feasibility of establishing a no discharge zone in all parts of Puget Sound to protect water quality and public health. (ECY)

b) Develop a strategy for commercial vessels and install more commercial pump-out facilities. (ECY)

c) Develop an implementation/outreach strategy for the no discharge zone designation. (ECY)

d) Continue clean vessel program focused in shellfish growing areas. (Parks)

e) Assess, prioritize, install and maintain toilet facilities in key areas to protect shellfish resources. (WDFW, Parks, other partners depending on location)

1.4 Support strategies to reduce sewer and stormwater outfalls to waters of the state. (DNR)

DNR, in collaboration with ECY, DOH and PSP, will implement an outfall and effluent reduction strategy to reduce impacts to state-owned aquatic lands and associated resources from sewer and stormwater discharges. The strategy will focus on greater participation in the National Pollutant Discharge Elimination System process by DNR; identification and prioritization of impacts to sediments and natural resources such as aquatic vegetation and shellfish; and alternatives to discharging wastewater and stormwater to improve water quality.

1.5 Coordinate and convene workshop(s) focused on contaminants in shellfish with agencies, researchers, tribal governments and stakeholders. (WDFW)

a) Identify available data and information relating to contaminants in shellfish.

b) Identify data gaps and prioritize needed information, including geographic areas where information is lacking.

c) Identify potential resources, collaborative opportunities and funding sources to support further information and data gathering.

1.6 Ensure that oil spill planning and preparedness protect Puget Sound and coast shellfish resources through better coordination and collaboration among agencies, tribal governments and industry. (ECY, NOAA, PSI, WSG, DOH, WDFW)

a) Improve the identification of shellfish areas in the resources at risk sections of geographic response plans (GRPs) and in other relevant mapping tools such as ERMA®− (Environmental Response Management Application) and the state's coastal atlas by developing standardized language for shellfish for inclusion in GRPs and links to appropriate GIS layers for shellfish growing and harvest areas and for culturally significant areas to the tribal governments. (ECY)

b) Generate and distribute a "how to" guide to increase registration of shellfish growers and tribal fishers/enforcement personnel in the vessels of opportunity program. (ECY)

c) Encourage participation by shellfish growers and tribal governments in northwest area contingency planning processes so area plans address shellfish-specific responses. (ECY)

d) Increase the availability of HAZWOPER (Hazardous Waste Operations and Emergency Response) and incident command system training for shellfish growers and tribal governments to improve knowledge of spill response fundamentals (funding dependent). (PSI, WSG, ECY)

e) Include tribal governments and shellfish growers in oil spill response drills as appropriate. Conduct at least one oil spill response drill within a geographic area including one or more shellfish beds by 2017. (ECY)

f) Establish a plan for baseline monitoring of shellfish in vicinity of a spill, including early notification to area shellfish harvesters by agency staff to collect samples before contaminated by oil. (DOH, WDFW, ECY)

g) Determine training options for local sensory panel experts for post-spill testing hosted by NOAA's Office of International Affairs and Seafood Inspection. (NOAA)

h) Clarify the protocol to request support from sensory experts and share sensory panel results from federal to state agencies in a timely manner. (NOAA)

GOAL 2: EMBRACE STRATEGIES TO ADDRESS OCEAN ACIDIFICATION'S IMPACT ON SHELLFISH.

Strategies to address ocean acidification – Implement key early action recommendations from the Blue Ribbon Panel (ECY)

In 2012, the Washington State Blue Ribbon Panel on Ocean Acidification recommended 42 actions that established a comprehensive strategy for addressing ocean acidification in Washington. The Marine Resources Advisory Council (MRAC) was created to advance these recommended actions, and works in collaboration with the Washington Ocean Acidification Center at the University of Washington and others to support ocean acidification research. MRAC will ensure on-the-ground implementation of the panel's comprehensive strategy by evaluating, coordinating, advocating and communicating about actions being done in Washington. MRAC will work with stakeholders, policymakers and tribal governments, many of whom are already working to address ocean acidification impacts to their communities and way of life. Over the next few years, MRAC will:

2.1 Monitor and investigate ocean acidification impacts in Washington:

a) Continue monitoring of ocean acidification conditions, helping to inform hatchery conditions and management of growing areas (related to Blue Ribbon Panel actions 6.2.1; 7.1.1; 7.2.1; 7.3.2; 7.4.1).

b) Conduct biological experiments to understand the effects of ocean acidification on marine species (related to Blue Ribbon Panel actions 7.1.1; 7.2.1; 7.3.2; 7.4.1).
c) Develop and refine forecast models of ocean acidification (related to Blue Ribbon Panel actions 7.1.1; 7.2.1; 7.3.2; 7.4.1).
d) Continue support for the Washington Ocean Acidification Center at the University of Washington to provide leadership on ocean acidification research (related to Blue Ribbon Panel actions 9.1.1; 9.1.2).
e) Develop a local source attribution model to understand how local sources of nutrients and carbon impact ocean acidification (related to Blue Ribbon Panel action 7.2.1).

2.2 Understand how local, land-based contributions affect ocean acidification by:

a) Providing support to water quality programs that reduce nutrient and organic carbon loading (related to Blue Ribbon Panel actions 5.1.1; 5.1.2).
b) When modeling tools are complete, evaluate programs and activities that can minimize impacts of local contributions to ocean acidification (related to Blue Ribbon Panel actions 5.2.1; 5.2.2).

2.3 Coordinate implementation and evaluation of adaptation and remediation strategies by supporting efforts to:

a) Implement a test seaweed cultivation and collection program (related to Blue Ribbon Panel action 6.1.1).
b) Restore native oyster populations that may improve resilience to ocean acidification (related to Blue Ribbon Panel actions 6.3.3; 6.3.4).
c) Apply multiple remediation strategies in specific locations or test areas to evaluate effectiveness of strategies in addressing ocean acidification impacts (related to Blue Ribbon Panel action 6.3.2).
d) Research the capacity for genetic adaptation to ocean acidification in important marine species (related to Blue Ribbon Panel action 6.3.5).

2.4 Increase the visibility and understanding of ocean acidification across Washington through outreach and education by supporting efforts to:

a) Incorporate ocean acidification science curriculum into the Next Generation Science Standards (related to Blue Ribbon Panel actions 8.2.1; 8.2.2).
b) Organize and support events and conferences focused on ocean acidification and its impacts (related to Blue Ribbon Panel action 8.1.2).
c) Target use of outreach and social marketing to increase understanding of ocean acidification impacts and strengthen Washington's capacity for adapting, reducing harm locally and engaging partners to develop solutions (related to Blue Ribbon Panel actions 8.1.2; 8.1.3; 8.1.4; 8.2.2).

Recommendations from the Olympic Coast National Marine Sanctuary, which formed a joint Intergovernmental Policy Council and Sanctuary Advisory Council Ocean Acidification Working Group in 2013, identified the following key early actions (KEAs) from the Blue Ribbon Panel as coastal tier 1 priorities: Actions 7.1.1; 7.3.2; 7.3.3; 8.1.2 and 9.1.2. This KEA prioritization is accompanied in its report by the following recommendations:

- Advance ocean acidification monitoring for the outer coast.
- Adequate representation of the outer coast on the Washington Ocean Acidification Center scientific advisory team.

- Conduct laboratory and field studies related to ocean acidification impacts on the outer coast.

For the full report, visit: http://olympiccoast.noaa.gov/involved/sac/sac_actions.html.

GOAL 3: ADVANCE VITAL SHELLFISH RESEARCH.

3.1 Washington Sea Grant shellfish research projects (WSG)

Over the next four years, the National and Washington Sea Grant (WSG) programs have committed funding for 10 research grants totaling more than $2.4 million to examine critical issues for shellfish aquaculture such as ocean acidification, warning systems for hypoxia and harmful algal blooms, and geoduck management. Projects will look at precautionary guidelines for culture of native rock scallops, an innovative technology to support the recovery of the Olympia oyster and studies to reduce early mortality.

Target dates:

- *New projects initiated: January 2015 and 2016*
- *Interim reports: April 2016 and 2017*
- *Final reports: April 2018*

3.2 Federal Shellfish Research Program (NOAA)

In collaboration with other federal agencies, NOAA Fisheries will create a federal shellfish biologist position to develop and oversee a future shellfish research program at the Kenneth K. Chew Center for Shellfish Research and Restoration in Manchester, Washington.

Target date: October 2017

3.3 Study the effects of Washington shellfish aquaculture operations. (WSG)

WSG was funded by the Legislature to commission research examining possible negative and positive effects, including cumulative and economic impacts of evolving Washington shellfish aquaculture practices. The research team is using modeling approaches and available data to complete pilot studies for Willapa Bay and central Puget Sound composed of several components: spatial analysis, Puget Sound circulation and ecosystem models, qualitative food web analyses and an economic synthesis.

Target dates

- *Interim report to Legislature: December 2014*
- *Final report: December 2015*

3.4 Create a prioritized list of shellfish research needs. (Pacific Shellfish Institute [PSI])

Target dates:

- *Engage the shellfish cultivation and restoration community, including tribal governments, to update the report West Coast Research and Information Needs and Priorities*
  - *September 2015 and March 2016*
- *Finalize the document: June 2016*

3.5 Assess the potential effects of sea level rise on native and farmed shellfish beds in Willapa Bay and Grays Harbor estuaries. (TNC)

SLR will deepen these estuaries and could impair shellfish farming as well as juvenile fish habitat. The Nature Conservancy (TNC) will conduct a risk assessment based on SLR inundation scenarios using the Sea Level Affecting Marshes Model and analyze shoreline characteristics and uses that would impede or support migration to new spaces. Apply the results to the current round of shoreline master program (SMP) updates in Pacific and Grays Harbor counties so adaptation strategies can be considered.

Target dates:

- *Work with Ecology staff and county planners and consultants to develop the concept and its role in SMPs for Southwest Washington: December 2014*
- *Draft risk assessments with presentation slides and maps go to technical peers for initial review: March 2015*
- *Review initial results with local shellfish farmers and other industry representatives: April 2015*
- *Final assessments available for local applications: June 2015*

3.6 Early warning system for harmful algal blooms (WSG, NOAA)

The Olympic Region Harmful Algal Blooms (ORHAB) Partnership on the coast and SoundToxins in Puget Sound are important programs that help the Department of Health target its toxin monitoring and testing to protect public health for those who harvest shellfish in our marine waters.

SoundToxins is a diverse partnership of businesses, tribal governments and Puget Sound residents that monitor for harmful algae in Puget Sound, managed by NOAA's Northwest Fisheries Science Center and WSG. It provides early warning of harmful algal bloom (HAB) events, thereby minimizing risks to human health and reducing the economic losses to Puget Sound fisheries. The program works with partners and scientists to determine the environmental conditions that promote the onset and flourishing of HABs and unusual bloom events and to document unusual bloom events and species entering the Salish Sea. SoundToxins continues to be supported via short-term research grants from NOAA and state agencies; however, a dedicated source of funding is needed to continue its vital role in Puget Sound.

The ORHAB partnership was founded in 1998 as a scientific collaborative among state, tribal and federal agencies and the University of Washington, with initial support from the NOAA Center for Sponsored Coastal Ocean Research. Its mission is to monitor plankton blooms and the presence of toxins to advance the understanding of these important coastal processes. By bringing together leading research scientists with state and tribal shellfish managers, ORHAB provides a constantly improving scientific basis for making decisions about the risks of shellfish openings. The long-term, coastwide database compiled by the ORHAB partners from sites from Neah Bay to the Long Beach Peninsula has proved extremely useful for studying broader coastal dynamics. The work of ORHAB's state partners has been supported with a surcharge on sales of state recreational shellfish licenses. Support for ORHAB's tribal partners has become more difficult to sustain, and additional funding is needed to continue the very beneficial role they play in the partnership.

Target Dates:

- *Identify potential funding sources for SoundToxins and ORHAB: March 2016*
- *Secure funding: December 2016*

3.7 Review and research shellfish ecosystem services (PSI)

a) Assess the influence of cultivated shellfish on localized water quality and sediment parameters. Build on review of shellfish ecosystem services conducted by the U.S. Geological Services during the first phase of the Washington Shellfish Initiative.

b) Provide recommendations for including shellfish cultivation in water quality trading scenarios when a water body is listed for excess nutrients or low dissolved oxygen under section 303(d) of the Clean Water Act.

Target dates:

- *Begin study: spring/ summer 2015*
- *Study completed: early 2017*
- *Deliver NEP Reducing Nutrients in a Watershed final project report to Ecology: December 2017*

3.8 Assess the economic contribution of shellfish farming and wild harvest in Washington.

a) Convene state agencies and industry to design a system to improve data collection and sharing of information on the economics of shellfish with respect to harvest and production. (state agencies, industry, tribal governments)

b) Convene a task group to enhance our understanding of the upstream and downstream economic value of shellfish to build appreciation of the value-added economic components (jobs, revenue) (WDFW) including, but not limited to:

- retail sales
- tourism
- trade
- tribal commercial
- state commercial and recreational harvest

In addition, tribal governments and their citizens rely on ceremonial and subsistence shellfish harvest. Like tribal commercial harvest, this harvest is protected through treaty rights. The monetary value of ceremonial and subsistence harvest and associated treaty rights cannot be quantified, but should be acknowledged by the task group.

3.9 Promote collaborative, ecosystem-based management in Willapa Bay and Grays Harbor.

Willapa Bay and Grays Harbor are complex estuarine ecosystems that support wild stocks of finfish and Dungeness crab and a historic shellfish aquaculture industry, as well as a rich array of other species. Management challenges at the system scale, such as SLR, ocean acidification, nutrient and sediment transport, burrowing shrimp and Japanese eelgrass, are affecting both natural and anthropogenic processes. Resolving these challenges requires adaptive management and collaborative actions built on a commonly shared understanding of how the ecosystems function, how they have changed over time and what future conditions may be like. The steps below will promote cooperative, system-scale management by compiling and synthesizing information and addressing important information gaps:

a) Compile, synthesize and maintain historical data, management plans and research findings relevant to system-scale management challenges in Willapa Bay and Grays Harbor, focusing on how these ecosystems function, how they have changed over time and projections of changes that can affect management options. Make the information available via a purpose-built website. (TNC)
b) Convene resource managers, scientists and stakeholders to verify a common understanding of the ecosystems and the top-priority management challenges in each of them, and to identify research needs and information gaps that represent barriers to tackling the management challenges at a system scale. (WSU Extension Pacific County with assistance from TNC)
c) Help address the needs identified in (b) by matching them with appropriate potential funding sources, sharing the information with other participants and promoting collaborative project proposals. (TNC with assistance from WSU Extension Pacific County and other stakeholders)

GOAL 4: IMPROVE THE PERMITTING PROCESS TO MAINTAIN AND GROW SUSTAINABLE AQUACULTURE.

4.1 Programmatic biological assessment for federal permitting of shellfish activities (NOAA)

The U.S. Army Corps of Engineers (Corps), in consultation with the National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS), will develop a programmatic biological assessment (PBA) for Section 7 ESA consultation for common activities permitted by the Corps associated with shellfish, planting, harvest and restoration. Use of the PBA will increase the Section 7 consultation efficiency for applicants who meet the PBA terms and conditions.

Target dates:

- *Corps initiation of consultation: fall 2015*
- *NMFS and USFWS completion of consultation: spring 2016*
- *Corps implementation: Immediately upon completion of Section 7 consultation*
- *Report of permits issued with PBA: annually 2016–18*

4.2 Shellfish Interagency Permit Team Phase II (NOAA, ECY)

a) Upon completion of federal PBA evaluate federal/state permitting

Target dates:

- *Investigate potential of programmatic permitting: April 2016*
- *Evaluation of 2017 Nationwide Permit 48: April 2016*

b) Report to Governor on Shellfish Interagency Permit Team Phase I activities, including results and recommendations to increase efficiency of the permit process.

Target dates:

- *Draft report: February 2016*
- *Final report: March 2016*
- *Develop steps to implement recommendations: August 2016*

c) Continue quarterly meetings of full Shellfish Interagency Permit Team to maintain broad engagement with tribal, local, state and federal agencies.

- Develop a communication and outreach plan: July 2016

- Evaluation of effectiveness: ongoing
- Permit timelines to evaluate current and potential requirements for permit timelines: December 2016

d) Convene Shellfish Interagency Permit Team working groups to achieve multi-agency review of new farm permit applications.

Target dates:
- *Ad-hoc response to requests for new farm permit assistance: ongoing*
- *Develop a work plan for improved implementation: August 2016*

4.3 Improve guidance for local shoreline master programs for shellfish aquaculture. (ECY)

Develop Permit Writers Handbook. Guidance for local government and Ecology permit writers on applicable laws and rules, limits and conditions, BMPs, cumulative impacts, no net loss, and the latest information and science useful for administering shellfish shoreline permits. SIP would serve as a technical review panel. Ecology (funding dependent)

Target Dates: by fall 2016
- *Complete draft outline and timeline*
- *Complete draft RFP and scope of work for handbook development*
- *Secure funding*

4.4 Increased involvement of Department of Agriculture in shellfish farming and interagency coordination. (WSDA)

a) Continue engagement with industry through policy team shellfish lead.
b) Schedule reoccurring meetings with WSDA, industry, tribal governments and partner agencies to share information, keep lines of communication open and identify opportunities for coordination.
c) Continue agency and industry discussions on aquaculture coordinator role and ombudsman role at WSDA.

GOAL 5: RESTORE NATIVE SHELLFISH – OLYMPIA OYSTERS AND PINTO ABALONE.

5.1 Olympia oysters:

a) Continue collaborative work to reestablish sustainable breeding populations in the state's 19 priority areas located in Puget Sound. *Note: Breeding populations have already been restored in two (Liberty Bay, Fidalgo Bay) of the 19 priority areas. On-the-ground work is underway in many of the remaining 17 areas. (WDFW, tribal governments, Puget Sound Restoration Fund [PSRF])*

b) Collaboratively maintain and operate the Kenneth K. Chew Center for Shellfish Research and Restoration at the Northwest Fisheries Science Center's Manchester Lab and assist with optimization techniques for native Olympia oyster and pinto abalone production in support of state shellfish restoration goals. (NOAA, PSRF)

Target date: ongoing through September 2016

c) Produce 2,500 bags of Olympia oyster seed (seeded cultch) to accelerate Olympia oyster recovery at priority sites. Genetically diverse seed will be produced at the Kenneth K. Chew Shellfish Center using conservation protocols co-developed by PSRF, University of Washington and Washington Department of Fish & Wildlife. (PSRF)

d) Conduct water quality monitoring associated with shellfish production at the Kenneth K. Chew Center. Measurements of dissolved oxygen, salinity, temperature, pH and pCO_2 in hatchery water supply will be available daily to researchers at the center and annual seasonal data summaries available online. (NOAA)

Target dates: annual data summaries: September 2016

e) Complete the Ecology-funded, 10-acre native oyster enhancement project in Port Gamble Bay. (PSRF)

f) Seek funding to initiate an additional 10 acres of enhancement in two or three of the 19 priority locations to help reestablish breeding populations. (PSRF)

g) Advance partnerships to accelerate and expand native shellfish restoration through funds from NRCS' Environmental Quality Incentives Program, which provides payments to farmers for habitat restoration. Identify opportunities and establish processes to provide payments to tribal governments and shellfish growers for restoration of Olympia oyster habitat. (NRCS)

h) Evaluate native oyster restoration opportunities in Willapa Bay and Grays Harbor. (WSU Extension Pacific County)
- Conduct a planning phase to evaluate feasibility of restoration work in coastal estuaries, based on current available science, to determine whether more research and evaluation are needed.
- Complete survey of subtidal environments to conduct a more accurate assessment of current population size.

5.2 Pinto abalone (WDFW, PSRF)

a) Optimize hatchery efforts to more efficiently produce juvenile and larval abalone (with funding from WDFW, DNR and NOAA).

b) Outplant 5,000 juvenile abalone (2,500 in 2015; 2,500 in 2016).

c) Outplant 2 million larval abalone.

d) Complete the DNR-funded project to assess previous larval out plants and refine larval out plant methodologies.

5.3 Other native shellfish

a) Take conservation actions if other native shellfish stocks are determined to be in decline or threatened. Actions may include restoration, stock status research and fishery closures.

GOAL 6: ENHANCE RECREATIONAL SHELLFISH HARVEST.

6.1 Enhance recreational shellfish harvest. (WDFW, DOH) *Note: This section also interconnects with Goal 1 on improving water quality as a key mechanism for increasing access to recreational shellfish harvest.*

a) Maintain levels of seeding on recreational beaches by WDFW. Incremental funding increases will be needed to maintain a base level of seed planting.
- Document increases in harvest trips and state funding resources.
- Identify and pursue other avenues for funding.

b) Identify opportunities for enhancement at key coastal recreational beaches. (WDFW)

c) Increase recreational shellfish harvest at two large and strategically placed public tidelands. (WDFW, DOH)

GOAL 7: EDUCATE THE NEXT GENERATION ABOUT SHELLFISH RESOURCES, ECOSYSTEMS SERVICES AND WATER QUALITY. ENGAGE THE PUBLIC IN SHELLFISH RESOURCES THROUGH EDUCATION AND OUTREACH.

Preserving and understanding local shellfish resources, the role they play in the ecosystem, what they contribute to local economies, the history and culture of shellfish in Washington, the human actions that affect their health, the actions that are needed to protect shellfish resources and, finally, the consequences for both humans and the ecosystem if shellfish populations decline.

7.1 Formal education goals:

a) Develop high-quality tools, curricula and materials that 1) teach K-12 students about shellfish resources in both classroom and field settings; 2) help schools meet Common Core and Next Generation Science Standards (NGSS); and 3) provide district support and train teachers to enable them to independently use the materials. (Pacific Education Institute [PEI])

b) Integrate shellfish education topics (which include ocean acidification) in multiple subject areas as they provide a real-world case study. (PEI)

c) Develop professional learning opportunities that help teachers connect shellfish resources to NGSS. (PEI)

d) Recommend sample shellfish curriculum resources for educators on the OSPI Environmental and Sustainability Education standards website. (OSPI)

e) Partner with tribal governments, state agencies and nonprofit organizations to provide internship opportunities for college students. (WSG)

f) Translate shellfish and ocean acidification scientific research findings into fact sheets and other accessible information to share on a credible website (WSG) for access by K-12 students and educators. (WSG)

7.2 Informal education and outreach goals:

a) Foster broad public understanding of local shellfish resources and the role they play in local ecosystems and economies. Topics include the history and culture of shellfish throughout Washington, human activities that impact shellfish resources and the consequences, for both humans and the ecosystem, if shellfish populations decline. Conduct activities and host events such as Whatcom Water Days, Kitsap Water Festival, Celebrate Oakland Bay, RainFest on the outer coast, State Park Shellfests, Oysterfest, Vashon-Maury Island Low Tide Festival and the Wooden Boat Festival (Olympia). (WSG)

b) Foster citizen engagement and understanding of the role of shellfish in the coastal ecosystem.
- Provide opportunities for citizen science monitoring, technical assistance programs, workshops and activities, including the State of the Oyster Study, technical assistance to tideland owners, marine biotoxin monitoring, and septic system education classes and socials.
- Provide education and outreach tailored to coastal communities and visitors, including Willapa Bay Oysters documentary series curricula and outreach activities. (WSG)
- Continue Shellfest and other educational/interpretive opportunities about shellfish and water quality, in Puget Sound, Georgia Straits, Grays Harbor, Willapa Bay and the outer coast. (WDFW, Parks, WSG)
- Develop interpretive signage at public access sites with shellfish resources on the coast and at Puget Sound locations. (Parks)

- Promote shellfish safety through Web communication and posting public beaches that are closed to shellfish harvest due to marine biotoxins, pathogens and pollution. (DOH)
- Host the Washington Shellfish Trail. (WSG)
- Develop education materials and outreach to grocery stores, farmers markets and seafood restaurants about safe shellfish handling. (WSG)

c) Host a gathering of informal shellfish educators to share resources and information. (WSG)

Key of state agency abbreviations:

- DNR – Department of Natural Resources
- DOH – Department of Health
- ECY – Department of Ecology
- Parks – State Parks
- WSCC – State Conservation Commission
- WSDA – Department of Agriculture
- WDFW – Department of Fish and Wildlife

Taylor Shellfish Company, Mazanti Shellfish Farm
Project No. 2022103702
Consistency Analysis

Attachment I

NOAA's National Shellfish Initiative

The goal of the National Shellfish Initiative is to increase shellfish aquaculture for commercial and restoration purposes, thereby stimulating coastal economies and improving ecosystem health. The focus is on bivalves or mollusks, not on crustaceans. This initiative will help meet the growing demand for seafood while creating jobs, restoring depleted species, conserving habitat for important commercial, recreational, and endangered fish species, improving water quality, and stabilizing and protecting coastlines.

Overview of the National Shellfish Initiative

Put simply, this initiative recognizes the broad suite of benefits provided by shellfish aquaculture and aims to increase shellfish production and wild shellfish populations in U.S. coastal and marine waters. To that end, NOAA – in collaboration with public and private partners – will focus on a limited number of actions under each of the following five topics:

1. ***Enhanced shellfish restoration and farming*** – Support the authorization of shellfish sanctuaries/restoration sites and additional aquaculture permits/leases that are aligned with the twofold goal of providing environmental and economic benefits; build hatchery capacity to supply seed for commercial shellfish production and public/private restoration projects; and develop innovative culture and post-harvest processing methods.
2. ***Research on environmental effects*** – Conduct research on the interactions between shellfish and the environment in terms of climate change, ocean acidification, naturally occurring pathogens and parasites, and other factors; gather data needed to assess and refine restoration strategies and priorities; examine synergies with the shellfish industry.
3. ***Streamlined permitting*** – Improve coordination among federal agencies to facilitate timely permitting of shellfish farms and restoration projects; develop model permit processes; participate in reissuance of Army Corps of Engineers' Nationwide Permit 48 for commercial shellfish aquaculture.

Overview of NOAA'sNational Shellfish Initiative, cont'd

4. ***Spatial planning*** – Engage in local and regional planning efforts to site commercial shellfish production and shellfish restoration projects. This will include engaging with the Regional Planning Bodies that carry out coastal and marine spatial planning under the National Ocean Policy.
5. ***Innovative financing*** – Develop indicators that "monetize" ecosystem services provided by shellfish aquaculture, such as nutrient reduction and carbon sequestration. (Payments for ecosystem services, were they available, may spur participation in both commercial and restoration aquaculture.)

NOAA is seeking to leverage its existing staff, science knowledge and capabilities, regulatory authorities, and grant programs in partnership with others to implement the Initiative. An internal staff work group led by the NMFS Office of Aquaculture (with participation from several NMFS headquarters and regional offices, NOAA science centers, and the National Sea Grant Program office) is coordinating NOAA's efforts. To identify priorities and specific opportunities, this staff group is

- reaching out to industry participants, restoration groups, states, and others;
- reviewing recommendations provided by the National Shellfisheries Association and the East Coast Shellfish Growers Association based on recent surveys of their membership;
- reviewing research priorities and restoration strategies identified by industry associations, restoration NGOs, and others;
- reviewing topics and priorities for upcoming NOAA grant competitions (budget permitting); and
- reaching out to other DOC (e.g., Economic Development Administration) and federal agencies (e.g., USDA and NSF) to identify and coordinate grant opportunities to support the Initiative.

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Taylor Shellfish Company, Mazanti Shellfish Farm
Project No. 2022103702
Consistency Analysis

Attachment K

Assessing Potential Benthic Impacts of Harvesting the Pacific Geoduck Clam *Panopea generosa* in Intertidal and Subtidal Sites in British Columbia, Canada

Author(s): Wenshan Liu, Christopher M. Pearce and Grant Dovey
Source: Journal of Shellfish Research, 34(3):757-775.
Published By: National Shellfisheries Association
URL: http://www.bioone.org/doi/full/10.2983/035.034.0305

Journal of Shellfish Research, Vol. 34, No. 3, 757–775, 2015.

ASSESSING POTENTIAL BENTHIC IMPACTS OF HARVESTING THE PACIFIC GEODUCK CLAM *PANOPEA GENEROSA* IN INTERTIDAL AND SUBTIDAL SITES IN BRITISH COLUMBIA, CANADA

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ABSTRACT The Pacific geoduck *Panopea generosa* is the largest burrowing clam in the world and adults can live up to a meter below the sediment surface. To extract these clams, harvesters use pressurized water jets to dislodge surrounding sediments. This type of disturbance could have significant effects on the local benthic environment, but has been little examined. The present study was conducted on one intertidal and one subtidal plot to assess potential effects of commercial-scale geoduck harvesting on the sedimentary benthic environment and nearby eelgrass beds. Sediment samples were collected inside the impacted plots and at intervals up to 75 m away while eelgrass samples were collected adjacent to the impacted plots and at intervals up to 50 m away, seasonally over 2 y. Harvest of the subtidal plot occurred at one year and mock harvest of the intertidal plot occurred after one preimpact sample. Sediment and infaunal qualities examined included: grain size, percent organics, total nitrogen, total organic carbon, sulfide content, redox potential, and infaunal community structure. Eelgrass parameters studied included shoot length, shoot density, and biomass. Sedimentation rates during harvesting were examined and compared with those of natural occurrence. Suspended sediments were increased by harvesting, but generally limited to the footprint of the harvested area, and were not greater than those created by wind/storm conditions. No changes were observed, however, in any of the measured sediment or infaunal variables on or near the harvested plot or in adjacent eelgrass. In addition, no significant response in eelgrass parameters was observed. This study indicated little effect of commercial geoduck harvesting practices beyond short-lived resuspension of sediment on the two harvested plots.

KEY WORDS: benthic impact, eelgrass, geoduck, clam, harvest, *Panopea generosa*

INTRODUCTION

The Pacific geoduck clam *Panopea generosa* (Gould, 1850) is distributed from Alaska to Baja California (58–28° N) (Bernard 1983). It lives in the low intertidal zone and subtidally as deep as 110 m, buried in sand, silt, and gravel (Goodwin & Pease 1989, Bureau et al. 2002, Zhang & Hand 2006). It is the largest infaunal clam in the world, growing up to 3.25 kg whole weight and living up to a meter below the sediment surface (Goodwin & Pease 1987). This species is also long-lived, the oldest individual on record being approximately 168-y old (Bureau et al. 2002).

The Pacific geoduck clam currently supports the most valuable dive fishery on the west coast of North America, 1,963 metric tons (MT), worth US$36.2 million, being landed in Washington state (WA) in 2010 (Washington Department of Fish and Wildlife 2012); 1600 MT, worth C$40.9 million, in British Columbia (BC), Canada in the same year (BC Ministry of Agriculture 2010); and 312 MT, worth US$3.8 million, in Alaska in the 2009/2010 fishing season (Alaska Department of Fish and Game 2014). In addition, a fishery for two species of geoduck (*Panopea generosa* and *Panopea globosa*) in Mexico has grown rapidly since the early 2000s to landings of 2,000 MT in 2011, worth US$30.0 million (Aragón-Noriega et al. 2012). Two relatively underdeveloped fisheries (annual harvest less than 20 MT) for smaller species of *Panopea* occur in Argentina with *Panopea abbreviata* (Morsán & Ciocco 2004, Morsán et al. 2010) and New Zealand with *Panopea zelandica* and *Panopea smithae* (Breen et al. 1991, Gribben & Creese 2005, New Zealand Fisheries 2013).

Aquaculture production of geoducks started intertidally in WA in the mid-1990s and has increased quickly; approximately 613 MT of cultured clams, worth US$18.5 million, were harvested in 2010 (Washington Department of Fish and Wildlife 2012). There has been widespread interest in the culture of geoducks in BC for many years, but commercial-scale development has been hindered until fairly recently by a lack of governmental policy/legislation and concerns of how geoduck culture impacts the environment. Nevertheless 52 MT of farmed geoduck, worth C$1.1 million, were harvested in 2010 in BC (BC Ministry of Agriculture 2012, BC aquaculture production statistics from BC Ministry of Agriculture, unpublished data received August 2012). Environmental concerns with geoduck aquaculture are usually focused on the harvest process since pressurized water jets (or ''stingers'' in industry vernacular) are used to dislodge the soft-bottom substrates around the clams to extract them. This procedure is not used just by aquaculturists, it is also the typical harvest technique used in the wild fisheries of all *Panopea* species and so similar environmental concerns surrounding harvest practices apply to the various *Panopea* fisheries as well.

Geoduck harvesting by water jets may be highly disruptive of the substrates (Goodwin 1978, Breen & Shields 1983). During the harvest, disturbed sediments are suspended in the water column. While large particles settle fairly rapidly in the immediate vicinity, finer ones will be carried away by water currents, forming turbid plumes, and subsequently redeposited some distance away (Short & Walton 1992). After a geoduck is removed, a shallow hole about 0.5 m in diameter, partially filled with an emulsion of loose substrate and water, is created (Goodwin 1978, Breen & Shields 1983). The ecological implications of harvesting, however, may extend far beyond such purely physical, sedimentary effects. As the substrate is disturbed,

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DOI: 10.2983/035.034.0305

both abiotic and biotic attributes of the benthos may also be altered. Geoduck harvesting may impact the benthic environment in a number of ways: (1) alteration of sediment grain size due to loss of fine particles and loose compaction of redeposited substrate that is more susceptible to removal by water currents (Goodwin 1978); (2) loss of organic matter, minerals, and heavy metals associated with loss of fine particles, as the fines (<63 μm) tend to accumulate or bond with such materials more than other grain-size fractions (Horowitz & Elrick 1987, Tam & Wong 2000); (3) exposure of anoxic sediments and oxygenation of sediment pore water, affecting sediment chemistry (Palazzi et al. 2001, Straus et al. 2008); (4) release of materials back into the water column, including nutrients, eggs or cysts, and contaminants (Pilskaln et al. 1998, Tengberg et al. 2003, Straus et al. 2008), subsequently affecting water quality and animal and plant growth; (5) reduction in infaunal abundance due to damage, burial, and exposure to currents and predators (Goodwin 1978, Breen & Shields 1983, Currie & Parry 1996); and (6) impact on nearby aquatic communities in areas outside the immediate harvest bed due to creation of turbid plumes and deposition of materials from such plumes (Short & Walton 1992). The areas nearby harvest plots may be important near-shore marine habitats such as open sand/mud flats and eelgrass (seagrass) meadows, both hosting diverse animal and plant communities (Cain & Bradbury 1996, Short & Wyllie-Echeverria 1996, Vermaat et al. 1997, Chambers et al. 1999, Rossi et al. 2007). Deposition of materials from turbid harvest plumes onto nearby areas may lead to changes in sediment grain size and infaunal communities through burying, smothering, crushing, and alteration of the benthic chemical microenvironment (Miller et al. 2002, Airoldi 2003). Further, decreased light levels due to shading, as a result of increased turbidity from sediment plumes and deposition of sediments on leaf surfaces, may reduce eelgrass growth and survival (Moore et al. 1997, Cabello-Pasini et al. 2002, Tamaki et al. 2002).

The potential impact of geoduck harvesting on benthic environments appears to be minimal for commercial subtidal fisheries in both WA and BC. Goodwin (1978) reported that (1) harvesting did not significantly affect sediment grain size distribution in harvest plots as a whole; (2) harvesting did not create dramatic decreases in the major infaunal species present; and (3) holes created during a disturbance had disappeared completely 7 mo after the harvest. There were, however, significant decreases in the percentage of fine and coarse sediments within the harvest holes immediately after harvesting (Goodwin 1978). Breen and Shields (1983) did not find any significant difference in sediment grain size distribution or simple relationship in changes in infaunal community structure between harvested and nonharvested plots, but did report an increase in species diversity in the disturbed one. Using a modeling approach, Short and Walton (1992) concluded that most suspended materials settled within 1 m of the holes created and that transport and deposition of suspended sediments associated with geoduck harvesting would have minimal impacts on the physical environment of the harvest bed and adjacent area. No studies, however, have examined the potential effect of harvesting subtidally cultured or enhanced geoduck populations, where clam densities would more likely be higher than in the wild.

Theoretically, intertidal areas may be more resilient to disruptions than subtidal ones as they are subject to more frequent and intense natural disturbance. Thus, impacts of intertidal harvesting might be expected to be even less than those observed in the subtidal wild fisheries. This supposition is tempered by the fact that clam densities (and hence level of disturbance) in the former will be much higher than those in the latter. But recent studies have confirmed the lack of impact. Sauchyn et al. (2013) reported that impact of small-scale intertidal harvests on various sedimentary variables was limited in terms of scale and duration. Price (2011) concluded that commercial-scale harvesting did not cause any distinct response in infaunal communities within harvest plots and that effects on infauna were within the range of natural variation experienced by the community and not of long-term ecological significance. Regarding infaunal community structure, Price (2011) also found that harvesting did not cause any ''spillover'' effects in areas adjacent (up to 60 m outside) to the plots. The objective of the present study was to evaluate the spatial and temporal extent of the potential impact of large-scale subtidal and intertidal geoduck harvests on the benthic environment.

MATERIALS AND METHODS

Study Sites and Sampling Locations

The study was conducted between October 2008 and October 2010 at two sites in the Strait of Georgia, BC, both comprising a harvest plot, a nearby nonharvest reference area, and an eelgrass bed (Fig. 1). The Cortes Island (CI) site (50° 02′ N, 124° 58′ W, approximate) was located in the northern part of the Strait, on a subtidal sandy strip 3.5–7.8 m below chart datum on a portion of a geoduck fisheries bed. The harvest plot (100 × 60 m) was a geoduck fisheries enhancement area placed within the commercial bed, previously seeded between 1999 and 2000 and ready for harvesting during the course of the present study. The area nearby the enhanced plot had never been seeded or harvested.

The Nanoose Bay (NB) site (49° 16′05.68″ N, 124° 10′43.74″ W, center of harvest plot) was located on a shellfish (Pacific oyster and Manila clam) tenure on an intertidal sand flat (3.6–5.1 m above chart datum at high tide). The entire study site, including the harvest plot (30×15 m), had not been used for aquaculture for many years before this study and no geoduck clams or other cultured bivalves were present, although clams and oysters were being commercially cultured nearby. At the time of this study there were no commercial-scale intertidal geoduck farms within BC that were ready for harvesting, hence a mock harvest was conducted (i.e., the ground was disturbed as if a harvest were occurring, but no geoducks were actually present). While the mock harvest mimicked the physical disturbance that occurs during such an event, the study was not able to assess the potential effects of releasing/suspending certain biological components associated with geoduck culture (e.g., faeces, pseudofaeces). It should be noted that there was a small eelgrass-bed intrusion in the northeast corner of the harvest plot at NB (Fig. 1).

At the start of the project, current profiles were determined at both sites using an Acoustic Doppler Current Profiler (Teledyne RD Instruments, San Diego, CA) set centrally in the plots destined for harvesting. Current direction and velocity were recorded every 10 min for a period of 6 days at CI and 7 days at NB. Data from three depth bins (0.3, 2.8, and 5.7 m above sea bed at CI; 0.2, 0.6, and 1.1 m above sea bed at NB) were

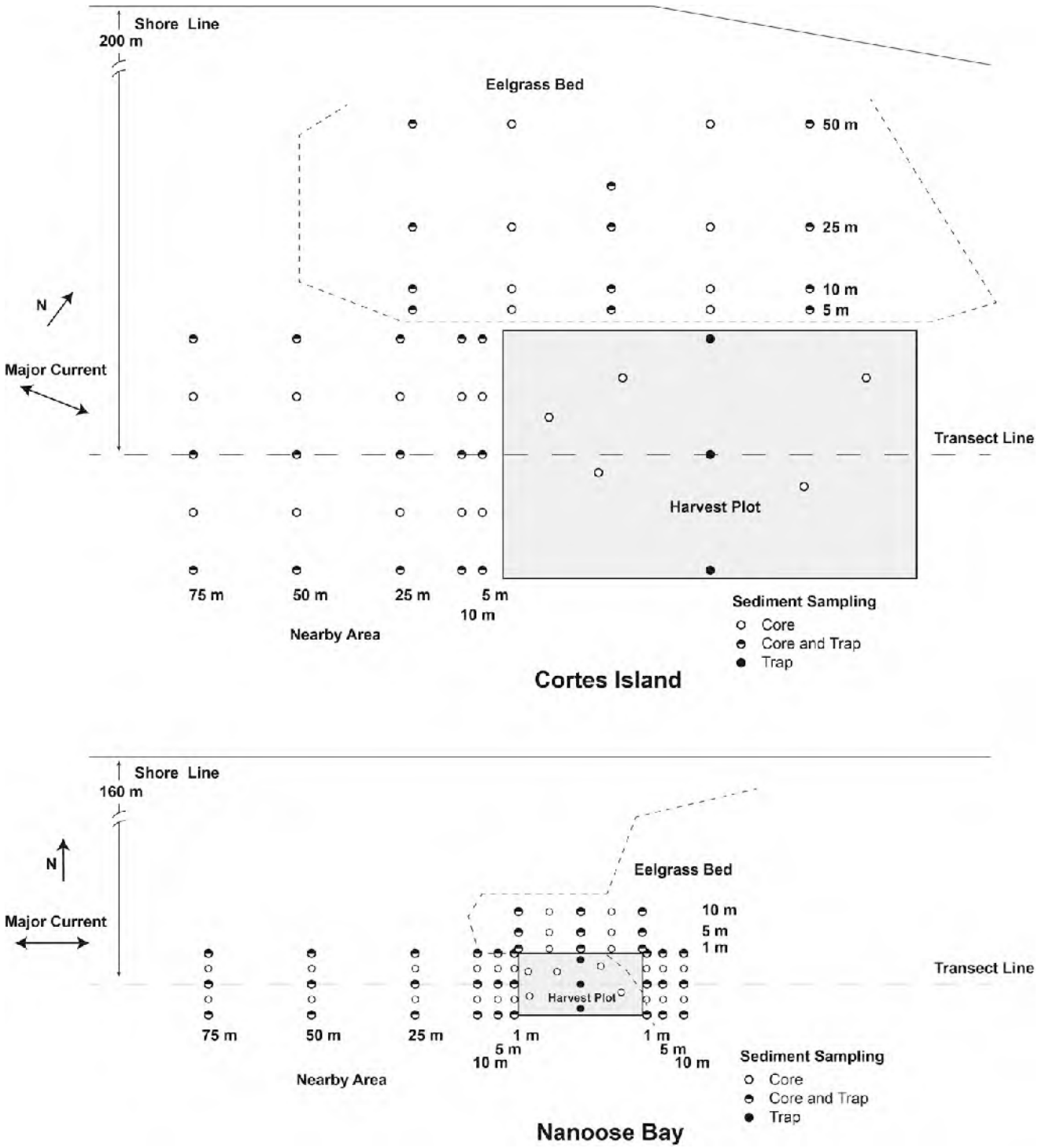

Figure 1. Experimental layouts of subtidal study site at CI (harvest plot: 100 × 60 m) and intertidal study site at NB (harvest plot: 30 × 15 m). The figure is drawn proportionally. Shaded boxes are harvest plots. Small-dotted lines represent the edges of eelgrass beds and large-dotted lines represent sampling transects. See text for more details.

extracted and averaged to determine major current directions and velocities. The data were then used to determine transect lines through the centers of the harvest plots and parallel to the major current direction. The nearby reference areas were positioned in the predominant down-current direction of the harvest plots at both sites as this was the area predicted to be most likely impacted by suspended sediments. Nearby eelgrass beds were in the direction paralleling the current (CI and NB) and up-/down-current of the harvest plot (NB) (Fig. 1). Typical current speed was 6–18 cm/s at CI and 0–12 cm/s at NB.

In the nearby areas, five sampling distances were allocated at CI and six at NB along the transect lines: 5, 10, 25, 50, and 75 m from the edge of the harvest plot at CI and 1, 5, 10, 25, 50, and 75 m at NB. The harvest plot was considered as 0 m for both

TABLE 1.

Sampling and harvest schedules at CI and NB.

CI		NB	
Date	Time point	Date	Time point
October 9–10, 2008	–12	October 16, 2008	–0
February 12–13, 2009	–8	October 18, 2008	Harvest
July 6–7, 2009	–3	October 20, 2008	+0
October 2–3, 2009	–0	January 7–8, 2009	+3
October 4–5, 2009	Harvest	March 31–April 1, 2009	+6
October 6–7, 2009	+0	November 3, 2009	+13
February 7–8, 2010	+4	April 29–30, 2010	+18
May 4–5, 2010	+7	October 10, 2010	+24
October 5/27, 2010	+12		

–, Months before harvest; +, months after harvest; –0, immediately prior to harvest; +0, immediately post harvest.

study sites. The gradient sampling design assumed that maximum impact occurred at or adjacent to the harvest plot with impact intensity decreasing with distance, dropping to nil at a certain distance from the area of harvest (Borja et al. 2009). Previous small-scale, intertidal research revealed that impacts of harvest were localized to within 10 m of the harvest zone (Sauchyn et al. 2013). We therefore considered the 50 and 75 m distances to be likely control locations. For the eelgrass bed at CI, four sampling distances from the edge of the harvest plot (5, 10, 25, and 50 m) were assigned (Fig. 1). The eelgrass bed at NB was located in two directions from the harvest plot (shoreward and seaward), three sampling distances (1, 5, and 10 m) being used for each direction (Fig. 1). The maximum eelgrass-bed sampling distances approximated the eelgrass boundary or the access limit during low tides (i.e., the seaward direction at NB).

Sampling Schedules and Variables

Samples were taken in the harvest plot, nearby area, and eelgrass bed over a 2-y period, ranging from 1 y prior to harvest to 1 y post harvest for CI and immediately prior to harvest to 2 y post harvest for NB (Table 1). The different sampling schedules at the two sites reflected a trade-off between longer-term, preharvest sampling, which allowed documentation of the natural variability prior to disturbance, and longer-term, postharvest sampling, which allowed assessment of the potential rate of recovery of impacted variables over multiple seasons/years. At each time, samples were taken at each sampling distance in the nearby area and eelgrass bed from five points ($n = 5$), which were spaced approximately evenly across the length or width of the harvest plot (Fig. 1). Five random samples were also taken within the harvest plot at each sampling time at both study sites (Fig. 1). Within the harvest plot and nearby area, samples were collected to determine sediment grain size, percent organics, total nitrogen, total organic carbon, sulfide content, redox potential, infaunal community structure, and sedimentation during harvesting. Within the eelgrass bed, samples were collected to examine sediment grain size, infaunal community structure, eelgrass shoot length, eelgrass shoot density, eelgrass biomass, and sedimentation during harvesting. It should be noted that eelgrass samples were not taken immediately post harvest at either study site since harvesting was not conducted directly on the eelgrass beds and no direct physical damage to the eelgrass populations would be expected from the disturbance so soon after harvest. Indirect harvest effects on the eelgrass, due to siltation and/or release of dissolved compounds from the sediments, would unlikely be detected for some time after the disturbance. Additional samplings were undertaken to monitor seasonal eelgrass variations.

Sample Analysis: Sediment Physics and Chemistry

At each sampling point and time, the top 2-cm layer of sediments was collected using a sample corer (6.5-cm diameter × 20-cm height), transported to the laboratory on ice, and frozen at –20°C. After samples were thawed and overlying seawater removed, subsamples were freeze-dried for later determination of percent organics, total nitrogen, and total organic carbon. The remaining portion of the samples was dried at 60°C to constant weight for later determination of sediment grain size. Organic content was expressed as a percentage of sample dry-weight loss after combustion at 500°C for 5 h. Total nitrogen and organic carbon were determined by high-temperature combustion in a Carlo Erba CHN analyzer (NA-1500) and expressed as percentages of sample dry weight. Sediment grain size was determined by sifting samples through a series of nested 203-mm diameter sieves on a sediment shaker. Particle compositions were calculated as percentages of total sample dry weight for gravel (>2,000 μm), very coarse/coarse sand (2,000–500 μm), medium sand (500–250 μm), fine/very fine sand (250–63 μm), and silt/clay (<63 μm), according to the Wentworth (1922) scale.

Sulfide content and redox potential of sediments collected at 2- and 6-cm depth were measured. At CI, a sample corer (6.5-cm diameter × 20-cm height) with two small holes (1.7-cm diameter, 4 cm apart vertically) was pushed into the seabed at each sampling point to position the two holes at 2- and 6-cm depths. A sediment sample was then taken from each hole using a 10-ml cut-off plastic syringe. The syringe was sealed air-tight, stored on ice, and transported to the laboratory. At NB, a sample corer (as above, but with the two holes sealed with duct tape) was pushed into the seabed at each sampling point. The whole corer, with contained sediments, was then sealed air-tight at the two ends and taken on ice to the laboratory, as the presence of gravels made it difficult to apply the syringes on site given the time available. Samples were analyzed within a few hours after collection. Prior to analysis, samples were left at room temperature in the dark for 1 h. Sulfide content was measured with a silver/sulfide electrode and redox potential with a platinum redox electrode, after the method of Wildish et al. (1999). Redox potential readings were corrected to a standard hydrogen reference electrode.

Sample Analysis: Infaunal Community

A sediment core (6.5-cm diameter × 10-cm height) was collected at each sampling point and time. During preliminary samplings at both study sites we rarely encountered larger species such as bivalves and gastropods that could not be taken by a corer 6.5 cm in diameter. After overnight storage at 4°C, the cores were washed on a 0.5-mm sieve and the materials retained were preserved in 8% phosphate-buffered formalin for 1–2 wk and then transferred to 70% ethanol for longer-term storage. Prior to identification, the materials were washed on a 1-mm sieve. We chose this mesh size based on (1) protocols established for the US Environmental Protection Agency for

sampling subtidal benthic macroinvertebrate assemblages in Puget Sound (Puget Sound Water Quality Authority 1987) and (2) preliminary observations on our own 0.5-mm fraction which revealed that it was relatively clean in comparison with the 1-mm component, being made up of mostly smaller individuals or juveniles of what was present in the 1-mm fraction. While many studies on infaunal populations have used either 0.5 or 1-mm mesh sizes for screening, some recent work has examined the meiofaunal (45–1,000 μm) community (e.g., Gallucci et al. 2012), which can be an important component of soft-sediment environments. The present study did not assess potential impacts on meiofaunal populations, which would include recruiting larvae. All retained organisms were classified to the lowest taxonomic level by one designated infaunal taxonomy specialist. The numbers of species and individuals and Shannon–Wiener index were calculated for each core (Crawford et al. 2003, Borja et al. 2009).

Sample Analysis: Eelgrass

Eelgrass samples were taken from a 40×40-cm quadrat at each eelgrass-bed sampling point and time. All above-ground shoots in the quadrats were severed and stored at –20°C until examination. The thawed samples were sorted to determine maximum shoot length and shoot density (CI), cleaned of any visible epifauna, and dried at 60°C to constant weight to determine per-quadrat dry biomass (CI and NB) for each sampling point.

Harvesting and Sedimentation During Harvesting

At CI, the harvest plot had a surveyed geoduck density of 1.58 ind/m^2 prior to harvest in 2008. A total of 1,554 geoducks (mean weight: 0.82 kg) were collected in two work days by a commercial dive crew using standard harvest practices. This represented a harvest intensity of 0.26 ind/m^2 on the 6,000-m^2 plot, which is substantially higher than what would be occurring in the wild fishery. The range of densities on wild geoduck beds in the vicinity of the harvest plot was 0.03–0.32 ind/m^2, but the wild fishery operates on a 3-y rotation at a harvest rate of only 1.8% estimated biomass per year or a maximum of 5.4% estimated biomass every 3 y (Fisheries and Oceans Canada 2012). The wild fishery would, therefore, target an overall removal rate of 0.02 ind/m^2 every 3 y for wild geoduck beds near the study site, illustrating how potential impacts from cultured/enhanced geoduck harvesting may be amplified compared with the wild fishery. Individual clams were identified by their "shows" (siphon tips protruding from the sediments) and harvested one by one.

At NB, a mock harvest was carried out by inserting a pressurized water jet, powered by a 5.5-hp water pump, repeatedly into the substrate across the 450-m^2 harvest plot during a low tide, creating approximately 9 holes/m^2 (essentially the whole plot being disturbed). There was a small eelgrass-bed intrusion in the northeast corner of the harvest plot and it was also affected (Fig. 1). Typically, intertidal tenures in WA are planted with 20,000 predator-protection tubes per 0.5 acre with two to three juveniles placed in each tube (Davis 2004), which amounts to a seeding density of 20–30 ind/m^2. Assuming one geoduck per tube survives (Davis 2004), then a harvest density would be approximately 10 ind/m^2, which is very similar to our 9 holes/m^2. Typically, intertidal harvests in WA are carried out using the swath technique whereby the entire culture plot is stung out, moving from one end of the plot to the other in a systematic fashion.

Deposition of suspended materials created by harvesting was determined using sediment traps. At both study sites, three sediment traps were used in the harvest plot (along the central line perpendicular to the transect line) and at each sampling distance in the nearby area and in the eelgrass bed (Fig. 1). Each trap was 40 cm high and 7.7 cm in diameter, with an aspect ratio >5 (Ongley 2006). Prior to harvesting, the traps were deployed for 2 days to collect background suspended sediment data and then redeployed just before harvesting and collected 2–3 days later when the harvest was completed. It should be noted that the subtidal traps collected both sediments created during harvesting and those redeposited by water currents after it was completed. The intertidal traps, however, only collected sediments redeposited by water currents after harvesting was completed as the tide came in. It should also be noted that, at both study sites, it was quite windy before harvesting, but very calm during and after.

At each sampling point, the trap was placed in a larger polyvinyl chloride (PVC) pipe, embedded in the seabed, to minimize disturbance of the surrounding sediments during the set-up and removal of the traps. At NB, sediments inside the larger PVC pipes had been carefully dug out, so that the openings of the traps placed inside were 15 cm above the seabed, to increase the submersion time of the traps as the tide came in. No sediments in the larger PVC pipes were removed at CI and the openings of the traps were 40 cm above the seabed.

After recovery, the traps were kept in the dark for at least 12 h to allow suspended material to settle and overlying seawater was then siphoned off. The trapped materials were transferred into preweighed 50-ml plastic tubes and centrifuged for 10 min at 1,509 *g*. The resultant solids were washed with distilled water, centrifuged again under the same conditions, and dried at 60°C to constant weight. Sedimentation rates were determined as dry sediment weight collected per trap per day (g/trap/day) at each sampling point.

Sedimentation from Additional Sampling

Suspended sediments were collected at CI during a winter storm in 2011. Six sediment traps (three in the nearby area and three in the eelgrass bed) were deployed just before the storm (February 11) and retrieved after the storm (February 16). Background data on suspended sediments for a calm sea were not collected until March 20–24, 2011 since sporadic storms passed through the area for a long time.

Sampling during winter storms was not possible at NB as a tide low enough to facilitate sample collection during a storm event never occurred during the study period. Instead, annual sedimentation rate was monitored at NB every 2–3 mo for 1 y (April 2009 to April 2010). At each sampling time, nine sediment traps (three in the nearby area and three in both directions of the eelgrass bed) were deployed for 11–14 days during a tidal cycle. At both study sites, the set-up of sediment traps and processing of sediment samples were the same as previously described.

Statistical Analysis

Statistical analysis was facilitated using the software PERMANOVA + for Primer (Clarke & Gorley 2006, Anderson et al. 2008). This software was used to examine the main effects of

sampling distance and time, and their interaction, on various data sets from CI and NB (Tables 2 and 3), the harvest plot/nearby area and eelgrass bed of each study site (the two directions of eelgrass beds at NB) being analyzed separately. Infaunal data were fourth-root transformed and other environmental data were standardized, with the Bray-Curtis similarity and the Euclidean distance measures being used, respectively, to generate similarity matrices. Data in the text are presented as ranges from the lowest to the highest means observed across the different distances over the study period for each variable examined, unless otherwise specified. The false discovery-rate control procedure of Benjamini and Hochberg (1995) was used to control excessive type I error in the PERMANOVA tests with an overall significance level set at $P < 0.05$. A total of 19 PERMANOVA tests were conducted for CI and NB combined. This resulted in an adjusted significance level of $P < 0.005$.

Interpretations of potential harvesting effects in the present study are based on concepts of the BACI design (Green 1979, Stewart-Oaten et al. 1986, 1992, Goldberg et al. 2012). If the interaction between sampling distance and time is nonsignificant, this suggests that each distance (including the harvest plot and control location) shows the same pattern of variation in response to time, therefore indicating that the harvest effect is likely none. This is irrespective of the main effects and likely due to heterogeneity across space and considerable natural variability over time. If the interaction is significant, however, it does not necessarily mean that the harvest effect is significant as other factors may also be contributing to spatial and temporal variation. Attention was paid to consistent patterns in the data, if any, to elucidate if the significant interaction terms were more likely due to a harvest effect rather than natural variability.

In addition, two-way analysis of variance (ANOVA) was used to examine sedimentation before/during harvesting and one-way ANOVA used to examine sedimentation from additional sampling. Newman–Keuls (NK) analyses were used to identify the occurrence of significant pair-wise differences. Analysis of variance and NK were conducted using the software NCSS 2007 (Kaysville, UT). All data in the ANOVA analyses were log-transformed to satisfy normality and homogeneity, as confirmed by Kolmogorov–Smirnov and Levene's tests, respectively. The level of significance of all ANOVA tests was set at $P < 0.05$.

RESULTS

Harvest Plot and Nearby Area: Sediment Physics and Chemistry

Sediments of the harvest plot and nearby area at CI were composed mainly of medium sand (48.0%–58.8%), followed by very coarse/coarse and fine/very fine sands (17.5%–26.5% and 18.9%–26.9%, respectively). Silt/clay accounted for only <0.3% of the sediments and no gravel was encountered (Fig. 2). Percent organics ranged from 0.42% to 0.64%, total nitrogen from 0.015% to 0.025%, and total organic carbon from 0.078% to 0.169%. Sulfide contents were 12.5–326.4 μM at 2-cm depth and 45.4–273.0 μM at 6-cm depth. Redox potential at the respective depths was 188.5–334.8 mV and 186.5–323.7 mV (Fig. 3). The software PERMANOVA did not reveal any significant interactions between sampling distance and time for any of these data sets except for sulfide content and redox potential at 2-cm depth (Table 2). There was no consistent pattern, however, to relate the significance to the harvest (Fig. 3).

Sediments of the harvest plot and nearby area at NB were composed mainly of fine/very fine sand (41.8%–82.2%). The site was also characterized by a wide range of gravels (0.1%–36.5%), suggesting a heterogeneous sediment composition. Percents of very coarse/coarse sand, medium sand, and silt/clay were low (2.8%–13.3%, 8.7%–25.6%, and 2.5%–7.5%, respectively) (Fig. 4). The interaction between sampling distance and time was significant for sediment grain size (Table 3). This significance appeared to be related to the +18 sampling (April 30, 2010), when a recent land-water runoff swept away finer sediments at 50 and 75 m, but had the opposite effect at the other distances (Fig. 4). Percent organics at NB ranged from 0.80% to 1.54%, total nitrogen from 0.034% to 0.074%, and total organic carbon from 0.27% to 0.56% (Fig. 5). Sulfide contents were 34.7–445.7 and 152.9–492.5 μM at 2- and 6-cm depths, respectively, and redox potential 120.3–262.9 and 91.1–257.0 mV, respectively (Fig. 5). The interaction between sampling distance and time was nonsignificant for each set of sediment chemistry variables examined at NB (Table 3).

Harvest Plot and Nearby Area: Infaunal Community

The number of species per core at CI ranged from 7.6 to 25.2, the number of individuals from 11.2 to 61.6, and the Shannon–Wiener index from 1.6 to 2.8 (Fig. 6). The interaction between sampling distance and time was nonsignificant for infaunal community structure (Table 2). At each sampling time, annelids, arthropods, and molluscs (predominately bivalves) were the most common infauna, accounting for 20.0%–44.3%, 20.4%–49.7%, and 12.0%–46.4% of the respective total individuals enumerated over the entire harvest plot and nearby area.

At NB, the numbers of species and individuals per core were 5.2–16.6 and 10.2–98.0, respectively. The Shannon–Wiener index ranged from 1.0 to 2.2 (Fig. 7). The interaction between sampling distance and time was nonsignificant for infaunal community structure (Table 3). Annelids, arthropods, and molluscs (predominately bivalves) were the most abundant fauna observed at each sampling time, accounting for 38.1%–59.6%, 17.7%–50.4%, and 6.3%–20.8%, respectively, of the total individuals counted in the entire harvest plot and nearby area.

Harvest Plot and Nearby Area: Sedimentation During Harvesting

At CI, sediments collected at each distance (0–75 m) ranged from 0.22 to 0.69 g/trap/day before the harvest, but were lower (0.04–0.09 g/trap/day) during the harvest except for the harvest plot (0.88 g/trap/day) and the 5-m distance (5.72 g/trap/day) (Fig. 8). The much higher value at 5 m was caused by one large replicate value (16.86 g/trap/day), which was likely due to direct "spill" from the harvest. After that large value was removed from the analysis, two-way ANOVA showed that the interaction between sampling distance and time was significant ($F_{(5,23)} = 4.38$, $P = 0.006$). An NK test revealed that there was no significant difference among all distances in the background before-harvest data. During harvesting, sediment levels in the harvest plot (0 m) were significantly higher than those at all the other distances except for 5 m, yet comparable to those before the harvest. When compared with the before-harvest data, although generally less sediment was collected at each distance from 5 to 75 m during the harvest, the differences were significant only for 75 m.

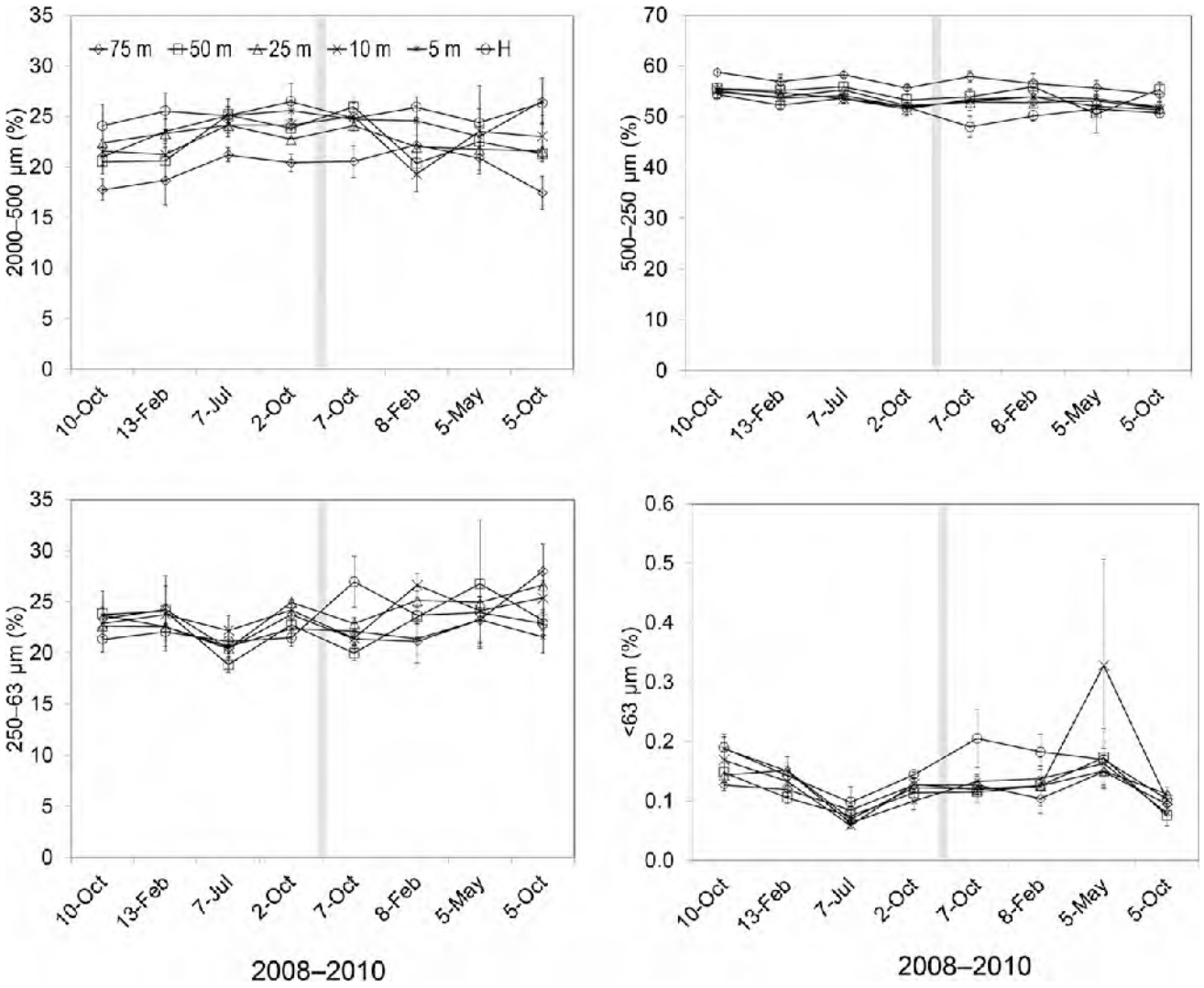

Figure 2. Sediment grain size compositions in harvest plot (H) and nearby area at CI. Shaded boxes indicate time of harvest (October 4–5, 2009). Error bars are SE ($n = 5$).

At NB, sediments collected at each distance (0–75 m) ranged between 0.78 and 1.47 g/trap/day before the harvest, but were lower (0.09–0.62 g/trap/day) during the harvest (Fig. 8). Two-way ANOVA showed that the interaction between sampling distance and time was significant ($F_{(6,28)} = 5.14$, $P = 0.001$). An NK test revealed that significantly less sediment was collected during the harvest than before the harvest at each distance except for the harvest plot (0 m) and 5 m.

Eelgrass Bed: Sediment Physics

At CI, sediment composition of the eelgrass bed was similar to that of the harvest plot and nearby area, being 13.1%–28.2% for very coarse/coarse sand, 43.3%–58.5% for medium sand, 18.9%–40.7% for very fine/fine sand, and <0.5% for silt/clay (data not shown). The interaction between sampling distance and time was nonsignificant for sediment grain size (Table 2).

Sediment compositions of the eelgrass beds at NB were predominately fine/very fine sand (63.5%–84.6% and 71.1%–88.3% for the seaward and shoreward beds, respectively), followed by medium sand (7.2%–18.6% and 6.5%–18.0%), very coarse/coarse sand (3.3%–12.2% and 1.0%–5.8%), and silt/clay (2.6%–6.8% and 2.0%–9.4%). Gravel content was low for both beds (<4.0%) (data not shown). The interactions between sampling distance and time were nonsignificant for sediment grain size in both eelgrass beds at NB (Table 3).

Eelgrass Bed: Infaunal Community

At CI, the number of species, the number of individuals, and the Shannon–Wiener index were 6.6–20.2, 13.4–95.0, and 1.4–2.6 per core, respectively (data not shown). The interaction between sampling distance and time was nonsignificant for infaunal community structure (Table 2). At each sampling time, molluscs (bivalves) were the more observed infaunal group, accounting for 37.5%–63.7% of the total number of individuals counted over the entire eelgrass bed, followed by annelids and arthropods (13.6%–30.7% and 16.1%–42.2%, respectively).

Infaunal community structures of the seaward and shoreward eelgrass beds at NB—number of species per core: 7.2–17.0 and 6.2–15.6; number of individuals per core: 14.0–85.2 and 13.4–80.8; Shannon–Wiener index: 1.7–2.3 and 1.4–2.4—were

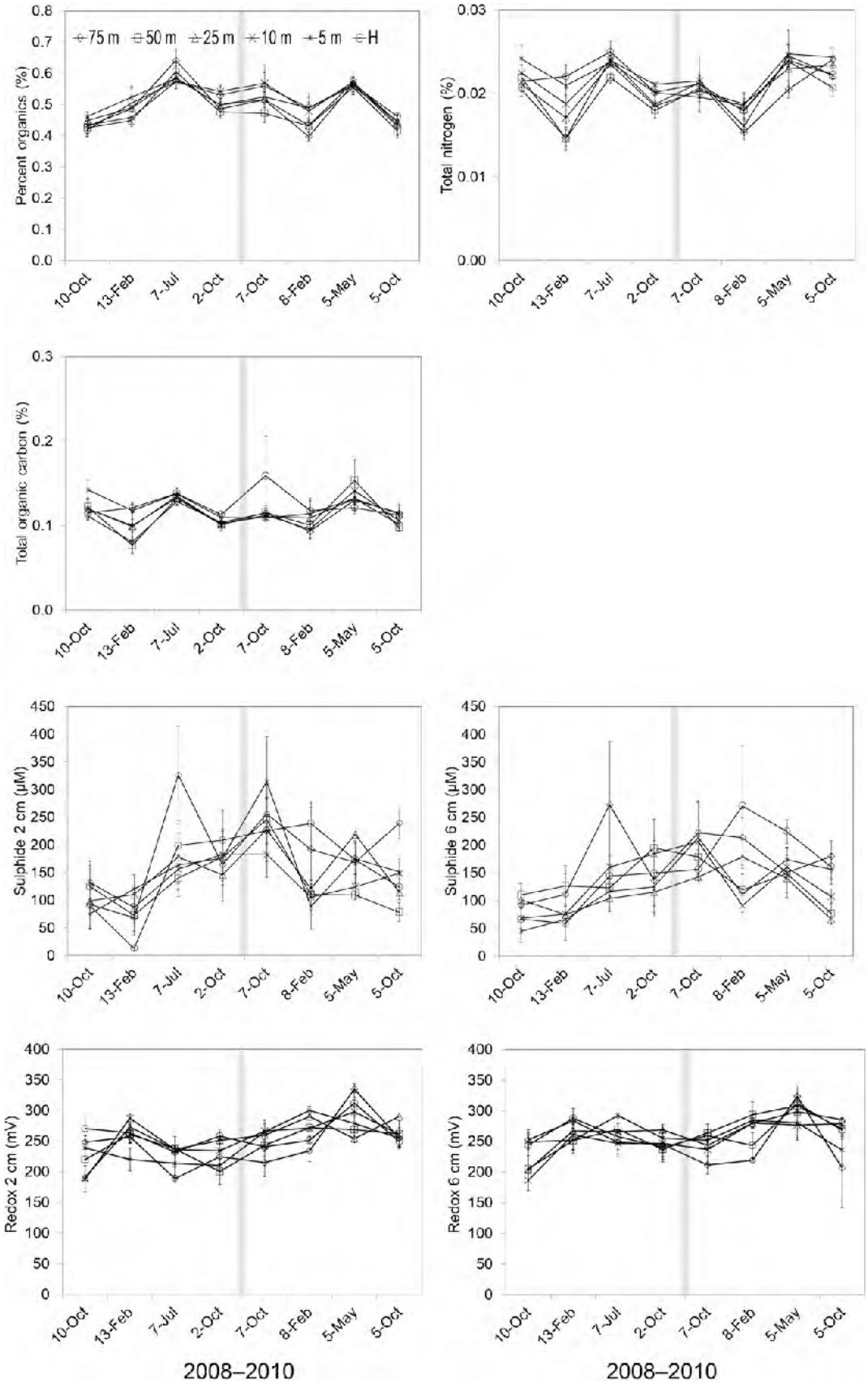

Figure 3. Percent organics, total nitrogen, total organic carbon, sulfide content, and redox potential in harvest plot (H) and nearby area at CI. Shaded boxes indicate time of harvest (October 4–5, 2009). Error bars are SE ($n = 5$).

TABLE 2.

Results of PERMANOVA of effects of sampling distance, time, and interaction on various sets of variables from CI.

	Variables	Sources	*df*	*F*	*P*
Harvest plot and nearby area	Sediment grain size	Distance	5	5.79	<0.001
		Time	7	3.79	<0.001
		Distance × time	35	0.73	0.975
		Error	192		
	Percent organics, total nitrogen, and total carbon	Distance	5	2.14	0.033
		Time	7	17.31	<0.001
		Distance × time	35	0.99	0.514
		Error	192		
	Sulfide content and redox potential 2 cm	Distance	5	1.52	0.137
		Time	7	10.78	<0.001
		Distance × time	35	1.64	**0.003**
		Error	192		
	Sulfide content and redox potential 6 cm	Distance	5	1.60	1.099
		Time	7	6.73	<0.001
		Distance × time	35	1.21	0.130
		Error	192		
	Infaunal community structure	Distance	5	0.98	0.434
		Time	7	36.68	<0.001
		Distance × time	35	0.79	0.802
		Error	192		
Eelgrass bed	Sediment grain size	Distance	3	13.91	<0.001
		Time	7	7.33	<0.001
		Distance × time	21	0.71	0.932
		Error	128		
	Infaunal community structure	Distance	3	6.27	<0.001
		Time	7	19.89	<0.001
		Distance × time	21	1.01	0.461
		Error	128		
	Eelgrass parameters	Distance	3	3.22	0.005
		Time	8	14.15	0.001
		Distance × time	24	0.63	0.973
		Error	144		

Significance ($P < 0.005$, adjusted) in interaction is indicated with bold.

similar (data not shown). The interactions between sampling distance and time were nonsignificant for infaunal community structure for both eelgrass beds (Table 3). At each sampling time, annelids, arthropods, and molluscs (predominately bivalves) were the most common taxa, accounting for 30.5%–62.8%, 3.1%–44.4%, and 11.3%–41.1%, respectively, of the total number of individuals enumerated over the entire eelgrass beds.

Eelgrass Bed: Eelgrass Parameters

At CI, the maximum shoot length of eelgrass ranged from 45.4 to 76.8 mm, shoot density from 3.5 to 16.5 per quadrat, and biomass from 1.28 to 7.83 g/quadrat (Fig. 9). The eelgrass was exclusively *Zostera marina*.

At NB, the eelgrass biomass ranged from 0.57 to 9.23 g/quadrat for the seaward bed and from 0.97 to 12.58 g/quadrat for the shoreward bed (Fig. 9). The eelgrass species present at NB were *Zostera marina* and *Zostera japonica*. The inconsistent distribution of the two eelgrass species over space and time made it difficult to compare such variables as shoot length and density. Neither of the interactions between sampling distance and time were significant for eelgrass parameters at CI and NB (Tables 2 and 3).

Eelgrass Bed: Sedimentation During Harvesting

At CI, the amounts of suspended sediments collected at each distance (0–50 m) were 0.28–0.83 g/trap/day before the harvest. Lower amounts of sediment were collected at each distance during the harvest (0.02–0.04 g/trap/day), except for the harvest plot (0 m) (0.88 g/trap/day) (Fig. 8). Two-way ANOVA showed that the effects of sampling distance, time, and their interaction were all significant (distance: $F_{(4, 20)} = 6.23$, $P = 0.002$; time: $F_{(1, 20)} = 68.1$, $P < 0.0001$; interaction: $F_{(4, 20)} = 15.1$, $P < 0.0001$). An NK test revealed that significantly more sediment was collected in the harvest plot (0 m) than at all the other distances during the harvest and that significantly less sediment was collected during than before the harvest at each distance (0–50 m) except for the harvest plot (0 m).

At NB, the amounts of sediments collected at each distance (0–10 m) before harvesting were 0.65–1.08 g/trap/day in the seaward bed and 1.12–4.34 g/trap/day in the shoreward bed. During harvesting, the amounts were lower than before harvesting at 1 and 10 m (0.26 and 0.59 g/trap/day) of the seaward bed, 5 and 10 m (0.36 and 0.26 g/trap/day) of the shoreward bed, and the harvest plot (0 m) as well (0.45 g/trap/day) (Fig. 8). Higher amounts of sediments were observed during than before harvesting at 5 m in the seaward bed (2.92 g/trap/day) and at

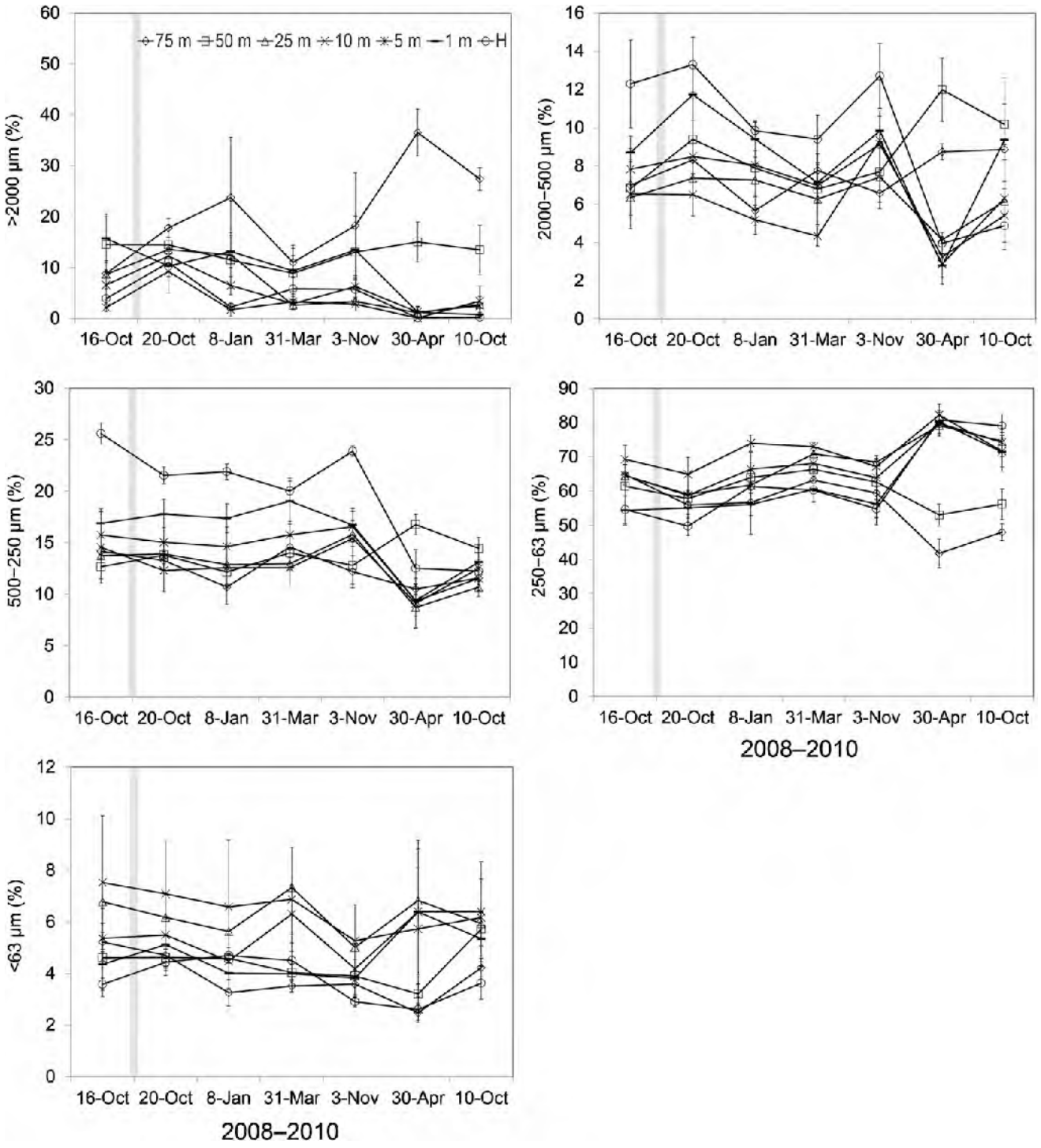

Figure 4. Sediment grain size compositions in harvest plot (H) and nearby area at NB. Shaded boxes indicate time of harvest (October 18, 2008). Error bars are SE ($n = 5$).

1 m of the shoreward bed (2.22 g/trap/day). Two-way ANOVA results, however, did not reveal any significance for sampling distance, time, or their interaction ($F_{(3,16)} = 2.37$, $F_{(1,16)} = 1.73$, and $F_{(3,16)} = 0.95$, respectively, all $P > 0.05$) for the seaward bed. For the shoreward bed, two-way ANOVA revealed that significantly less sediment was collected during than before harvesting ($F_{(1,16)} = 12.34$, $P > 0.003$) and that the effects of sampling distance and interaction between distance and time were not significant ($F_{(3,16)} = 1.31$ and $F_{(3,16)} = 2.36$, respectively, both $P > 0.05$).

Sedimentation from Additional Sampling

The recorded wind speed was 9.8/20 km/h (average/maximum hourly) on February 11; 19.7/33 km/h on February 12; 13.4/28 km/h on February 13; 20.7/35 km/h on February 14; 7.0/19 km/h on February 15; and 6.3/15 km/h on February 16, at the closest

TABLE 3.

Results of PERMANOVA of effects of sampling distance, time, and interaction on various sets of variables from NB.

	Variables	Sources	*df*	*F*	*P*
Harvest plot and nearby area	Sediment grain size	Distance	6	11.36	<0.001
		Time	6	5.29	<0.001
		Distance × time	36	1.79	**<0.001**
		Error	196		
	Percent organics, total nitrogen, and total carbon	Distance	6	5.36	<0.001
		Time	6	6.78	<0.001
		Distance × time	36	1.03	0.411
		Error	196		
	Sulfide content and redox potential 2 cm	Distance	6	2.23	0.013
		Time	6	10.31	<0.001
		Distance × time	36	1.219	0.141
		Error	196		
	Sulfide content and redox potential 6 cm	Distance	6	2.13	0.017
		Time	6	2.19	<0.001
		Distance × time	36	1.20	0.154
		Error	196		
	Infaunal community structure	Distance	6	3.43	0.002
		Time	6	28.92	<0.001
		Distance × time	36	1.59	0.019
		Error	196		
Eelgrass bed seaward	Sediment grain size	Distance	2	0.46	0.825
		Time	6	11.58	<0.001
		Distance × time	12	0.660	0.921
		Error	84		
	Infaunal community structure	Distance	2	2.28	0.100
		Time	6	18.31	<0.001
		Distance × time	12	1.51	0.122
		Error	84		
	Eelgrass parameters	Distance	2	2.44	0.098
		Time	8	9.19	<0.001
		Distance × time	16	0.42	0.976
		Error	108		
Eelgrass bed shoreward	Sediment grain size	Distance	2	24.47	<0.001
		Time	6	4.80	<0.001
		Distance × time	12	0.47	0.995
		Error	84		
	Infaunal community structure	Distance	2	3.94	0.018
		Time	6	9.08	<0.001
		Distance × time	12	1.71	0.073
		Error	84		
	Eelgrass parameters	Distance	2	3.16	0.047
		Time	8	13.76	<0.001
		Distance × time	16	1.02	0.438
		Error	108		

Significance ($P < 0.005$, adjusted) in interaction is indicated with bold.

weather station at Campbell River, BC (Climate ID: 1021261; Meteorological Service of Canada 2012). The wind was mostly from the southeast, which would have had higher impact at CI. The amount of sediments collected during the winter storm event at CI was 0.36 ± 0.02 g/trap/day (mean ± SE, $n = 6$) which was significantly (one-way ANOVA, $F_{(1,10)} = 69.95$, $P < 0.01$) greater than that collected during a calm sea (0.02 ± 0.00 g/trap/day).

The annual sedimentation rates at NB were relatively low in April, June, and August (0.48 ± 0.09, 0.22 ± 0.06, and 0.10 ± 0.07 g/trap/day, respectively; mean ± SE, $n = 9$), elevated in November (2.07 ± 1.48 g/trap/day), and peaked in January (9.04 ± 2.35 g/trap/day), after which the rates decreased (1.92 ± 0.58 g/trap/day in next April). The amount of sediment collected in January was significantly higher than that at any other time of the year. November to March is typically the heavy precipitation season in the study areas (Environment Canada 2012).

DISCUSSION

Of the various benthic parameters examined in the harvest plots, nearby areas, and eelgrass beds, the interactions between sampling distance and time were mostly nonsignificant at both

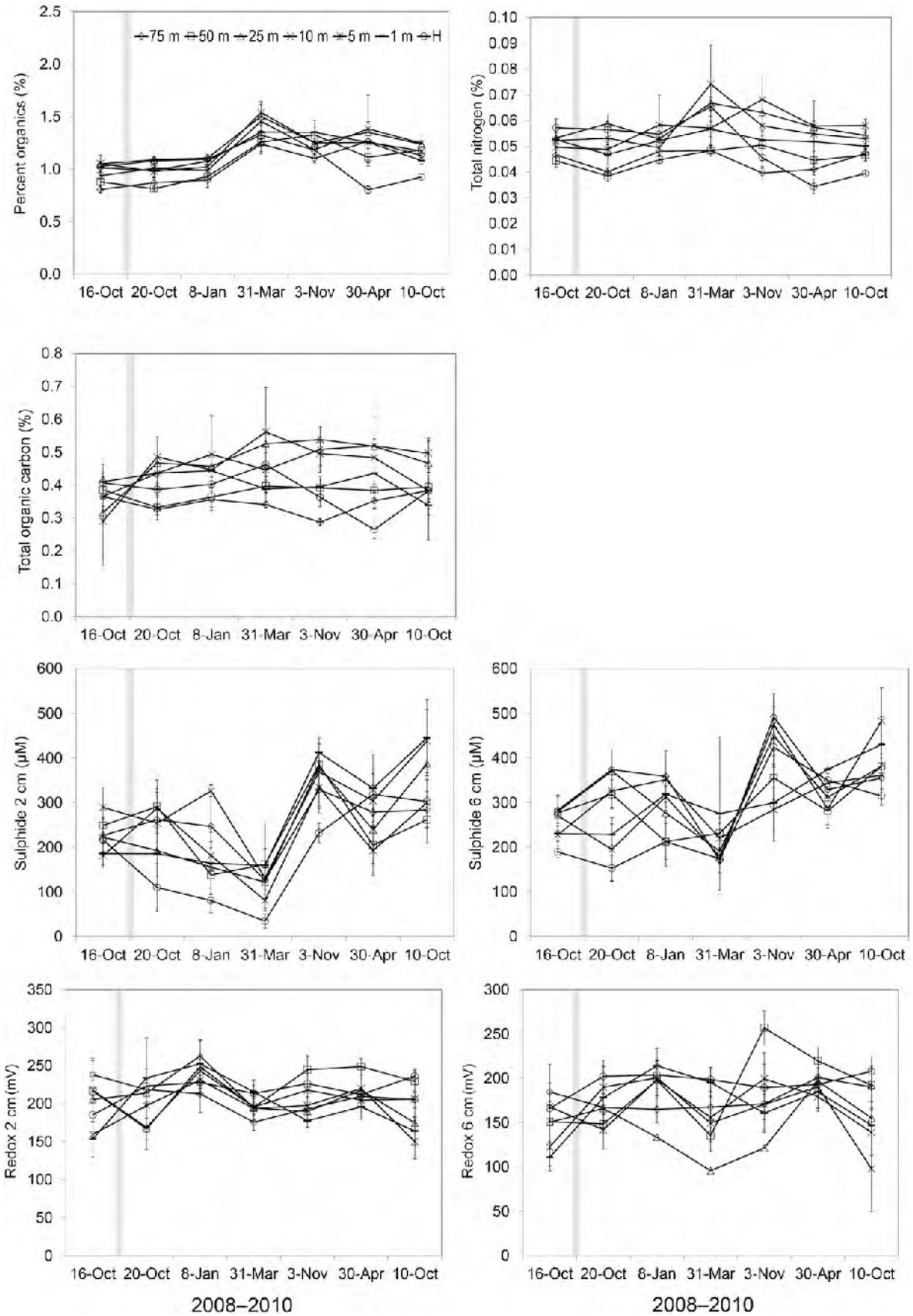

Figure 5. Percent organics, total nitrogen, total organic carbon, sulfide content, and redox potential in harvest plot (H) and nearby area at NB. Shaded boxes indicate time of harvest (October 18, 2008). Error bars are SE ($n = 5$).

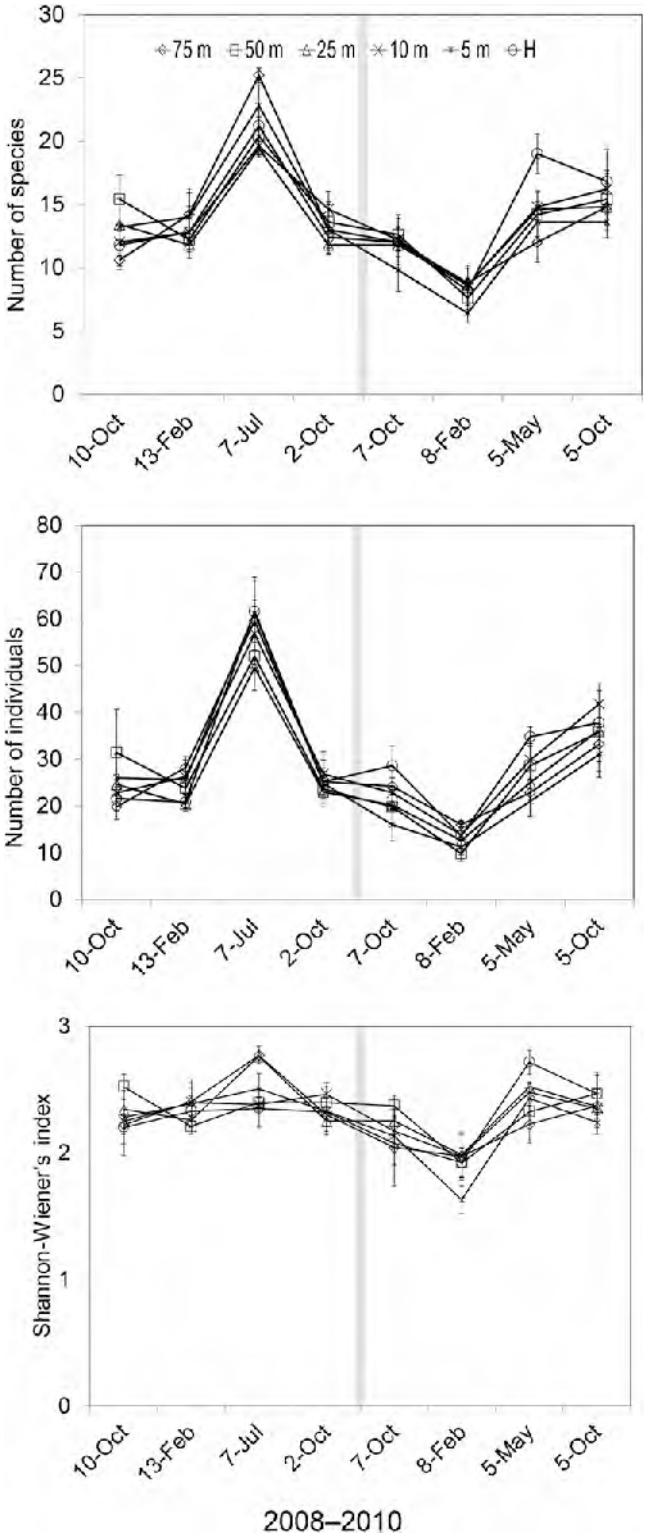

Figure 6. Infaunal community structure in harvest plot (H) and nearby area at CI. Shaded boxes indicate time of harvest (October 4–5, 2009). Error bars are SE ($n = 5$).

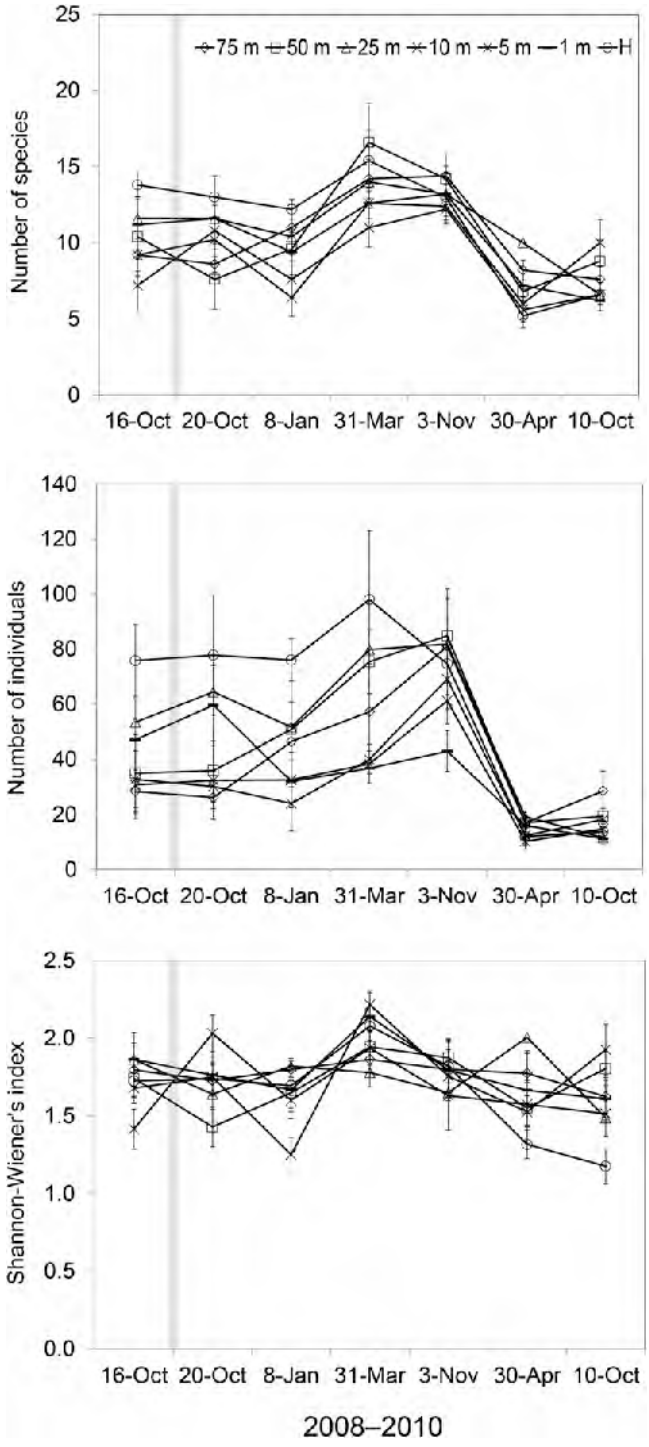

Figure 7. Infaunal community structure in harvest plot (H) and nearby area at NB. Shaded boxes indicate time of harvest (October 18, 2008). Error bars are SE ($n = 5$).

study sites, except for sulfide content and redox potential at 2-cm depth at CI and sediment grain size at NB. The former significance seemed not to have been directly related to harvest activities. The latter significance was related to a large land-water runoff at the +18 sampling. Overall, these results indicate no significant benthic impacts of harvesting geoduck clams at either site, including the harvest plots, nearby areas, and eelgrass beds. The results will be of relevance not only to the intertidal culture and subtidal enhancement of *Panopea generosa*, but also to the wild fishery of the species and to the culture and fishery of other *Panopea* species.

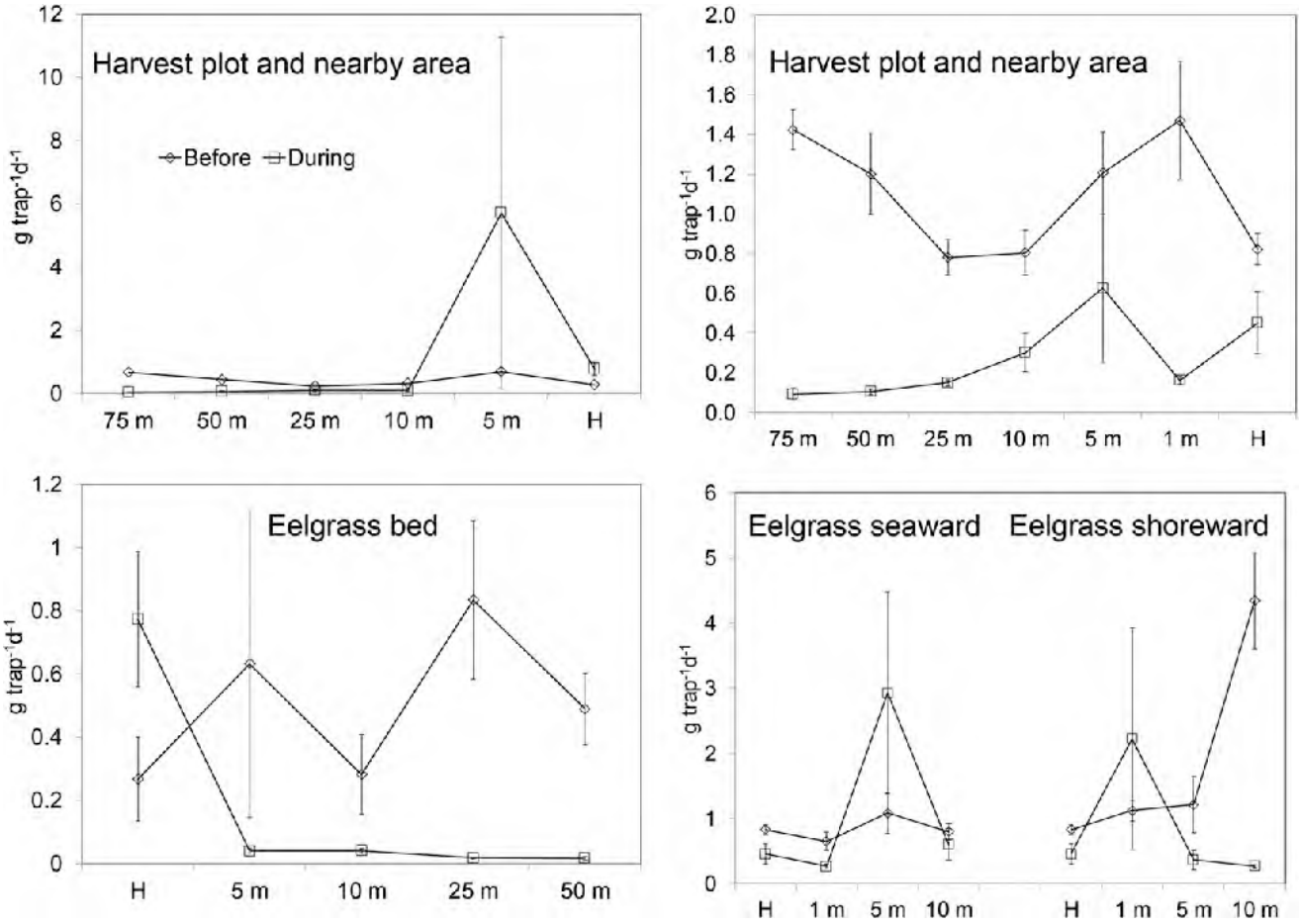

Figure 8. Sedimentation before and during harvest for CI (left column) and NB (right column). Error bars are SE ($n = 3$).

Harvest Plot

The results of the present study are consistent with previous research on the benthic impacts of subtidal wild fisheries and intertidal aquaculture. Subtidal studies by Goodwin (1978) and Breen and Shields (1983) revealed no dramatic changes in sediment grain-size distribution and no major change or simple relationship in infaunal community structure in harvest plots 7 or 10 mo after the disturbance. Species diversity (Shannon-Wiener index) actually increased as a result of harvesting in the study of Breen and Shields (1983). Similarly, Price (2011) reported that commercial-scale intertidal harvesting did not appear to significantly negatively affect various benthic parameters, including infaunal community structure, over time. In contrast to the present work, some previous studies have observed significant changes in certain benthic characteristics immediately after harvesting, such as sediment composition in harvest plots/holes or in infaunal community structure, but they were short-lived and disappeared within several months (Goodwin 1978, Price 2011, Sauchyn et al. 2013) or did not extend very far outside the area of harvest (<10 m, Sauchyn et al. 2013). Temporal changes in infaunal populations may be short term due to the fact that geoduck harvesting has the potential to displace and yet preserve benthic fauna so that they can recolonize the disturbed areas immediately after harvesting (Price 2011) and because small disturbed patches (resulting from point-source harvesting) can be recolonized more quickly by movement of fauna across sediments due to their higher edge/surface area ratios (Guerra-García et al. 2003).

Table 4 summarizes geoduck harvesting intensities in various subtidal and intertidal studies in WA and BC. Despite these studies varying in harvest intensities (e.g., harvest plot size, harvest duration, and number of holes per unit area) and likely in site-specific conditions (e.g., depth, tidal current, sediment composition, infaunal community structure, and productivity), the collective results suggest that geoduck harvesting has very limited impact on the benthic environment and any significant effect is generally short-lived or near-field. The results seen with geoducks contrast with other commercial shellfish harvesting activities such as suction-dredging cockles, in which a large area could be disturbed intensively within a relatively short time (e.g., a trench of 0.5–1.15 m wide and up to 8 km long per h per boat) causing long-lasting negative effects, up to 8 y, in sediment composition and bivalve stock in the fished area (Piersma et al. 2001). The recovery of the benthic environment after various forms of shellfish harvesting can often take days to months (Hall et al. 1990, Currie & Parry 1996, Kaiser et al. 1996, Ferns at al. 2000, Tuck et al. 2000, Kaiser et al. 2001, Constantino et al. 2009), in extreme cases years (Piersma et al. 2001), depending on the form and intensity of harvesting.

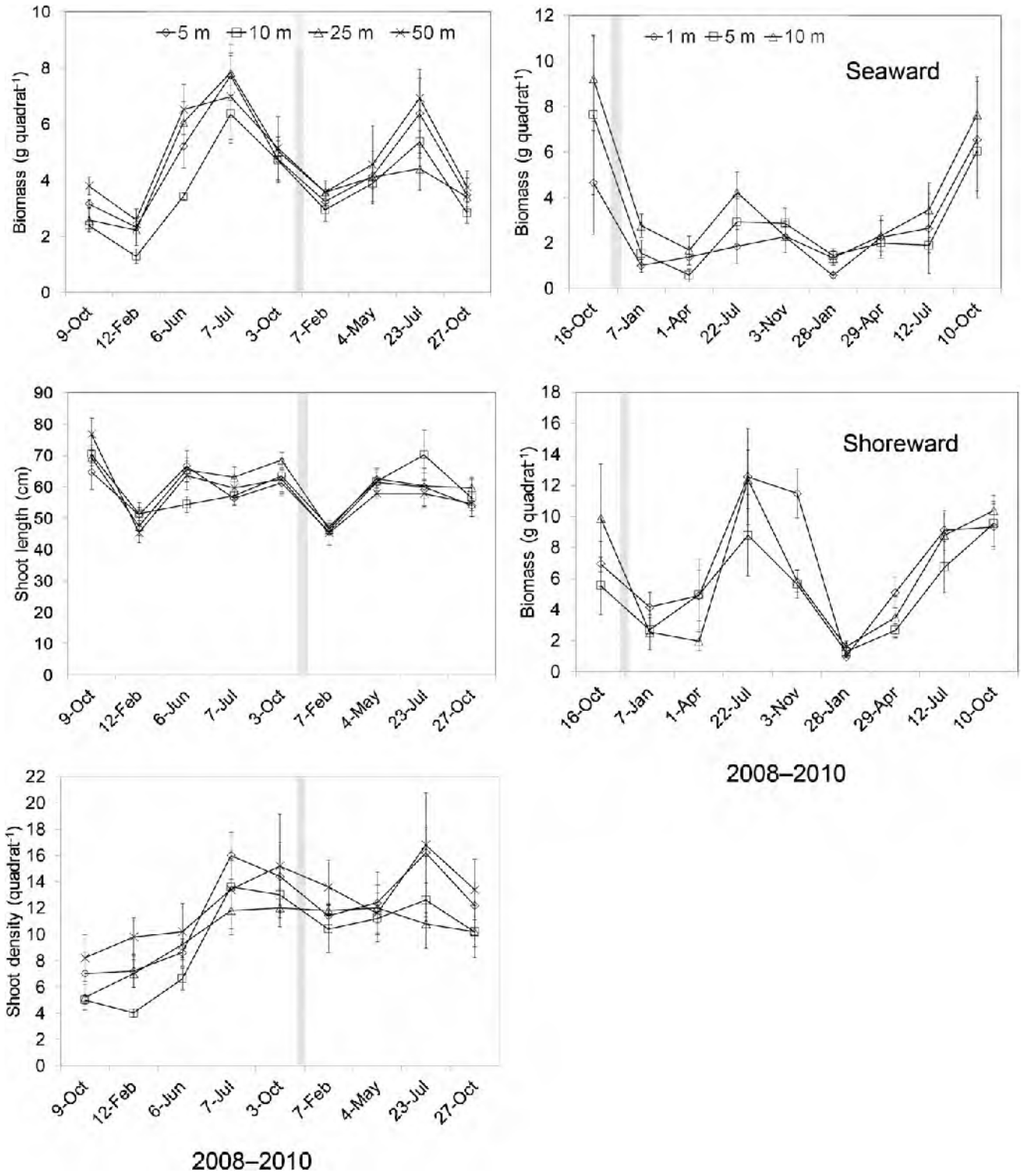

Figure 9. Eelgrass parameters for CI (left column) and NB (right column). Shaded boxes indicate time of harvest (October 4–5, 2009 for CI and October 18, 2008 for NB). Error bars are SE ($n = 5$).

Nearby Area

Subtidal geoduck harvesting with water jets places sediments in suspension and may result in effects within a broader area than the point of direct disturbance (ENVIRON International Corporation 2009). Depending on the current speed (0.05–1.00 m/s), small quantities of suspended materials from subtidal harvesting may be deposited up to 100–200 m down-current, but most settle within 1 m of the harvest holes (Short & Walton 1992). Intertidal harvesting at low tide can result in overland flow of water used in the operations, transporting suspended sediments over the exposed intertidal area to the water's edge

TABLE 4.

Summary of reported intensities of harvesting of subtidal and intertidal geoduck clams (*Panopea generosa*) in WA and BC, Canada.

Harvest plot size (m^2)	Total duration when harvest occurred (days)	Actual harvest days	Number of harvest holes (m^{-2})	Type of harvest	Reference
90	29	5	4.3	S, F	Goodwin (1978)
30	6	–	8.4	S, F	Breen and Shields (1983)
60	1	1	Swath harvest	I, A	Sauchyn et al. (2013)
2,500–4,500	2–5 (mo)	–	–*	I, A	Price (2011)
6,000	2	2	0.26	S, A/F	Present study
450	1	1	9	I, A	Present study

–, Not specified in the study; I, intertidal plot; S, subtidal plot; F, fisheries plot; A, aquaculture plot.
* The number of harvest holes per unit area is expected to be relatively higher on these aquaculture plots.
Note that an estimation of 2.5 holes/m^2 is assumed for high-density commercial geoduck fisheries beds in WA (Palazzi et al. 2001).

(Fleece et al. 2004). In both cases, it is the fines (<63 μm) that are the most relevant to transportation by water current and redeposition away from the source substrate, as they settle much more slowly and remain in the water column for longer periods than larger particles (Short & Walton 1992, Palazzi et al. 2001).

Based on a simulation model using a fine content of 8% in sediments, Short and Walton (1992) predicted that deposition of all suspended materials from a subtidal harvest would be 0.4 cm thick (including all grain sizes) in the affected down-current area if 2,500 holes were made per 0.25-acre bed or 2.5 holes/m^2, typical of high-density geoduck fisheries beds in WA (Palazzi et al. 2001). Palazzi et al. (2001) estimated a layer of 0.2 cm sediments of just fines if 10,000 holes were created per acre with a fine content of 3.5% and if all the fines settled within that acre. At the subtidal site CI, the fines accounted for <0.3% of the sediments. Such a low fine content, usually associated with a high-energy environment, is not uncommon in commercial geoduck fishery beds in BC and would be likely in future geoduck aquaculture tenures. Under such conditions, little fine materials would be available for suspension and subsequent redeposition due to harvesting. This supposition is supported by sedimentation data compiled from sediment traps in the nearby down-current area at CI. Suspended sediments collected during the 2-day harvest at 5–75 m were 0.04–0.09 g/trap/day (except for a large replicate value at 5 m), representing a layer of 0.001–0.002 cm thick over the whole nearby area [estimated using a sediment density of 1.84 g/cm^3 (Short & Walton 1992)]. Even if the present harvest intensity of the subtidal plot was increased 10 times to 2.6 holes/m^2 within the 6,000-m^2 harvest plot, the accumulation of suspended sediments would be projected to be 0.01–0.02 cm thick, well below the estimations of Short and Walton (1992) and Palazzi et al. (2001). Further, suspended sediment amounts collected during harvesting at CI were similar to those during a calm sea (0.02 g/trap/day), but much lower than those in a rough sea just before the harvest and during the winter storm at this study site (0.22–0.69 and 0.36 g/trap/day, respectively). In the intertidal study site (NB), the fines accounted for 2.5%–7.5% of the sediments (Fig. 4). The amount of suspended materials collected during the harvest at 1–75 m (except for one large replicate value at 5 m) was 0.09–0.30 g/trap/day, representing a layer 0.002–0.007 cm thick over the one-tidal cycle harvest (estimated as above). The annual sedimentation rates at NB varied in the range of 0.10–9.04 g/trap/day, including those in windy conditions (just before the harvest), and can be much higher than rates during harvesting.

The present study did not examine the phenomenon of overland flow, caused by water used for intertidal harvesting, carrying suspended sediments into the water column. Fleece et al. (2004) and ENVIRON International Corporation (2009) found that increased turbidity from intertidal harvesting was limited to the shore area <25′ from shoreline, peaked at 100 ± 50′ downstream of the harvest site, and declined rapidly within a short distance. The distance a turbid plume may travel is dependent on a number of factors including proximity of water edge to the harvest site, strength and direction of near-shore currents, sediment characteristics of the culture beach, and local weather during the harvest. Natural turbidity generated along the shoreline during windy days is generally not distinguishable from that created by harvesting and turbidity generated by harvesting is only visible on calm days (ENVIRON International Corporation 2009). Therefore, it seems probable that any effect of overland flow on the nearby water column by intertidal harvesting would be confined to a limited area close to the site, would not exceed that generated by natural forces, and would dissipate quickly as the tide came in. Note that this limited area potentially affected by the overland flow during harvesting is not the same as the nearby down-current area addressed by the present study. The latter was subject to the redeposition of sediments from the harvested plot after harvesting was completed and the tide came in.

Eelgrass Bed

No significant changes in sediment grain size, infaunal community, or various plant parameters of the eelgrass beds were detected at either study site in response to harvesting. Although results of the present study might be site specific, some general comments may be made regarding effects of geoduck harvesting on eelgrass beds at other potential culture sites. The depth limit of eelgrass distribution is largely regulated by light availability under water (Duarte 1991), suggesting that beds may not extend below a certain depth contour. For example, surveys in Puget Sound, WA, have shown that eelgrass rarely occurs deeper than the –5.5 m mean lower low-water contour (Palazzi et al. 2001). Similarly, in the present study,

the lower boundary of the eelgrass bed at the subtidal CI site occurred at approximately 3.5 m below chart datum. At present, harvesters in the geoduck fishery in BC are not allowed to fish in water shallower than 3.0 m below chart datum, placing them deeper than most eelgrass beds (Fisheries and Oceans Canada 2012). Accordingly, it is likely that future subtidal geoduck culture in BC will be permitted only in areas deeper than where eelgrass beds exist. Indeed, since these beds are considered to be sensitive aquatic vegetation and critical fish habitat in Canada, they are protected from harmful alteration, disruption, and destruction. Future geoduck enhancement/culture plots are unlikely to be allowed in or near eelgrass beds. Since the major near-shore current direction typically parallels shorelines, it is expected that deposition of materials from turbid plumes and increased turbidity from subtidal geoduck harvesting would be minimal in shallower eelgrass beds which would not be subject to the direct down-current influence from harvesting. Findings of the present study at CI are consistent with this notion as sediment amounts collected in the eelgrass bed through harvesting were comparable to those during a calm sea, but much lower than those during a rough sea (just before the harvest) and winter storm at that site.

The shoreward eelgrass bed paralleled the major current direction at the intertidal site NB. Despite the seaward eelgrass bed having been located in the down-current direction, materials available for redeposition from harvesting were first carried in the opposite direction toward the nearby area as the tide came in, leaving less material available for subsequent redeposition on the seaward eelgrass bed during the ebb tide. The amounts of sediments collected in both shoreward and seaward eelgrass beds were much lower during harvesting than during windy conditions (just before the harvest), except for a few large replicate values at 1 m (shoreward) and 5 m (seaward). Therefore, as with the nearby down-current areas, the low levels of sediments caused by harvesting near the eelgrass beds would be inconsequential at both study sites when compared with natural variation. This is consistent with our findings that there were no significant changes in grain size, infaunal community, or eelgrass parameters in the eelgrass beds at either site.

This study identifies little effect of commercial geoduck-harvesting practices beyond short-lived resuspension of sediment on the two harvested plots. More work needs to be done, however, to assess how changes in habitat, size of culture plot, frequency of culture, and seasonal timing of out-planting and harvesting may alter the degree of impact on, and rate of recovery of, the marine environment.

ACKNOWLEDGMENTS

Financial support was provided by the Aquaculture Collaborative Research and Development Program of Fisheries and Oceans Canada, the Underwater Harvesters Association, and the BC Ministry of Forests/BC Timber Sales. We thank Rick Birch and Dave English of ASL Environmental Sciences Inc. for Acoustic Doppler Current Profiler data analyses, Sandy Lipovsky of Columbia Science for infaunal identification and enumeration, Cynthia Durance for eelgrass species identification, Dr. Maureen Soon of the University of British Columbia for total nitrogen and total organic carbon analyses, and Parkes Design for the site-map drawing. We are grateful to the following persons (in alphabetical order) who assisted in the field and/or laboratory sampling: (1) Dr. Pearce's laboratory: Kalam Azad, John Blackburn, Dan Curtis, Lyanne Curtis, Anya Dunham, Lucie Hannah, Laurie Keddy, Rob Marshall, Haley Matkin, Lindsay Orr, Leah Sauchyn, and Janis Webb; (2) Fisheries and Oceans Canada (Pacific Biological Station): Dominique Bureau, Dan Leus, and Erin Wylie; (3) undergraduate students from Vancouver Island University (Fisheries and Aquaculture Department): Carol Bob, Heather Brown, Luke Devenish, Sara Gordon, Mark Ma, Rianna Martindale, Daniel McNeill, Patrick O'Reilly, Steven Paie, Dave Poter, Kate Rolheiser, and Owen Skipper-Horton; (4) West Coast Geoduck Research Corporation: Lawrence Anderson, Bob Antifave, Mike Atkins, James Austin, Cory Carmen, Bruce Clapp, Kirk Montgomery, Evan Scoffings, Tracy Scott, Greg Sorensen, Kevin White, and Sean Williams. Peter and Susan McLellan allowed the Nanoose Bay study site to be set up on their aquaculture tenure. Scientific advice for the research project was provided by Miriam O from Fisheries and Oceans Canada. We also thank Michelle James (Underwater Harvesters Association) and Kerry Marcus (Fisheries and Oceans Canada) for valuable input on the manuscript.

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