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A Review of Adverse Effects from Industrial Geoduck Aquaculture Sites in South Puget Sound

State of Washington

Shoreline Hearings Board Documentation

August 2013

Presentation Overview

This presentation will cover the following:

I. Applicable Regulations, Few Protections
II. Existing Conditions
III. Aquaculture Adverse Effects Documented by Scientific Experts
IV. Significant Scientific Data Gaps, Yet Expansion Continues
V. Scientific Evidence Does Not Support Shellfish Industry's Claim That Oysters or Geoduck Significantly Improve Water Quality in Puget Sound
VI. Summary

Goal: To address the multitude of effects of geoduck aquaculture in South Puget Sound that adversely effects critical habitat on a continual basis, changes unique sandy unstructured habitat to structured habitat, degrades prey/food web resources and displaces native species.

It is well documented that the practices and methods used by shellfish growers are nearly identical on each site. This presentation is applicable to each geoduck expansion proposal with the primary variables being site size and cumulative impacts from all aquaculture sites in the project area.





I. Applicable Regulations, Few Protections

A. Shoreline Management Act Being Ignored

Overarching goal to Protect, Restore and Preserve Puget Sound Habitat and native species. Industrial aquaculture is well documented to change natural shoreline habitat and native species which is contrary to existing law. In addition, citizens are losing the right to safely use the shorelines for recreation and navigation.

B. Endangered Species Act Not Being Enforced

1. According to the National Marine Fisheries Biological Opinion (1)

   "Initially, National Marine Fisheries Service determined that the proposed action is likely to adversely affect LCR Chinook salmon, CR chum salmon, Puget Sound Chinook salmon, and the southern DPS of green sturgeon. During consultation, NMFS analyses revealed that although the activities carried out under the proposed action were likely to adversely affect the environment in the action area, they were not likely to adversely affect these species." P2

   "Finally, the NWP will not cover pest management methods other than the installation of predator exclusion nets as considered in this consultation."P3

   "Prior to planting clam seed on the tidelands, beds are prepared in a number of ways depending on the location. Bed preparation increases the chances of seed survival and allows for full use of available land. Types of preparatory work may include raking debris, adding gravel and/or crushed shell to the beach to create more suitable substrate, cleaning the beds of algae, mussel mats and other growth. P13. "Prior to planting geoduck, bed preparation may include raking debris and cleaning the beds of algae, mussel mats and other growth." P15

2. Jones and Stokes NMFS Consulting Memorandum (2)

   Comment 61: 34) Page 5-35, Line 1 on: Is there any grey literature or non-peer reviewed studies available? Since it is plausible that geoducks will compete for prey resources (particularly in sheltered bay and coves and when they are planted in high densities) and dominate as a consumer of the local food web, and then you must assume that juvenile salmonids and forage fish will have less to eat which will lower their growth and survival. This translates into a reduction in prey for bull trout and marbled murrelets and may constitute an adverse effect. I think it would be prudent to alleviate this uncertainty (Line 6) prior to the Corp allowing more widespread geoduck culture given the tenuous condition of salmonid and bull trout populations in Puget Sound. It is difficult to see how given the substantial uncertainty how issuance of the NWP#48 would result in minimal individual adverse environmental effects either separately or cumulatively on the aquatic environment.

   Response: The Corps is not proposing to allow more widespread geoduck culture. The proposed action, issuance of NWP 48, covers only existing aquaculture operations. This action does not entail any increase in geoduck farming beyond the minor changes that may result on a year-to-year basis as areas within an existing lease are cultured or allowed to remain fallow. Pages 16-17

C. Fish and Wildlife Salmon and Forage Fish Work Windows Not Applied to Aquaculture

The aquaculture industry has the largest nearshore footprint with the most expansion of any activity in the nearshore, but successfully lobbied to be exempt from hydraulic permits that protect salmon and forage fish.

II. Existing Conditions:

A. Conversion of Flats to Geoduck Aquaculture

The shellfish industry targets South Puget Sound's limited sandy unstructured flats habitat for geoduck aquaculture expansion. This unique habitat is coincident with forage fish, ground fish and provides essential prey resources for ESA and non-ESA listed species, especially salmon, as detailed below:

Importance of Selected Nearshore Habitats-(3)

Numerous habitat types occur within the nearshore environment, providing a host of critical functions for invertebrates, juvenile and adult fish, and foraging opportunities for birds:

—Eelgrass meadows
—Kelp forests
—Flats
—Tidal marshes
—Sub-estuaries
—Sand spits
—Beaches and backshore
—Bluffs
—Marine riparian zones

Flats – Flats generally include gently sloping muddy or sandy substrates, or a mixture of pebbles and cobble within intertidal or shallow subtidal areas. Studies indicate that flats perform a variety of ecological functions, including:

—Primary production including eelgrass
—Nutrient cycling
—Habitat/support for juvenile and adult fish
—Shellfish production
—Prey production for juvenile salmon, flatfish, and shorebirds
—Detritus sink
—Predator protection for sand lance
—Wave dissipation for salt-marsh

Flats are generally located in low intertidal areas and at the mouths of streams and rivers, where sediment transported downstream is deposited. Much of the production on flats is due to the accumulation of organic matter and dense flora of algae, primarily diatoms, that are mixed with the fine sediments. Invertebrate assemblages associated with algal communities and flats include insect larvae, amphipods, polychaetes, clams, shore crabs, tanaids, and mysids. Juvenile salmon and their invertebrate prey species are seasonally abundant on flats. Other fish that feed on flat communities include several species of flatfish, bay goby, and Pacific staghorn sculpin. Shellfish densities can be very high on flats containing gravel. Shorebirds commonly forage on flats, consuming shellfish and other invertebrates.

Other stressors to flats include dredging, filling, over-harvest of shellfish, overabundance of organic matter, fecal and chemical contamination, shading from overwater structures, and competition from non-native species.

B. Depletion of Zooplankton for ESA listed and non-listed species

Importance of Zooplankton (3)

Zooplankton fill an important ecological niche as the link between primary production and fish productivity. Fish that are 50 to 200 mm in length derive a major part of their nutrition from zooplankton. Juvenile salmonids prey heavily on gammarid amphipods, harpacticoid copepods, and calanoid copepods. The importance of zooplankton and the potential effects of uncoupling links in the food web can be observed in salmon studies conducted in the Strait of Georgia. These studies have shown a 90 percent decline in Strait of Georgia coho salmon likely due to a lack of food during their estuarine residence.

Critical organisms in composite foodwebs have been constructed for Puget Sound. These include calanoid copepods and gammarid amphipods, which convert organic matter making it available in the food web. These zooplankton are also important prey for secondary consumers. Principal secondary consumers are schooling fishes such as Pacific herring, sand lance, and surf smelt, which are prey to a wide variety of larger fish species and marine birds. Other secondary consumers include greenlings, gunnels, and flatfish, which are preyed upon by larger mammals such as seals, sea lions, and orcas.

Importance of Nearshore and Zooplankton to Salmon (3)

Chinook salmon are the most estuarine-dependent salmonid, followed by chum and pink salmon. The remaining salmonids do not rely as heavily on the nearshore as juveniles; however, sea-run cutthroat and bull trout use the nearshore extensively as subadult and adults.

Juvenile salmon use estuaries with a diverse range of biological and physical conditions, indicating their adaptability to a wide range of habitats. Numerous causes have been forwarded to explain salmon population declines in the Puget Sound; those occurring in the marine environment include:

—Ocean survival
—Loss or degradation of tidal wetlands and shallow vegetated habitats by dredge and fill operations
—Loss of beach habitat by shoreline armoring, overwater structures, and other shoreline modifications
—Harvest impacts
—Contaminant inputs

Although observational evidence exists to indicate that losses or modifications of nearshore habitats affect juvenile salmonids, few quantitative data have been collected. There is a general lack of direct data quantifying the role of estuaries and nearshore environments in the survival of juvenile salmonids. However, indirect linkages and ecosystem modeling provides indications of adverse impacts that result from shoreline modifications and development prevalent in the study area.

III. Aquaculture Adverse Effects

A. Multitude of cumulative impacts on nearshore habitat from clearing, planting, netting, zooplankton/food web depletion during grow out phase and harvesting production cycle on Forever Sites

Scientific Presentations:

Coastal Geomorphology and Coastal Geology Analysis of Proposed Henderson Inlet, and Eld Inlet Geoduck and Clam Farms, Thurston County, WA — Presentation by Jim Johannessen, Coastal Geologic Services Inc.

A Review of Effects on Forage Fishes, Zooplankton and Marine Vegetation from Three Geoduck/Clam Farm Proposals in Henderson Inlet and One Proposal in Eld Inlet, Thurston County, WA — Presentation by Daniel Penttila, Salish Sea Biological

Effects of Plastic Pollution from Bivalve Shellfish Aquaculture in South Puget Sound — Presentation by Charles Moore, Algalita Marine Research Foundation

Price/VanBlaricom Geoduck Aquaculture Harvesting Study Lacks Statistical Rigor — Presentation by Dr. Gary Ritchie

B. Other Aquaculture Adverse Effects

1. SeaGrant/VanBlaricom Geoduck Research, August 2013 Presentation (4)

A. Conversion of Natural Habitat and Exclusion of Native Species (page 15)

—Fish and macroinvertibrate communities differ between culture (+structure) and reference plots

—Typical pattern favors structure = associated species

—Species preferring unstructured habitat largely excluded

According to the August 2013 Shorelines Hearings Board testimony of Glenn Van Blaricom and Jonathan Houghton, native ground fish decreased and sculpin increased at the aquaculture sites. It should be noted that sculpin are predators of small fish like juvenile salmon and forage fish.

B. Disturbance of natural species and habitat, forever cycle, page 5

Years	Disturbance
0	Outplanting of young geoducks; placement of tubes and netting
0-1, or 0-2	Presence of tubes and netting in varying combinations
1-2	Removal of tubes and netting
1-2 to 6-7	Presence of growing geoducks at relatively high densities
6-7	Harvest of marketable size geoducks
6+ or 7+	Post Harvest

2. Native Species Being Eliminated at Aquaculture Sites as Documented by Industry Pest Management Plan (5)

Cockles, barnacles, crabs, native blue mussels, sand dollars, starfish, moonsnails, horse clams, shorebirds, ducks eelgrass

3. Cumulative Impacts Are Not Being Addressed by Approving One Site at a Time

IV. Scientific Concerns Not Addressed, but Expansion Continues:

Dr. Megan Dethier, noted nearshore scientist, *Concerns and Questions Relevant to Infaunal and Epibenthic Impacts of Geoduck Aquaculture* (6):

Concern: Seeding of young geoducks in netted PVC tubes on the beach is likely to alter local physical and biological conditions, both those on the surface of the sediment and those in the sediment. Much less invasive shoreline aquaculture techniques, such as gravelling beaches or adding surface netting, have been found to affect the size and oxygen level in the sediments, as well as the diversity and composition of non-target local organisms (see References below).

Concern: Harvest of geoducks from high-density aquaculture beds will involve near-total liquefaction of the sediment to at least 50 cm. While organisms in the intertidal zone are adapted to small-scale physical disturbances (from waves, ghost shrimp, crab-pits, etc.), this large scale is not part of their evolutionary history. Other forms of intense habitat disruption, such as mechanical dredging for clams, have been outlawed. Intertidal holes are known to fill with sediment within weeks or months after small-scale digging, but there has been no research on recovery of normal intertidal sediment characteristics after liquefaction. A very limited amount of research has been done on impacts of subtidal geoduck harvesting on non-target species, but none in the intertidal zone where the native flora and fauna are completely different. Thus many questions arise.

Concern: Natural soft-sediment habitats not only are part of the food web of Puget Sound but perform key 'ecosystem functions' such as nutrient cycling. These processes are highly dependent on the structure of the oxic/anoxic layers in the sediment. Bacteria, protozoa, and other microbes in the sediment are important decomposers of dead organic matter trapped in the sediment. Carbon, nitrogen, and sulfur are all cycled between the sediment, porewater, air and ocean by these species and by larger worms, clams, and crustaceans, as well as by chemical reactions that occur in the stable layers of sediment. Nutrients often get adsorbed onto sediment particles, and these may be released when sediment is resuspended in the water by harvesting.

Concern: Nothing is known about actual post-harvest recovery time for the entire suite of animals and plants that normally inhabit these beaches. Statements have been made such as "recovery should be relatively quick" (Entrix 2004, p. 7-1) but there are no directly relevant scientific data to support this claim. Recovery of small, highly mobile organisms with short life spans may indeed be rapid; these would likely include small crustaceans such as copepods and amphipods. For other species, such claims are unfounded. Long lived species that inhabit potential geoduck beaches such as other clams and perhaps some worms will eventually recolonize beaches, but it would take years of growth before they returned to their previous sizes, densities, and interactions with the rest of the community. Rates of complete recovery of biodiversity may be slow.

Concern: The flora and fauna of muddy-sand South Sound beaches, while less abundant than those of some other beach types, nonetheless are moderately diverse in lifestyle and position in the food web. Presumably they interact with the rest of the nearshore ecosystem in a variety of ways, but there has been minimal research about these interactions. Suggested ecological roles include: sand dollar beds providing nurseries for young Dungeness crabs; native (smaller) clams providing food for siphon-nipping fishes; small crustaceans living in tubes or on the surface providing key food for salmon and other fishes; and both worm tubes and seaweeds providing locations where herring lay their eggs.

Concern: There are studies that indicate that the presence of a large filter feeding population can decrease phytoplankton biomass in the system. This process is more likely in areas with low tidal flow and high concentrations of filter feeders. One possible impact of this could be the reduction of food supplies for other filter feeders in the system.

V. Scientific Evidence Does not Support Shellfish Industry's Claims that Oysters or Geoduck Significantly Improve Water Quality

Modeling Nitrogen and Carbon Removal by Pacific Oysters in Hood Canal
New 2012 Study — Conclusion. (7) "Our results indicate that even at very high densities, the Pacific oyster's capacity to remove total nitrogen and carbon flux from Hood Canal is limited throughout most of the year."

Nitrogen Removal with Shellfish Harvest in Oakland Bay and Puget Sound
Herrara Consulting, February 5, 2010 (8) "Shellfish harvest removes more of the nitrogen input to Oakland Bay than Puget Sound, but it removes no more than 1 percent of the dissolved nitrogen load in either location.

The Molluscan Study, Final Report
2010. (9) For large sized geoducks, clearance rates ranged from 5.07 to 8.36 l h (-1). We conclude that a main requirement needed to support the hypothesis that geoducks are ecosystem engineers via filtration of phytoplankton is not met.

Hood Canal Nitrogen Research — Interesting Findings — October 2010. The Influence of Watershed Characteristics on Nitrogen Export to and Marine Fate in Hood Canal, Washington, US. (10)
"Hood Canal, Washington, USA, is a poorly ventilated fjord-like sub-basin of Puget Sound that commonly experiences hypoxia. This study examined the influence of watershed soils, vegetation, physical features, and population density on nitrogen (N) export to Hood Canal from 43 tributaries….Domestic wastewater discharges and red alders appear to be a very important N source for many streams, but a minor nutrient source for the estuary as a whole."

VI. SUMMARY

The nearshore must be addressed from an ecosystem perspective (3)

The nearshore environment is influenced by a plethora of factors, both natural and anthropogenic, due to its placement in the larger landscape. Factors that effect oceanic, freshwater and terrestrial systems individually, all come together in a "great mixing bowl" to create a unique environment in the Puget Sound nearshore. Understanding all of the unique characteristics and complexities is a tremendous task that will take many years of dedicated, well coordinated research and analysis. However, this will require a shift from our approach of single-species, or single-habitat management to an integrated ecosystem approach. For example, we need to understand that land-use practices along our shorelines have direct and indirect influences on the nearshore ecosystem (i.e., loss of vegetation, changes in sedimentation, water quality, and hydrology). These influences result in changes such as habitat structure, food supply and other elements that can reduce the viability of multiple species within the system. The nearshore is therefore not only part of an individual watershed, but is also the thread that binds together multiple watersheds. Thus, it is imperative that we not only understand the nearshore ecosystem as a unique "marine" system, but that we also look across the landscape to determine how the nearshore interacts with influences from other distinct ecosystems.

Action is needed in the nearshore(3)

Numerous studies and reports have previously identified the problems facing the nearshore environment (i.e., PSWQA 1988a,b; Shreffler and Thom 1993; West 1997; WADOE 1994; Broadhurst 1998; Lynn 1998; PSWQAT 1998; WADNR 2000; PSWQAT 2000), and have drawn conclusions similar to this report.

Yet, while state and federal agencies, tribes, and other stakeholders have long recognized the importance of Puget Sound resources and the effects of anthropogenic impacts, the response to previous recommendations for improved protection of resources has been lacking. Protection, restoration and recovery actions have lagged while the human population and development have increased dramatically. The lack of appropriate and adequate levels of protection has led to significant declines of nearshore species and habitats. The most obvious signs of loss include the Endangered Species Act listings of Hood Canal Summer Chum salmon, Puget Sound Chinook salmon, Bull trout, a petition to list Coho salmon and 18 marine fishes, and a proposal to list the system's top predator, the orca whale.

References

1	National Marine Fisheries Service (NMFS). 2009. Endangered Species Act Section 7 Formal Programmatic Consultation and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation, Nationwide Permit 48 Washington. NMFS Tracking Number 2008/04151. Prepared for the U.S. Army Corps of Engineers by NMFS Northwest Region. April 28, 2009. 111pp.
2	Jones and Stokes.2008. Memorandum from Chris Earle to Corrie Veenstra (USACE), Response to Services Comments on NWP 48 BA for Washington.
3	Starkes, Jim. 2001. Reconnaissance Assessment of the State of the Nearshore Ecosystem. Eastern Shore of Central Puget Sound, including Vashon and Maury Islands (WRIAS 8 AND 9) Report prepared for King County Natural Resources. Prepared by Pentec Environmental.
4	Glenn R. VanBlaricom, Jennifer L. Price, P. Sean McDonald, Jeffrey R. Cordell, Timothy E. Essington, Aaron W.E. Galloway, Megan N. Dethier, and David A. Armstrong Evaluations of the Ecological Effects of Geoduck (Panopea generosa). August 2013. Aquaculture Harvest Practices on Benthic Organisms in southern Puget Sound, 2008-2012 USGS Washington Cooperative Fish and Wildlife Research Unit, and School of Aquatic and Fishery Sciences, University of Washington, Seattle
5	DeFrancesco, Joe, Murray, Katie, Oregon State University. Clarke, Diane, University of California, Davis. 2010. Pest Management Strategic Plan for Bivalves in Oregon and Washington
6	Dethier, Megan N., Leitman, Amy, Matthews, Bill Phd. 2007. Concerns and questions relevant to Infaunal and Epibenthic Impacts of Geoduck Aquaculture
7	Echols, Ashley, Prigmore, Chris, Thatcher, Erin. 2012.University of Washington Department of Civil and Environmental Engineering. Modeling Nitrogen and Carbon Removal by Pacific Oysters in Hood Canal
8	Herrara Consulting. 2010. Nitrogen Removal with Shellfish Harvest in Oakland Bay
9	Washington State Department of Natural Resources, The Molluscan Study Final Report, An Estimate of Hood Canal Geoduck and Sea Cucumber Populations and Geoduck Filtration Rates. November 1, 2010
10	Steinberg, Peter D., Brett, Michael T., Bechtold, Scott, Richey, Jeffrey E., Porensky, Loren M., Smith, Suzanne N. 2010. Hood Canal Nitrogen Research; The Influence of Watershed Characteristics on Nitrogen Export to and Marine Fate in Hood Canal, Washington, USA.