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Washington State
Unnatural High Densities of Shellfish Aquaculture in Priority Intertidal Habitats Deplete Fisheries Resources Essential to Salmon and Whales

Section 1-Shellfish Ingestion of Fish Eggs and Larvae-(Fisheries Resources)

Peer reviewed studies listed on pages 2-3 clearly document that shellfish routinely ingest zooplankton which includes fish eggs, fish larvae, crab zoes and larvae of other important aquatic species important to Puget Sound biodiversity. Industry has for years stated that the high densities of shellfish they have added to the shorelines are "cleaning the water." Based on the studies, these unnatural high densities are certainly clearing the water column at unprecedented rates of eggs, larvae and crab zoes especially when in or adjacent to high ecological value forage fish spawning habitat or Critical Salmon Habitat.

Aquaculture Expansion Reducing Biodiversity in the Intertidal Nurseries

For the last 10 years, the shellfish industry have been allowed to expand in the intertidal areas with unnatural high densities of non-native Manila clams, non-native triploid Pacific oysters and geoduck developments where Puget Sound forage fish, crabs, flatfish and other important species have historically been depositing their eggs. High densities of non-native Manila clams are now planted from +7 to +3 tide and non-native Pacific oysters are planted from a +3 to 0 tide. The historical records show that in the intertidal area there were low densities of native clams and the native Olympia were primarily found at zero tide in some inlets.

Documents show that geoducks are considered mainly a subtidal animal and are also now being grown from the +3 to -4.5 tide in extremely high densities that range from 80,000 to 120,000 per acre. "The average South Sound subtidal wild geoduck density is .19 per sq.ft which equals 8,276 geoducks per acre (per DNR SEIS.

Dan Penttila's Concerns for the Environmental Effects on Forage Fish

Dan Penttila has been the recognized forage fish expert in Washington writing numerous reports for the Washington Department of Fish and Wildlife for over 38 years. In addition to his numerous reports, Mr. Penttila wrote the following guidance document for the Nearshore Partnership for forage fish as well as many other reports.

http://www.pugetsoundnearshore.org/technical_papers/marine_fish.pdf

Mr. Penttila testified at a March 2011 Pierce County Geoduck EIS Hearing expressing his concerns that an EIS should be required and recommended specific science studies be

conducted to learn more about shellfish ingesting fish eggs and larvae prior to further expansion. Details of Mr. Penttila's scientific concerns regarding significant impacts on forage fish from aquaculture can be found in the following links:
Mr. Penttila's Expert Report
http://www.caseinlet.org/uploads/Dan_Penttila_testimony_020111_1_.pdf
Mr. Penttila's Pierce County Testimony
http://www.caseinlet.org/uploads/Longbranch--Penttila--Moore_Hearing_Testimony.pdf

Anecdotal evidence as mentioned by Dan Penttila in the EIS hearing suggested that forage fish may be declining or may be disappearing from Totten Inlet at the same time that shellfish aquaculture has expanded to over 90% of the Totten Inlet shorelines. Egg and larvae ingestion from artificially large densities of farmed bivalves in the intertidal area of Totten Inlet could easily be the reason why..

Science Studies on Bivalve Ingestion

A. Independent Studies on the Impact of Bivalves Ingesting Fish Eggs, Crab Zoes, Copepods, Amphipods and Larvae

1. The CSAS (Canadian Science Advisory), Review of the effects of shellfish aquaculture on fish habitat, 2006, pages 33-34 (25-26).
http://www.dfo-mpo.gc.ca/CSAS/Csas/DocREC/2006/RES2006_011_e.pdf

"Field studies reported in the same study found that mussels consumed (based on stomach content analysis) copepods (<1.5 mm), crab zoeas (2mm), fish eggs (1-2mm), and even amphipods (5-6mm). Subsequent to this, Lehane and Davenport (Lehane and Davenport 2002) showed that mussels consumed organisms up to 3mm in length and that cockles (Cerastoderma edule) and scallops (Aequipecten opercularis) are also capable of consuming considerable quantities of zooplankton, both when suspended in the water column and when on the bottom. The size classes of organisms consumed in these studies suggest that the larvae of most commercial species may be at risk from this type of predation."

2. Ingestion of mesozooplankton by three species of bivalve
Lehane/Davenport, 2002-2006, Journal of Marine Biology Association of United Kingdom
http://www.caseinlet.org/uploads/Lehane_davenport.pdf

"All species examined had zooplankters in their stomachs." p617

"Numbers of organisms ingested by suspended and field (scallops) were not significantly different." p617

"Clearly bivalves, in particular (mussels), are not strict herbivores and non-algal food sources are readily ingested by them. As expected, the numbers of individual zooplankters or 'prey' ingested increased with mussel size." p618

"It is likely that extensive beds of bivalves can also control zooplankton densities and sizes. From the results presented here, and from interpretation of other studies, it is clear that a wide variety of bivalves do routinely ingest zooplankton."

"Phytoplankton is not an all year round source of food (Landry, 1981), so zooplankton may be relatively more important in the bivalve diet when the seston is phytoplankton-poor." p619

3. **The Trophic Linkage between zooplankton and benthic suspension feeders: direct evidence from analyses of bivalve faecal pellets**

Wai Hing Wong, Jeffrey S. Levinton, 2006, Marine Biology Research Article
http://www.caseinlet.org/uploads/Wong_Levinton_zooplankon.pdf

"Large zooplankton have been found in the digestive tracts of bivalve mollusks, e.g. American oysters (Virginica)." P 799

"Individuals (mussels) supplied with the mixture of phytoplankton and zooplankton demonstrated the best growth performance…"

"The classic model of bivalve filtering of phytoplankton may be inadequate to describe the trophic effects of bivalves on planktonic ecosystems."

4. **Larviphagy in native bivalves and an introduced oyster**

Karen Troost, Pauline Kamermans, Winn J. Wolff, 2008, Journal of Sea Research.
http://www.caseinlet.org/uploads/larviphagy_in_bivalves_Troost.pdf

"Once filtered, bivalve larvae are either ingested or rejected in pseudofeces. If ingested, almost all larvae die in the digestion process or in the feces."

"Rejection in pseudofeces generally also leads to death."

Section 2-Siltation of Spawning Habitats

Jim Johannessen—Geomorphologist Pierce County Hearing Expert Opinion

Jim Johannessen is noted for his 27 years as a geomorphologist specializing in Puget Sound restoration. He pointed out that sediment transport processes can direct the distribution of forage fish larvae in the water column over the farmed shellfish beds and the increased sediment transport and deposition on forage fish spawning beaches could smother forage fish eggs (Expert Report-Page 4). His recommendation for an EIS and specific studies can be seen in the following links:

Jim Johannessen Expert Report and Hearing Testimony
http://www.caseinlet.org/uploads/Jim_Johannesen_testimony_020111_1_.pdf
http://www.caseinlet.org/uploads/Longbranch--Gilbert_and_Johannessen_Testimony.pdf

Effects of Suspended Sediment on Eggs and Larvae of Lingcod, Pacific Herring and Surf Smelt
http://www.caseinlet.org/uploads/Canadian_Report_Sediment_Eggs_and_Larvae.pdf

Section 3-Combined Threats to Forage Fish Spawning Habitats

Sand lance and surf smelt survival is clearly at risk by the following 6 threats from aquaculture operations that are significant on an individual impact basis and especially on a combined impact basis:

1. spawning area substrate being changed by silt generated from aquaculture operations making it unsuitable for their spawning requirements
2. eggs being smothered from the silt generated from aquaculture operations
3. eggs/larvae being consumed by planted shellfish as they float in the water column
4. fish food sources being depleted by high densities of planted clams, oysters and geoducks as they filter the water. It is well documented that planted geoduck grow up to 2 pounds in the intertidal zone within 4-6 years while wild geoduck take decades to reach this weight in the subtidal areas. The intertidal zones are considered "nurseries" which would provide substantial zooplankton (A-65, 66) to fatten up planted shellfish especially in the winter months when phytoplankton grows more slowly
5. natural burrowing behavior (sand lance) being interrupted by geoduck tube placement and harvesting that alters their habitat and threatens their survival
6. known spawning times being impacted by the intertidal geoduck dive harvesting operations in less than -18 ft as industry fills their holiday orders

Summary

Oceans and Coasts Shellfish Reefs at Risk: Report Findings
http://conserveonline.org/library/shellfish-reefs-at-risk-report/@@view.html

"Shellfish reefs and beds are essential to the health of marine ecosystems, yet they are almost always solely managed as fisheries. There are many obstacles to successful management, but the greatest include the perceptions that a problem does not exist or that it a local problem only and that non-native shellfish can replace wild native species. These problems are exacerbated because of bay by bay management that does not recognize regional, national or global problems and solutions. Native oysters must be recognized for the reef habitat they provide across bays, regions and globally."

Decision makers in Puget Sound have been managing shellfish beds as fisheries for commercial purposes, not as habitat that is part of a healthy ecosystem. We agree with the following statement made by the Puget Sound Partnership. The issue of zooplankton depletion needs to be addressed before we lose more of our Puget Sound ESA and non-listed species:
"Because nine of the ten Puget Sound species identified as endangered or threatened rely on nearshore environments, the declines are at least in part, likely related to problems in nearshore ecosystems in Puget Sound." (PSP--Coastal Habitats--Page 3).

If high densities of planted bivalves are depleting valuable fisheries resources, then the adverse ecological effects from bivalve aquaculture violates the Endangered Species Act (ESA), the Magnuson Stevens Act (MSA), and the Washington Shoreline Management Act (SMA), because forage fish are such a large percentage of the diets of listed Puget Sound Chinook adults and juveniles. Given the scientific acknowledgement that farmed bivalves essentially filter everything in the water column, it should not be a surprise that these farmed bivalves are ingesting and destroying public fisheries resources.

Federal, state and local laws should be coordinated to protect high value forage fish spawning habitats, Critical Salmon Habitat, eelgrass/macroalgae beds and shorelines with high Ecological Management Unit scores (EMU) by not allowing industrial operations to diminish these valuable resources.