Industrial Aquaculture Direct Impacts to Nearshore Habitat That Adversely Affects Wild Salmon and Whale Recovery in Washington

We can't just say save the whales, we have to save the Chinook, and the food for the Chinook. Otherwise we are really fooling ourselves that we can save the Sound.[1]

Wild salmon recovery is a Salish Sea issue that is being widely embraced by officials and citizens in our area. In order to fully integrate salmon recovery efforts, both Puget Sound and Washington coastal communities must work towards habitat and native species protections for all industries that are operating in our marine waters.

Finfish aquaculture adverse impacts caused by disease, parasites and the net loss of protein are widely known. While there are significant environmental effects that are similar and unique from both finfish and shellfish aquaculture, this report focuses on the direct impacts of shellfish aquaculture.

With our wild salmon, sturgeon and now rockfish on the Endangered Species list, the preservation of Nearshore habitat is essential. Allowing the continuation and expansion of aquaculture in priority fish habitat is an action that directly jeopardizes Salmon Recovery goals as required by the Endangered Species Act. Native species cannot effectively compete with industrial aquaculture in these limited habitats that are the most conducive to their existence. Damage and destruction of Nearshore does not produce dead fish; it impacts the food web resulting in the significant loss of the Viable Salmonid Population (VSP).

Section 1—Shellfish Aquaculture Direct Impacts to Critical and Essential Fish Habitat in Puget Sound Nearshore

1. Habitat Modification of the Nearshore
    - Siting aquaculture operations (especially geoduck) in forage fish spawning habitat that is considered a priority protection habitat.
    - Restricting expansion of fish spawning habitat by allowing aquaculture in this priority habitat.
    - Scraping shorelines to prepare tidelands for planting. Dredging the substrate with barges for oyster production. Placing oyster bags on Nearshore covering natural substrate and prey. Liquefying Nearshore during geoduck harvesting. All of these practices remove necessary organisms and marine vegetation critical for listed and non-listed species recovery.
    - Modifying sand/gravel substrate composition and introducing silt by dredging and liquefying operations in this priority spawning habitat for forage fish and other species.
    - Placing crushed rock and shell in the Nearshore areas altering natural processes.
    - Restricting expansion of marine vegetation/eelgrass beds by allowing aquaculture to expand adjacent to this priority habitat.
    - Destroying eelgrass beds by planting and harvesting operations.
    - Placing tubes and nets in intertidal area which alters wave dynamics.
    - Cleaning the nets and removing algae from the Nearshore which is an essential ecological component.

[1] Penn, Focus Magazine, March 2009. P 24-29.

- Disturbing forage fish spawning and rearing habitat from perpetual operations in the immediate vicinity.

2. Prey Base Impact
    - Introducing bivalves in the Nearshore that are known to filter significant volumes of water ingesting fish eggs, crab and shrimp larvae (cockles (geoduck is a clam), mussels and scallops.
    - Liquefying substrate which suppressing tube worms and corophium that are an important prey base for salmon (per preliminary SeaGrant geoduck research).
    - Placing tubes and liquefying the lower intertidal area where sand lances bury themselves at night to avoid predation. The sand lance is a very important food source for juvenile Chinook salmon.
    - Spraying annually 3 tons of carbaryl pesticide on up to 800 acres of Willapa Bay/Grays Harbor tidelands to eradicate mud and ghost shrimp which has a direct effect on ESA listed fish and the prey base they depend on.
    - Covering significant area of substrate with oyster bags that eliminate available prey base.

3. Migration
    - Placing structures in the intertidal area that causes wild salmon to alter migration into deeper waters increasing predation

4. Water Quality
    - Liquefying substrate that causes turbid water quality that has yet to be independently measured or certified to be in compliance with the Clean Water Act
    - Liquefying substrate that disturbs organic matter, toxins, heavy metals
    - Placing densities of bivalves in the water column that do reduce the dissolved oxygen in the immediate and down current vicinity as shown in the Totten/Taylor Mussel raft EIS

As detailed above, industrial aquaculture practices alter the Nearshore in varying degrees. The Puget Sound Partnership is increasing protection efforts of feeder bluffs and spawning areas at the same time that industry is targeting these same areas for geoduck feedlots as documented by the following quotes:

Puget Sound Partnership Legislative Priority

> *"Protecting Nearshore habitat by requesting a moratorium on new shoreline hardening and overwater structures in the vicinity of feeder bluffs and spawning areas."*

Geoduck Culture on Intertidal Beaches – DNR Report--Jonathan Davis, scientist who often works under contract to the shellfish industry.

> *Beaches that accumulate sand in bars and flats from the erosion of coastal bluffs are often the best sites for geoduck culture as these areas tend to accumulate sands that are clean and free of significant quantities of gravel, wood or shell debris. The most successful geoduck farming is conducted on beaches with sand that is at least three feet deep.*[2]

[2] Geoduck Culture on Intertidal Beaches: Procedures, Expenses and Anticipated Income for an Intermediate-Size Farm. Jonathan P. Davis, Baywater, Inc., 2004. Page 3. See:

Section 2—Importance and Definition of Essential Fish Habitat (EFH)

- EFH is defined in the Magnuson-Stevens Act as "***...those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.***" The rules promulgated by the NMFS in 1997 and 2002 further clarify EFH with the following definitions: **waters** - aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; **substrate** - sediment, hard bottom, structures underlying the waters, and associated biological communities; **necessary** - the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and **spawning, breeding, feeding, or growth to maturity** - stages representing a species' full life cycle.

  http://sero.nmfs.noaa.gov/hcd/efh_faq.htm

- As defined in section 3(10) of the Magnuson-Stevens Act, EFH is those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Examples of "waters" that may be considered EFH include open waters and wetlands, estuarine and riverine habitats, wetlands hydrologically connected to productive water bodies. Water quality is interpreted to be a component of this definition. EFH should consider water to provide the appropriate parameters of quality such as physical, chemical, and biological properties. This may address nutrient levels, oxygen concentrations, turbidity levels, among others. The interpretation of "substrate" includes artificial reefs and shipwrecks if those areas provide EFH. Substrate may also include entirely or partially submerged structures, such as jetties. "Biological communities" could include mangroves, tidal marshes, mussel beds, cobble with attached fauna, mud and clay burrows, coral reefs, and submerged aquatic vegetation. Migratory routes such as rivers and passes serving as passageways to and from anadromous fish spawning grounds should be considered EFH. The definition of EFH may include habitat for an individual species or an assemblage of species, whichever is appropriate within each FMP.

  http://www.nmfs.noaa.gov/habitat/efh/TechnicalGuidancetoImplementtheEFHRequirementsfortheMagnuson-StevensAct.htm

Section 3—Importance of Forage Fish to Salmon Recovery and Survival

Why Are Forage Fish Habitats Not Being Protected from Aquaculture Impacts?

- The importance of forage fish is well documented. For detailed information on sand lance, surf smelt and herring habitats, please view the supplemental forage fish report at:

  http://washington.sierraclub.org/tatoosh/Aquaculture/FHForageFishHabitat.pdf

- The documented sand lance, surf smelt and herring spawning habitats in Puget Sound are shown on the map link below. This map should be compared with the existing aquaculture sites in South Puget Sound on the second link, as it clearly shows that the aquaculture industry has been operating in documented forage fish habitat areas without environmental review.

  http://washington.sierraclub.org/tatoosh/Aquaculture/FFSpawningmaps.pdf

  http://washington.sierraclub.org/tatoosh/Aquaculture/FHAquacultureSoSound.pdf

- The tidal elevation chart link shows that all three forage fish species and aquaculture operations are too closely located if we are trying to preserve those areas in recovery efforts.

  http://washington.sierraclub.org/tatoosh/Aquaculture/FFtidechart.pdf

- The Food Web Chart link points out that forage fish are critical to the survival of salmon, whales and other Puget Sound species.

  http://washington.sierraclub.org/tatoosh/Aquaculture/FFFoodweb.pdf

Section 4—Importance of Marine Vegetation to Recovery and ESA Listed Species

Why Is Marine Vegetation Not Being Protected From Aquaculture Impacts?

The importance of kelp and eelgrass is well-documented. The following link provides detailed information and specific site information where aquaculture operations have been placed in eelgrass areas.

http://washington.sierraclub.org/tatoosh/Aquaculture/FHVegetation.pdf

Industry is seen clearing vegetation essential for spawning, rearing, and habitat for forage fish and salmon on page 16 of the Sierra Club presentation found at:

http://washington.sierraclub.org/tatoosh/Aquaculture/SierraClub-Aquaculture-2010-Apr-detail-R06-final.pdf

Section 5—Adverse Impacts on Forage Fish – Intertidal Geoduck Feedlot Impacts

Impact #1—Questions to Wayne Daley (Fisheries Biologist)—Pierce County Taylor/Foss Hearing

Q: And how would an operation like this (intertidal geoduck farming) impact forage fish that is an important food source for the salmon?
A: Particularly, the sand lance is the critter that we're going to see the most severe impact, because of the nature of their life cycle. They utilize the sandy beaches to spawn in, and they spawn by digging into the sand and burying their eggs in that sand, anywhere from a tidal level of perhaps around plus-5, all the way up to an extreme high-tide area. And these eggs are deposited in the gravel and then emerge, over a very brief period of time after that, as juveniles. The larval stages of those forage fish then depend entirely on that immediate shoreline area as an area to grow and nurture before they get

to a size where they can survive in the deeper water. They're very dependent upon the quality of the water in that area as well. Is that rearing habitat for those juvenile forage fish also above the plus-5 tide line, or does it extend lower on the beach? It will extend down beyond that point, but, for the most part, it would be -- you'll find those critters somewhere between 1-zero or plus-5, on up into the high-tide area.

Q: So would part of that rearing habitat then overlap with the area of the beach that's being used by this operation?
A: Yes.

Q: By the Taylor operation?
A: Yes.

Q: How would the installation of an operation like this then impact salmon that's attempting to utilize that part of the beach for rearing habitat?
A: The forage fish, and particularly the smaller larval fish and up into the juvenile sizes, are dependant entirely on phytoplankton and zooplankton as a source of food. And so this water column that's adjacent to this intensive geoduck operation is going to impact -- going to have an adverse reduction in the numbers of phytoplankton and zooplankton in that water column, just from the feeding activity of geoduck.

Q: Meaning that the geoducks would be consuming the same food source that the sand lance would be depending on?
A: That's correct.

Q: You mentioned phytoplankton and zooplankton. Would that also be the copepods in that category as well?
A: They're a benthic community that is in the sand itself, and the larval stages and the juvenile stages of the sand lance are dependent upon those critters that are in the sand as well as floating free in the water.

Q: Would the installation of this densely packed geoduck facility also physically occupy the space that the sand lance would otherwise be occupying?
A: It's a structure that's there where they would normally be working their way along and utilizing that sand area. So it is definitely a structure that interferes with their normal behavior. I'll have you take a look at Exhibit 9.

Q: I'll pull that out for you. This is a study by Bindell Young, published in the Journal of Environmental Conservation. Are you familiar with that study?
A: Yes, I am.

Q: And does that part address this issue of whether an operation like this would physically displace sand lance habitat?
A: It addresses the issues concerning that there is such a little amount of knowledge available in terms of what we know about the interaction between the shellfish activity and the critters that are adjacent to it.

Q: And is that the study that makes reference to these aquaculture operations resulting in a monoculture situation on the beach?
A: Yes.

Q: What's a monoculture?
A: When the entire community of animals and plants is reduced to a single entity.

Q: Meaning the entity that's being cultured?
A: Yes. [3]

Section 6—Aquaculture Direct Adverse Impacts on Salmon

Impact #1—Questions to Wayne Daley (Fisheries Biologist)—Pierce County Hearing

Q: Okay. And on what do you base your conclusion that it would move the fish out of that natural migration corridor?
A: The natural habit of the salmon, particularly juvenile salmon, in utilizing the shorelines is the way they swim along the shoreline in search of food. And in that process, if they encounter this type of structure, they're going to be moved out of that area into a different area of the shoreline and away from an area where they would be normally searching for food.

Q: And do migrating salmon avoid the eelgrass in that same --
A: Migrating salmon will utilize eelgrass, because there's forage fish present there to eat.

Q: Okay. And your testimony is that migrating salmon would not use the habitat created by this aquaculture gear for that same reason?
A: That's correct.[4]

Impact #2—Pacific States Marine Fisheries Commission – EFH[5]

"The artificial propagation of native and non-native fish and shellfish species in or adjacent to salmon EFH has the potential to adversely affect that habitat by altering water quality, modifying physical habitat, and creating impediments to passage." [6]

"Various methods of shellfish culture and harvest also have the potential to adversely impact salmon EFH, such as dredging in eel grass beds, off-bottom culture, raft and line culture, and the use of chemicals to control burrowing organisms detrimental to oyster culture"[7]

Impact #3—Chinook and Bull Trout Recovery Approach for South Puget Sound Nearshore

[3] Testimony of Wayne Daley, Fisheries Scientist, Consultant -Habitat Restoration. Questioner David Bricklin. Public Hearing by Pierce County Hearing Examiner, Administrative Appeal: AA16-07, November 2, 2007. pp 132-135.
[4] Ibid, p 148.
[5] http://www.psmfc.org/efh/efh.html
[6] http://www.psmfc.org/efh/Jan99-sec3-23A.html
[7] Ibid.

"Shellfish aquaculture in South Sound alters plant and animal assemblages and results in the loss of shallow Nearshore habitat diversity important to salmon resources. These impacts may be potentially positive or negative depending on the type of aquaculture practice. We hypothesize that shellfish aquaculture reduces productivity, abundance, spatial structure, and diversity of salmon populations."[8]

Aquaculture Stressor Chart Link:

http://washington.sierraclub.org/tatoosh/Aquaculture/FHSalmonStressorChart.pdf

Impact #4—NOAA--Puget Sound Salmon Recovery Plan

"Cultivating shellfish in the South Sound results in the loss of shallow Nearshore habitat and habitat diversity that is important to salmon."[9]

Impact #5—Industry removal of sand dollar beds that are considered essential fish habitat as documented in the "Pest Management Strategic Plan for Bivalves in Oregon and Washington" and reported by citizens to state agencies. The Essential Fish Habitat requirements consider sand dollars as a "significant resource area" as shown below:

P**lan and design mining activities to avoid significant resource areas (such as consolidated sand ledges, sand dollar beds, or algae beds).**

Impact #6—Industry removal of native blue mussel beds using propane torch as documented in the Draft "Pest Management Strategic Plan for Bivalves in Oregon and Washington" and reported by citizens to state agencies. The Essential Fish Habitat requirements state:

"Biological communities" could include mangroves, tidal marshes, mussel beds, cobble with attached fauna, mud and clay burrows, coral reefs, and submerged aquatic vegetation.

http://www.nmfs.noaa.gov/habitat/efh/TechnicalGuidancetoImplementtheEFHRequirementsfortheMagnuson-StevensAct.htm

Impact #7—DNR-Final SEIS-Supplemental Environmental Impacts Statement, State of Washington Commercial Geoduck Fishery, May 23, 2001:"The exclusionary principle of not allowing leasing/harvesting in water shallower than -18 ft MLLW or 200 ft (sic yds) distance from shore (MHW); 2ft vertically from elevation of lower eelgrass margin, and within any regions of documented herring or forage fish spawning should under most conditions remove the influences of harvest-induced sediment plumes from migrating salmon. As the available information indicates that sediment plumes do not enter the nearshore zone, impacts to juvenile salmon habitat and prey resource should also be protected from impact by these policies if effectively regulated." P 83.

Geoduck tracts are also deeper (>18ft MLLW (-5.5 m)) than juvenile rearing areas, including migratory corridors. Most young fish (30mm) entering Puget Sound are generally observed in shallow shoreline

[8] South Puget Sound Salmon Recovery Group, *Chinook & Bull Trout Recovery Approach for the South Puget Sound Nearshore*, July 2004, p 45. Web Link 5.
[9] NOAA's National Marine Fisheries Service, *Puget Sound Salmon Recovery Plan*, January 2007, Ch 5, p 299.

areas at a depth of 1 meter or less (Shepard 1981). Eelgrass beds, commonly used for juvenile salmon rearing habitat, are excluded from commercial geoduck harvest. All commercial geoduck harvest must occur at lest two vertical feet seaward and deeper than eelgrass beds. A 180 ft horizontal buffer zone between eelgrass beds and geoduck harvest areas may be used when the slope is gradual. This optimizes harvest area and still provides a protective setback based on results of the Pentac study (Appendix 4 to the SEIS). The common practice is to establish boundaries using a 2 ft vertical buffer between eelgrass and geoduck harvest areas." P 82.

Impact #8—Preliminary Results of the SeaGrant Geoduck Aquaculture Investigations

The preliminary results of the SeaGrant studies from February include the Micah Horwith study on geoduck aquaculture's effects on eelgrass in Samish Bay and Glenn VanBlaricom's study outlining the results of the sediment core analysis, mainly at the Foss Farm location. In the case of eelgrass, the Horwith study demonstrated a statistically significant reduction in both eelgrass density and shoot size after geoduck harvest activities. Geoduck harvest also demonstrated a significant reduction in eelgrass reproduction (flowering) and a significant reduction in sediment organic content (an important food source for infauna) after geoduck harvest.

In the case of sediment core analysis, the study found a significant reduction in all densities of infauna, including Corophium and polychaetes (both important food sources for endangered Chinook). Sand dollar size and density were also significantly reduced by geoduck harvest activities. The presence of Sand Lance was also noted in the geoduck site at Foss.[10] [11]

Preliminary analysis of the slide-mounted samples revealed the presence of a microsporidian like parasite previously unknown in geoducks. The parasite was observed in 30 percent of geoducks in Totten Inlet, although infection intensity was very low and there was no evidence of parasite infections in Thordyke Bay or Freshwater Bay geoducks… Although microsporidia have been reported in oysters, mussels and cockles from Europe, Australasia, California and the eastern United States, no molluscan microsporidia have been reported from Canada or Puget Sound…Low-intensity infections are not thought to influence organismal health, but high-intensity infections could impact reproductive capacity. P 11.

Section 7—Army Corp of Engineers NWP48 Overview and Documented Impacts on Salmon Habitat

The shellfish industry is relying on the NWP48 that was issued in 2009 to justify acceptance and expansion of their operations. The following factual information outlining impacts to both Critical and Essential Fish habitat for salmon should be carefully examined that is an integral part of the NMFS opinion and the USF&W opinion:

[10] Streaming Video of VanBlaricom and Horwith SeaGrant Preliminary Presentation. Web Link 10.

[11] Sea Grant Washington, Geoduck Aquaculture Research Program – Interim Progress Report. Web Link 11.

National Marine Services Biological Opinion-Army Corps NWP48-Shellfish Aquaculture[12]

The biological opinion does state that existing aquaculture is not likely to result in any take, (harass or harm) of an individual endangered salmon. However, the opinion:

- Initially found that existing shellfish aquaculture is likely to adversely affect endangered Puget Sound Chinook salmon, but later changed this position due to uncertainty (page 3).
- The opinion states that the Army Corp of Engineers determined that existing shellfish aquaculture activities would not adversely affect critical habitat (CH) non-specifically, but would adversely affect essential fish habitat (EFH) (p 1), including EFH for groundfish (p 17).
- Both the NMFS (p 72, 85) and ACOE (p 1) concur that the action would adversely affect EFH.
- The opinion states that the proposed action is likely to adversely affect CH for Puget Sound Chinook salmon specifically (p 25). Conversely, the opinion also states that the action will not appreciably reduce the conservation value of designated critical habitat in general (p 57).
- According to the NMFS opinion, the BRT (biological review team) majority opinion is that the naturally spawned component of Puget Sound Chinook is likely to become endangered within the foreseeable future. The number two limiting factor is the degradation and loss of estuarine habitat (p 21).

The environmental effects on listed fish from farming shellfish in the intertidal zone are: (1) episodic water quality effects from physical interactions with the bottom (raking, tilling, and harvesting) increasing turbidity (2) Impacts to SAV(eelgrass) from aquaculture activities; (3) water quality and related effects from application of carbaryl insecticide to control burrowing shrimp in certain places; and (4) benthic disturbance. (p 39).

Willapa Bay/Grays Harbor Salmon and Other Native Species Impacts from Carbaryl Pesticide Applied to Tidelands

Because application of carbaryl is not a part of the proposed action and the COE has no regulatory authority over such applications, the COE has no capacity to minimize the effects of this activity. Therefore, although the effects of interdependent actions must be considered with the effects of the action, those effects are not considered in the ITS that accompanies this biological opinion. (p 43).

Pacific salmon (LCR Chinook salmon and CR chum salmon juveniles and adults) may use the estuarine habitat in Willapa Bay and Grays Harbor where carbaryl is applied. The southern DPS of green sturgeon (sub-adults and adults) also use the estuarine habitat in Willapa Bay and Grays Harbor where carbaryl is applied. Effects of the proposed carbaryl applications include potential reduction of the prey items, and waterborne exposure through drinking and across gills, and AChE inhibition. (p 43).

[12] NMFS Biological Opinion
http://www.co.pierce.wa.us/xml/services/home/property/pals/landuse/smpmay09comm2.pdf P.3-85.

Studies conducted by Dumbauld and others in Willapa Bay and Grays Harbor have used tow nets to capture juvenile Chinook salmon utilizing the water column over oyster beds after application of carbaryl. Juvenile Chinook salmon exposed to carbaryl in the water column will exhibit AChE inhibition and be subjected to increased risk of predation as a result. The NMFS concludes based on genetic data from adult Chinook salmon captures and recent studies of juvenile salmonids rearing outside their natal estuaries (E. Casillas pers comm. 2009) that it is likely that some ESA juvenile Chinook salmon from the LCR ESU will be taken. (p 48).

Carbaryl sprayed on mud flats can be transported substantial distances at concentrations that may have ecological impacts. Researchers found that close to 100 percent of Dungeness crabs were killed up to 100 m off the carbaryl application area (Doty, Armstrong et al. 1990). (p 45).

In summary, the biological opinion states that existing shellfish aquaculture is likely to adversely affect CH for endangered Puget Sound Chinook salmon and Hood Canal Summer run Chum salmon per the Endangered Species Act. The opinion also states that existing shellfish aquaculture is likely to adversely affect EFH for all fish species per the Magnuson Stevens Act. Since the activities are likely to be damaging to habitat, then this would logically infer that the action will also jeopardize listed species, as habitat and wildlife are inextricably linked.

USF&W NWP48 Biological Opinion[13]

Aquaculture Impacts to Eelgrass

"Aquaculture activities are expected to cause a reduction in eelgrass through direct displacement from bed preparation (mechanical dredging, tilling, raking and harrowing and shellfish harvesting (mechanical dredging, water injection). Eelgrass may recover, although it may take an extended period of time and densities are expected to be lower. Eelgrass will encroach on shellfish beds over time, but it is reasonable to assume it will provide limited and ephemeral habitat given the subsequent harvesting that will take place. The quality (density and biomass) of the eelgrass that may be present in shellfish beds is likely to be lower than the density of the native bed displaced when the shellfish bed was first created. Therefore, while some of the functions may be restored, it is unlikely that the recovering eelgrass will completely offset the lost function of the displaced eelgrass due to its reduced quality and ephemeral nature."

Aquaculture Impacts to Food Web vs. Natural Densities

Large shellfish operations growing large numbers of shellfish may cause a shift in the food web through reducing prey for primary consumers at the base of the food web. This is more likely to occur in sheltered embayments where flushing rates are low and foraging habitat for juvenile fish is limited or discontinuous. If shellfish are present at "natural" levels, their filtering activities would not upset the balance of the intertidal food web. However, aquaculture species are mostly non-native, planted at high densities, and filter larger quantities of water (phytoplankton) than the native oysters. Therefore, they

[13] http://www.dnr.wa.gov/Publications/psl_ac_usfw_2009_nwp48.pdf

may have a competitive advantage and reduce available food for other planktivores. This may be a more significant issue in confined or isolated embayments.[14]

Shellfish can compete directly with forage fishes through consumption of copepods and amphipods. Recent studies have shown that shellfish may also consume larger benthic and pelagic organisms (Davenport et al. 2000; Lehane and Davenport 2002, both in McKindsey et al. 2006, p. 25).[15]

While the USF&W pointed out the effects of mussel consumption of larger benthic and pelagic organisms, the following research includes scallops and cockles (clams). With clams, oysters and geoducks in various quantities being placed adjacent to forage fish spawning grounds and critical salmon habitat, the consumption of fish eggs, crab & shrimp larvae is an important consideration. "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."[16]

"These filtration estimates are substantial and could affect food resources for species in relatively isolated areas. Many of the organisms (amphipods, copepods) consumed by shellfish are also fed upon by juvenile salmonids and forage fish (Figure 4.16). This competition for food resources would likely not be a significant problem in areas where food resources are not limited. However, this competition could result in depleted prey resources for juvenile salmonids and forage fishes in areas where foraging habitat is limited and the density of shellfish is higher than the carrying capacity of the foraging habitat."[17]

"The link between changes in benthic community structure and listed species is as described above, a modification of the intertidal food web which could ultimately affect listed species (Jamieson et al. 2001, p. 42). Modifications in species diversity, biomass, and nutrient cycling [as pointed out by Bendell-Young (2006, p. 26) (Mattsson and Linden 1983, p. 93; Pearson and Rosenberg 1978, p. 92; Tenore et al. 1982, p. 92; Stenton-Dozey et al. 1999, p. 93; all as cited in Landry et al. 2006)] could reduce the resilience of the intertidal community such that the community would be less able to recover from repeated perturbations, natural or anthropogenic."[18]

"The factors that may have the greatest effect on juvenile salmonids and forage fish species relate to the timing and duration of the disruption and shift in community structure, and the availability of other foraging habitat within migrating distance. If juvenile salmonids and forage fish are required to travel

[14] USF&W Biological Opinion.
[15] ibid. p 125.
[16] Fisheries and Ocean Canada, Impacts to Fish Habitat from Aquaculture P.
[17] ibid. p 126.
[18] ibid. p 129.

long distances to find prey, their overall fitness may be reduced. Depending on the magnitude of these effects, there could be effects via the food chain to bull trout and murrelets."[19]

Section 8—Recovery Plans, Policies and Laws Relevant That Should be Enforced to Protect Habitat, Forage Fish, Salmon and Whales from Direct Aquaculture Impacts in the Nearshore

A. Shared Strategy for Puget Sound—South Sound

"Chinook use the South Sound habitats for feeding and growth, refuge from predation and extreme events, physiological transition between fresh and salt water, and migration. From this context, the South Sound strategy is focused on the Nearshore environments. There are, however, Chinook in the South Sound that spawn in McAllister Creek, Deschutes River, Percival Creek and other independent tributaries such as Woodland Creek, Mill Creek, Goldsborough Creek, Case Inlet streams, Carr Inlet streams, and East Kitsap streams. Historically, South Sound tributaries probably did not possess sustainable populations of Chinook. The marine/Nearshore areas, however, are currently utilized by Puyallup River Chinook, White River early run Chinook, which is the sole remaining early run stock in South Puget Sound, and the Nisqually Chinook, a summer/fall stock. "

"While there are very few reports of bull trout in the South Sound region, the US Fish and Wildlife Service identifies the South Sound marine and Nearshore as a potential area of importance for foraging, migrating and over-wintering habitat for bull trout." P. 297

The South Sound Salmon Technical team produced the Chinook and Bull Trout Recovery plan. This work, subsequently adopted by NOAA Fisheries, addressed near-shore habitat south of the Tacoma Narrows. The group continues to refine the document by adding additional levels of detail and producing new tools to select and prioritize Nearshore projects. The South Sound Recovery Plan identified and addressed the following human induced stressors that are contributing to the status of the salmon in the Nearshore and the hypothesized effect on the Viable Salmonid Population:[20]

- Shoreline Armoring
- Overwater Structures and Ramps
- Stormwater and wastewater
- Riparian Loss
- Wetland and Estuarine Modification
- Boat Traffic
- Invasive Species
- Shellfish Aquaculture

B. Department of Fish and Wildlife Wild Salmonid Policy

"The Wild Salmonid Policy addresses habitat protection and restoration because habitat is essential to wild salmonid protection" [21]

[19] ibid. p 129.
[20] http://www.psp.wa.gov/downloads/SALMON_RECOVERY/2009_workplan_updates/2009_south_sound_update.pdf
[21] WDFW, Final Joint WDFW/Tribal Wild Salmonid Policy, Habitat Protection and Restoration, Dec 1997.

"Habitat goals, performance measures, and action strategies should apply to all salmonid habitat, regardless of land use and regardless of ownership"[22]

The habitat policy is arranged along salmonid life history needs, and the physical processes and habitat types affecting them. It consists of nine components.

The Habitat Policy components are:

1. Habitat Protection and Management
2. Basin Hydrology and Stream Flow
3. Water and Sediment Quality and Sediment Transport
4. Stream Channel Complexity
5. Riparian Areas and Wetlands
6. Lakes
7. Marine Areas
8. Fish Passage and Access
9. Habitat Restoration

It is important to recognize the inter-relationships between these components. Inadequate attention to one or more habitat components can reduce, or eliminate, the benefit of achieving the performance measures of another.[23]

C. Development of Guidelines for Salmon Habitat Protection

Both finfish and shellfish are noted for their impacts, but no protective actions were ever pursued.

http://wdfw.wa.gov/hab/ahg/wetland.pdf

D. Hydraulic Code Rules---Protects Habitat From Shoreline Development But Not from the Most Direct Impacts from Industrial Aquaculture

"All known forage fish spawning sites are currently protected from net loss by specific language within the state Hydraulic Code Rules, GMS, SMP Guidelines and local CAOs, if applied and enforced."[24]

The following 2007 Attorney General Opinion is not consistent with existing laws and salmon habitat protection:[25]

"We answer the first question in the negative. RCW 77.115.010(2) limits application of Washington Department of Fish and Wildlife (WDFW) regulatory powers with respect to private sector cultured aquatic products. The limitation prevents WDFW from requiring a hydraulic project approval permit to regulate the planting, growing, and harvesting of geoducks grown by private aquaculturalists."

[22] ibid.
[23] ibid.
[24] Penttila, *Marine Forage Fishes in Puget Sound*, Technical Report 2007-03, p 20. Web Link 2.
[25] AGO 2007 No. 1, Extent to which hydraulic project approval permits or shoreline substantial development permits are required for the planting, growing, and harvesting of farm-raised geoduck clams. Web Link 7.

Details on the Hydraulic Code can be found at:

http://washington.sierraclub.org/tatoosh/Aquaculture/FHHydraulicCode.pdf

E. Department of Fish and Wildlife—Forage Fish Management Plan

"The precautionary approach utilizes caution when the agency is faced with a decision and a lack of information. The approach calls for reducing fishery or other activities if there is reason to believe that the activities will cause significant harm, even if such a link has not been established by clear scientific evidence."[26]

F. **Juvenile Salmonid Composition, Timing, Distribution and Diet in Marine Nearshore**

The natural processes that form and maintain habitats in the Nearshore serve as the foundation of the structure and foundation that supports salmon. Disruption of sediment and prey inputs, changes in hydrology and other processes results in a chain reaction, ultimately leading to lost or dysfunctional habitat for salmon. Impediments to natural processes need to be prevented or removal to allow for conditions conducive to salmon production. P 5-1.

http://your.kingcounty.gov/dnrp/library/2004/kcr1658/nearshore-part1.pdf
http://your.kingcounty.gov/dnrp/library/2004/kcr1658/nearshore-part2.pdf

King County-Implementation Guidance for the WRIA 9 Salmon Habitat Plan November 2006 (Table 3) Industrial aquaculture, especially intertidal geoduck operations, is being allowed in South Puget Sound counties contrary to the following salmon recovery guidance:

Creation of Shallow Water Habitat	• Create low velocity and shallow water habitat for juvenile salmonids and their prey • Restore upper intertidal habitat to allow for forage fish spawning • Restore connectivity to potential sediment sources, e.g., feeder bluffs • Provide expanded habitat for prey resource community production • Provide expanded habitat for aquatic vegetation growth • Restore natural beach slopes • Provide expanded habitat for LWD debris recruitment

http://www.govlink.org/watersheds/9/pdf/WRIA9implementplan11-8-06.pdf

[26] WDFW, Forage Fish Management Plan, 1998. p vi. Web Link 8.

Section 9—Puget Sound Partnership Action Agenda

According to the Governor of Washington

"[It is our task] to ensure that the Puget Sound forever will be a thriving natural system, with clean marine and freshwaters, healthy and abundant native species, natural shorelines and places for public enjoyment, and a vibrant economy that prospers in productive harmony with a healthy Sound." [27]

"The following are concepts for agency request legislation we are planning to propose to the Governor for consideration for 2010 legislative session.

1. Protecting Nearshore habitat by requesting a moratorium on new shoreline hardening and overwater structures in the vicinity of feeder bluffs and spawning areas. The legislation would also propose a collaborative process to improve the Shoreline Management Act. The goals would be to stop the current loss of shoreline habitat, align the SMA with the Action Agenda, and develop recommendations to support local governments by providing the necessary resources to limit shoreline armoring and update Shoreline Master Programs (Action Agenda, Near-term Action A.2.7). PSP would propose joint agency request legislation with the Department of Ecology and/or Department of Fish and Wildlife."[28]

Section 10—NOAA's Fisheries Service Grants Federal Protection for Three Georgia Basin Rockfish Species, April 27, 2010

NOAA's Fisheries Service today announced that it is listing three populations of rockfish in Washington's Georgia Basin for protection under the Endangered Species Act.

The populations of two of the rockfish species - canary and yelloweye - have been designated as "threatened" and a third rockfish species - bocaccio - as "endangered." An endangered species is at high risk of extinction; a threatened species is vulnerable to extinction in the near future and in need of protection.

Populations of all three rockfish species in the Georgia Basin, which encompasses Puget Sound and the Strait of Georgia, were historically harvested at high levels, depleting their numbers. Rockfish are long-lived and mature slowly, with only sporadic episodes of successful reproduction, making them especially vulnerable to overfishing.

According to NOAA scientists, rockfish population growth has also been hampered because they are often caught unintentionally by fishermen targeting other species, and by environmental factors, such as degradation of their habitat near shore, pollution and lost fishing gear that continues to snare fish.

Although rockfish make up a substantial portion of the federally managed commercial bottomfish catch off the West Coast, especially off California, rockfish in Puget Sound are managed by the state.

[27] Puget Sound Action Plan P. 1
[28] Puget Sound Partnership Legislative Agenda Letter

The Washington Department of Fish and Wildlife prohibits fishermen from keeping any rockfish they may accidentally catch in the Puget Sound region. The state agency also forbids bottomfishing in waters deeper than 120 feet, where most of these adult rockfish are found.

There is currently a broad state and federal effort to improve the sound's water quality and habitat through the Puget Sound Partnership, which is aimed at conserving all marine life, including rockfish. Resident killer whales, Chinook salmon, chum salmon, steelhead and bull trout are already protected in the sound under the Endangered Species Act.

Today's listing is in response to a petition from an Olympia resident who asked the agency in 2008 to list Puget Sound populations of five species of rockfish. In addition to the three proposed today, the petition also included greenstriped and redstriped rockfish. Agency scientists said these last two species are at a "low risk" of extinction, and protection under the ESA was not needed at this time.

NOAA held a 60-day public comment period on the listings, from April 23 to June 22, 2009, and received a total of five comment letters on the listing proposals from local and state government, the public and others familiar with rockfish biology and management. All substantive comments were considered and addressed.

For more information on the rockfish ESA listing, see the Web at: http://www.nwr.noaa.gov/Other-Marine-Species/Puget-Sound-Marine-Fishes/ESA-PS-Rockfish.cfm

Section 11—Status of Pending Aquaculture Applications

Pierce County

Geoduck Applications Pending since 2007--4 on private tidelands and 2 on public lands

Army Corp and Ecology Joint Applications

Since January 2010, 4 Geoduck aquaculture applications and one geoduck seed massive barge application have been sent out for public comment

Section 12—Relevant Aquaculture Litigation

Clam Shacks

http://www.mrsc.org/mc/courts/supreme/109wn2d/109wn2d0091.htm

Washington Shellfish

http://www.protectourshoreline.org/articles/Washington%20Courts.htm

Pierce County vs. Foss/Taylor

Various court proceedings and McCarthy Hearing Examiner Case and Decision

Growth Management Hearings Board Case

Seattle Shellfish, et al v. Pierce County/WA Dept of Ecology, CPSGMHB Case No. 09-3-0010, January 19, 2010.
http://www.gmhb.wa.gov/searchdocuments/cpsgmhb/2010/09-3-0010%20fdo%20seattle%20shellfish.final.pdf

Marnin Shoreline Hearings Board Case

John Marnin and June Cook vs. Pacific Shellfish Growers Association SHB 07-021

Information on Sierra Club Aquaculture Activities is available at:

http://washington.sierraclub.org/tatoosh/Aquaculture/index.asp

Web Link References

Web Link 1—Protecting Nearshore Habitat in Puget Sound- An Interim Guide
http://wdfw.wa.gov/hab/nearshore_guidelines/nearshore_interim_guide_october_2007_final_draft.pdf

Web Link 2—Marine Forage Fish in Puget Sound
http://www.pugetsoundnearshore.org/technical_papers/marine_fish.pdf

Web Link 3—Washington Dept of Fish and Wildlife--Sandlance
http://wdfw.wa.gov/fish/forage/lance.htm

Web Link 4—Puget Sound Partnership Forage Fish
http://www.psparchives.com/our_work/species/foragefish.htm

Web Link 5—South Puget Sound Recovery Group—Chinook and Bull Trout
http://www.piercecountywa.org/xml/abtus/ourorg/exec/specialprojects/chinookrecovery/Nearshore/SPSSR%20Plan%20Draft%20V1.pdf

Web Link 6—Puget Sound Salmon Recovery Plan
http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Puget-Sound/upload/Ch5_S_Sound.pdf

Web Link 7—Attorney General Opinion on Hydraulic and Shoreline Development-Exclude Aquaculture
http://www.atg.wa.gov/AGOOpinions/opinion.aspx?section=archive&id=10248

Web Link 8—Forage Fish Management Plan
http://wdfw.wa.gov/fish/forage/manage/foragman.pdf

Web Link 9—USF&W NWP48 Biological Opinion
http://www.fws.gov/wafwo/publications/Biological_Opinions/2008_F_0461_BO.pdf

Web Link 10—SeaGrant Geoduck Research
http://www.wsg.washington.edu/research/geoduck/index.html

Web Link 11—SeaGrant Geoduck Research—Interim Report to Legislature
http://www.wsg.washington.edu/research/pdfs/reports/GeoduckIntProReport.pdf

Web Link 11—Shared Strategy for Puget Sound--Working with communities to restore salmon
http://www.sharedsalmonstrategy.org/