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Industrial Shellfish Aquaculture Standard Practices Authorize the Unlimited Removal of Washington State Aquatic Plants and Animals As Well As the Alteration of the Natural Shorelines

Regulators Are Not Complying With The Clean Water Act, Magnuson Stevens Act, Endangered Species Act, Shoreline Management Act and County Master Programs

Introduction

The introduction of un-permitted industrial nearshore (intertidal)geoduck aquaculture and the use of massive quantities of plastics to grow shellfish began altering the natural ecological functions of the habitat rich intertidal zone in the late 1990's. Oysters typically spread on the tidelands were replaced with plastic grow bags filled with oysters smothering the substrate. Intertidal geoduck aquaculture that was started as an experiment to supplement subtidal wild geoduck populations quickly spread to South Sound inlets and bays. At the same time, large scale mussel raft installations appeared in the subtidal areas of Totten Inlet with significant plans for expansion. Now, the upper intertidal beaches are being covered with netting for both geoduck and manila clam expansion. These industrial practices have changed the face of shellfish aquaculture and the expansion of these unsustainable practices is a threat to the health of Puget Sound native species, especially salmon where habitat loss is their greatest obstacle.

The State of Washington and Federal decision makers are ignoring the need for long term studies or an Environmental Impact Statement for the numerous individual and cumulative impacts in the intertidal zone as this industry expands without restriction in the most sensitive Designated Critical Salmon Habitat and Documented Forage Fish Spawning Habitats. Native plants and animals are being removed from beaches, shorelines are being altered and are being replaced with shellfish commodities. Even without studies on the impacts to the numerous aquatic species, industry and decision makers are stating there "are no significant impacts."

Industrial shellfish operations including geoduck, oysters and clams are altering over 6,400 acres of natural shorelines in South Puget Sound as shown by the red dots on the following link:

http://www.caseinlet.org/uploads/Aquaculture-South_PugetSound_1_.pdf

Unnaturally High Densities of Geoducks are Planted in the Nearshore

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Industry routinely publishes the high filtering capacity of all shellfish, but does not mention the adverse effects that come with those high densities of filtering shellfish. The planting in the nearshore of over 100,000 geoducks per acre plus in many cases thousands of Manila clams and 2,000 bags per acre of oysters is exponentially higher quantities of shellfish than were ever found naturally in the nearshore.

According to the DNR SEIS for Wild Geoduck Harvesting: "The average density on unfished tracts in Washington is 1.7 geoducks/m2, which is equivalent to 6,880 geoducks/acre."(Goodwin and Pease 1991). "The average South Sound subtidal wild geoduck density is .19 per sq. ft (8,276 per acre)".

The ecological benefits of natural shellfish densities and restoration of native species are not relevant to this discussion when examining industrial aquaculture practices combined with the placement of unnaturally high densities of shellfish high in the nearshore zone where they do not naturally grow.

The following information and published studies support the need for a Marine Conservation Plan that will protect Washington's valuable natural marine species and natural ecological functions.

Sierra Club Industrial Shellfish Aquaculture Power Point and Website
http://washington.sierraclub.org/tatoosh/Aquaculture/SierraClub-Aquaculture-2010-Jul-R08-final.pdf

Section A. Changing from a Conservation Estuary to an Aquaculture Production Estuary

The concept of changing the ecology from conservation estuaries to shellfish production estuaries is described in the science report named "The Ecological Role of Bivalve Shellfish Aquaculture in the Estuarine Environment": (Dumbauld, Ruesink, Rumrill, 2009)—page 215:
http://washington.sierraclub.org/tatoosh/Aquaculture/Aquaculture--dumbauld%20et%20al.pdf
"From a manager or land use planner's perspective, the first consideration in evaluating shellfish aquaculture in a given estuary should be an answer to the question: What are we and/or should we be managing for? Estuaries have a wide range of potential functions, have been and will continue to be influenced by many human activities, and similarly are influenced by many natural disturbances in addition to shellfish aquaculture. While the current paradigm for most managers is whole "ecosystem based" management (Grumbine, 1997), in reality managers have only progressed to varying degrees down this path, especially for marine systems. Thus the answer to "what are we managing for?" is driven by a wide variety of stakeholders and societal values (social historical, political, moral and aesthetic as well as economic; Leslie and McLeod, 2007;

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Weinstein, 2007; Ruckelshaus et al, 2008). Although these values are outside the purview of our intended review, we found it instructive to at least classify West Coast estuaries by the current level of aquaculture and other anthropogenic disturbance as Weinstein (2007) propose. Willapa Bay and Humboldt Bay might therefore be considered "production" estuaries with greater than 10% of the area occupied by shellfish aquaculture, while numerous other smaller estuaries with little aquaculture could be classified as other types."

It is important to note that this report discusses disturbances and recovery times as follows:

"While bivalve aquaculture might be viewed as a press disturbance over the long term in a given area, the individual activities act as pulse disturbances and Z. marina in U.S. West Coast estuaries can recover to pre-disturbance levels relatively rapidly (within a period of 2 years in some systems)." Page 215.

Puget Sound is not just a bay, but an estuary of national significance. It is in trouble as evidenced by the most endangered species listed in the country and a $50 million restoration budget. Since the majority of aquaculture areas are continually turned over with a new season of clearing, planting, maintaining and harvesting, there is virtually little "recovery " time where these areas will provide the same ecological functions to those species who rely on these critical Nearshore mid intertidal areas for feeding, rearing or migration. The comparison to periodic disturbances, boat wakes and earthquakes is not a realistic comparison to a permanent conversion to a "crop" operation. Our dwindling native species clearly do not have the luxury of waiting for their habitat and food resources to recover for minimal periods between clearing, planting, maintenance and harvesting.

Section B. 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 that 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. Federal funds designed to protect fisheries should not be used to promote commercial

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fisheries that benefit a few large companies at the expense of public resources.

Section C. SeaGrant Preliminary Geoduck Research
The preliminary research results published by Washington SeaGrant can be reviewed on the following links:

SeaGrant Interim Progress Report—Geoduck Aquaculture Research—2011
http://www.wsg.washington.edu/research/pdfs/reports/GeoduckReport2011.pdf

Page 16
"After geoduck harvest, reseeding and net installation (summer 2008), a range of effects on ecologically relevant aspects of Fisk Bar was detected. Within the farmed plot, an immediate and significant reduction in shoot density, rate of flowering and size of aboveground structures was observed for Z. marina along with a delayed and significant reduction in belowground branching activity. Z. marina was lost from the farmed plot between April 26, 2009 and July 18, 2009, in part because of reduced light levels created by a thick covering of Ulva algae on the predator exclusion nets. After harvest, the farmed plot has a significantly lower sediment organic content than the control plot on every survey date. The farmed plot also demonstrated a significant post-harvest loss of elevation that was not evident in one subsequent survey, suggesting a quick recovery.

Preliminary analysis indicates some evidence of minor "spillover effects" of geoduck aquaculture on the adjacent eelgrass meadow. Effects included smaller, more densely packed Z. marina shoots and increased organic content of sediment nearer the farm. Together, these patterns may represent typical "edge effects" in which geoduck aquaculture has effectively formed a meadow edge where non existed before (Figure 9).

In the summer of 2011, there was preliminary evidence of recolonization of Fisk Bar by Z. marina. Although plant densities were low, small numbers of shoots were recorded across the farmed plot. Because these shoots were often too far from the control plot to be the product of vegetative propagation, it is likely that their recruitment was through seeds and seedlings (Figure 10).

In the accessory PVC tube installation experiment, the transplanted seedlings perished within four months in all four plots, both experimental (with tubes) and control (no tubes). A higher rate of decline was observed in plots with tubes installed. These results indicate that this location was not favorable to eelgrass recruitment and growth. After 14 months, the plots with tubes demonstrated a significantly greater loss of sediment elevation, suggesting that tube installation and a lack of eelgrass may increase rates of scour on surrounding sediment. These results, however are for the specific study area and may not be characteristics of all geoduck aquaculture locations.

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Research Highlights
In Fisk Bar, where eelgrass recruited to the area after geoducks were planted, harvest activities produced effects on almost every measured biological and physical parameter of the farmed and reference sites with limited "spillover effects" from the farmed area to adjacent reference sites. However in 2011, one year after the removal of tubes and nets from the new culture cycle, the first signs of eelgrass recovery were observed, indicating that current farming practices do not make sites unsuitable for later colonization of eelgrass.

SeaGrant Interim Progress Report—Geoduck Aquaculture Research—2010
http://www.wsg.washington.edu/research/pdfs/reports/GeoduckReport2010.pdf

SeaGrant is conducting research on primarily three limited issues: Benthic effects of harvesting, eelgrass effects and genetics/parasites/disease. It is important to note that this research does not take into account that the industry practice is a perpetual production cycle of preparing the beach, planting, netting, harvesting. This cycle is repeated again within a few weeks which results in a minimal "recovery" period for aquatic plants and animals. Page 16

Ecological Effects-Page 7
"Nevertheless, declining trends in a few taxa coincident with harvest disturbances were observed at some sites, including reduced abundance of some worms and small crustaceans within the harvest area and adjacent areas. There is evidence of recovery of these populations within six months. Continued analysis of the data are required to determine whether response of important taxa differs from the general community."

Eelgrass Effects-Page 14
"After harvest, a range of effects on ecologically relevant aspects of Fish Bar was detected.
Within the farming area, Z. marina exhibited an immediate and significant reduction in shoot density, rate of flowering, and in the size of above ground structures, and a delayed and significant reduction in below ground branching activity."

"Preliminary analysis indicates some "spillover" effects of geoduck aquaculture on the adjacent eelgrass meadow. Possible effects include smaller, more densely packed Z. marina shoots and increased organic content of sediment nearer the farm."

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Parasites and Disease-Page 11
"Researchers observed a parasite, previously unknown to geoduck: a Steinhausia-like microsporidian parasite within geoduck eggs (ova)."
Cultered Wild Interactions—Backup Report-2010
http://www.wsg.washington.edu/research/pdfs/reports/Friedman_RGD2_2010.pdf

"The microsporidian-like parasite resembling Steinhausia sp. is illustrated in Figure 2. The biology of Steinhausia-like parasites are poorly understood but its presence may impact reproductive success if present at high infection intensity. Although microsporidia hae been reported in oysters, mussels and cockles in Europe, Australasia, California and the eastern United States, no molluscan microsporidia have been reported from Canada or Puget Sound." Page 9.

Geoduck Aquaculture Research Program, Progress Report, 2009
http://www.wsg.washington.edu/research/pdfs/reports/GeoduckIntProReport.pdf

Ecological Effects-
"Diver surveys conducted at planted sites suggest that the addition of structures associated with geoduck aquaculture may change the community of mobile organisms visiting the site during high tides. Populations of structure-associated rock crabs, sea stars and other animals may increase, while populations of flatfish and other sandy-bottom species may decrease when nets and tubes are added to intertidal beaches."

Section D-The Eleven Impacts of Industrial Aquaculture that SeaGrant Research Does Not Address

Impact #1--Bivalve Ingestion of Fish Eggs and Larvae

Dan Penttila, the most recognized forage fish expert in Washington State, has pointed out in reports and testimony that the adverse impacts of shellfish aquaculture on forage fish need to be examined in an EIS prior to further expansion. The following four studies clearly document that all types of shellfish consume fisheries resources (eggs and larvae) and even if not ingested are destroyed.

For more detailed information on Mr. Pentilla's statements and reports, see the following

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link: http://wa.sierraclub.org/tatoosh/Aquaculture/SierraClub_Zooplankton_depletion_2(1).pdf

Evidence of these significant impacts are detailed in the following five studies:

The Four Independent Studies on the Impact of Bivalves Ingesting Fish Eggs, Crab Zoes, Copepods, Amphipods and Larvae Are Listed Below:

A. Shellfish Independent and Peer Reviewed Studies on Ingestion of Fisheries Resources in the Nearshore "nursery" (forage fish eggs/larvae, fish eggs/larvae, barnacle eggs/larvae, worm eggs/larvae, crab zoes, copepods and amphipods, etc.)

The following study clearly refutes the unsubstantiated "opinion" of the shellfish industry's contract scientist that geoduck are relatively dormant as shown on the Environ reports. The applicant has also presented evidence of the high filtration rates of geoduck which is especially relevant when over 120,000 new geoduck are planted per acre in 5 acre (600,000) new geoduck in this species rich area.

Industry also does not point out that the massive filtration and quick growth of shellfish which also adds to the biodeposits (fecal matter) which has not been addressed.

- **1. Population abundance estimates of the New Zealand Geoduck Clam**

  http://www.thefreelibrary.com/Population+abundance+estimates+of+the+New+Zealand+geoduck+clam%2c...-a0130777653

"Although several studies on P. abrupta have shown that show-factors are depressed during winter (Goodwin 1973, 1977; Fyfe 1984), winter is a period of active gametogenic development in populations of P. zelandica (Gribben et al. 2004). If P. zelandica were remaining inactive for extended periods of time, then it seems unlikely they could meet all metabolic needs, including gamete production during winter. Fyfe (1984), in a study of geoduck in Ritchie Bay, British Columbia, found that P. abrupta may lay "dormant" for periods of up to 2 months, possibly in response to low winter temperatures and food availability (Goodwin 1973, 1977; Fyfe 1984). However, the plots were only visited once a month during the winter period. Fyfe (1984) assumed that previously tagged geoduck not visible at the next sampling period had remained inactive for at least that period. This may certainly not have been the case. In fact, gametogenesis in P. abrupta from both Washington (Andersen 1971, Goodwin 1976, Beattie & Goodwin 1992) and British Columbia (Sloan & Robinson

- **2. The CSAS (Canadian Science Advisory), review of the effects of shellfish**

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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."

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

- "All species examined had zooplankters in their stomachs." P 617
- "Numbers of organisms ingested by suspended and field (scallops) were not significantly different." P 617
- "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." P 618
- "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." P 619

- **4. 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."

- **5. 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."

E. DNR-SEPA Determination of Significance Wild Geoduck Harvesting-Documents Evidence of Sand Lance Eggs in Water Column and DNR Separation of Dive Harvesting from Sand Lance Habitat

Blake Island, Washington Study Results-Spawning and Wild Geoduck Harvest
http://www.caseinlet.org/uploads/DNR_SEPA_Blake_Island_Geoduck_Harvest.pdf

"After deposition, sand lance eggs may be scattered over a wider range of the intertidal zone by wave action. The incubation period is about four weeks. Upon hatching, the larval sand lance measures about 5 mm, and are virtually transparent. Like other forage fish, larvae and juvenile sand lance are subject to predation. As larvae they are at the mercy of the local currents and tides until they are about 22 mm in length. They then "school up", adopt their adult coloration and can be found in bays and inlets throughout Puget Sound. Sand lances are somewhat unique in their generalized diurnal behavior pattern, feeding in the open water during the day and burrowing into the sand at night to avoid predation (source: http://wdfw.wa.gov/fishlforage/lance.htrn). There is substantial vertical separation between sand lance spawning (+5 ft. MLL W to mean higher high water) and proposed water depths of (subtidal) geoduck harvest activity on this tract (-22 ft. to -70 ft., MLLW). Exhibit A, pages 5-6.

Port Gamble, Washington Study Results-Spawning and Wild Geoduck Harvesting
http://www.caseinlet.org/uploads/DNR_SEPA_Port_Gample_Geoduck_Harvest.pdf

"Sand lances are an important part of the trophic link between zooplanktons and larger predators in the local marine food webs. Like all forage fish, sand lances are a significant component in the diet of many economically important resources in Washington. On

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average, 35 percent of juvenile salmon diets are comprised of sand lance. Sand lances are particularly important to juvenile Chinook salmon, where 60 percent of their diet is comprised of sand lance. Other economically important species, such as Pacific cod *(Gadus macrocephalus),* Pacific hake *(Merluccius productus)* and dogfish *(Squalus acanthias)* feed heavily on juvenile and adult sand lance. There is substantial vertical separation between sand lance spawning (+5 feet to mean higher high water) and geoduck harvest activity (-25 ft. to -70 ft., MLLW). (Subtidal)Geoduck fishing on the Port Gamble tract should have no detrimental impacts on sand lance spawning." Exhibit A, page 6.

Impact #2—Sand lance lose documented forage fish habitat to burrow in sediments where geoduck tubes are inserted every square foot and industry harvesting threatens their survival

According to the documented life history, sand lance burrows in the lower intertidal sediments. Loss of this forage fish habitat and prey resource for ESA listed species violates the Endangered Species Act (ESA), the Magnuson Stevens Act (MSA), and the Shoreline Management Act (SMA).

Impact #3—Plastic Predator/Growing Devices--Shellfish industry introduction in the late 1990's of marine plastic pollution from plastic tubes, nets, bands, zipties, oyster bags and canopy nets

The Issue

The shellfish industry places over 120,000 pieces of plastic into **each acre** of geoduck farms as well as using plastic canopy nets (30ftx 30ft) over geoduck and manila clam beds in Puget Sound intertidal areas. In addition, thousands of plastic grow bags per acre are filled with oysters and placed in intertidal areas where oysters used to be grown naturally.

According to the Department of Ecology, there are 247 intertidal geoduck sites in over 360 acres throughout our South Sound inlets. Many of these sites are located in the limited number of Designated Critical Salmon Habitat and/or Documented Forage Fish Spawning Habitat. In all, over 5,000 acres of aquaculture are already in production in South Puget Sound.

Recent Developments:

The Center for Biological Diversity has petitioned EPA to add marine plastic pollution as a "pollutant" under the Clean Water Act. Included in their petition were rubber bands

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and plastic nets, the same plastics that the shellfish industry places in Puget Sound. http://www.biologicaldiversity.org/campaigns/ocean_plastics/pdfs/Petition_Plastic_WQC_08-22-2012.pdf

In addition, the study "Microplastics in the marine environment" confirms scientist's opinion that plastics used by the aquaculture industry do degrade and are harmful. http://plasticsoupfoundation.org/wp-content/uploads/2011/08/Microplastics-in-the-marine-environment.pdf

Two Well Known Marine Plastic Debris Experts Speak Out on This Issue

Curtis Ebbesmeyer, Phd, an oceanographer and marine plastic expert stated:
"Such plastic poses one of the grave threats to the health of Puget Sound. The particulate plastic from such PVC tubes enters the food web and does untold harm to all the creatures in Puget Sound, including us. It is not healthy to each geoducks raised in such a fashion."

Charles Moore, a world renowned marine plastic marine debris expert, stated the following at the Pierce County Hearing on March 15, 2011:
"To summarize, the introduction of plastics into the marine environment poses hazards of three main types: ingestion, entanglement, and the transport of exotic species (Barnes). PVC is especially toxic and poses hazards to environment, health and every state of its existence. Other plastics may eliminate some, but not all of these problems. Therefore, it does not appear possible to introduce any plastics into the marine environment without harmful consequences."

For more detailed information on the adverse impacts of geoduck aquaculture marine plastic pollution, visit the following link:
http://wa.sierraclub.org/tatoosh/Aquaculture/SierraClub_Plastic_Pollution-2(1).pdf

Canopy Nets Reduce Biodiversity, Increase Sedimentation and Organic Matter as documented below:

1. WDF&W Scientist Recommendation To Not Use Nets On Tidelands:
http://www.caseinlet.org/uploads/Netting-Pierce-Aquaculture--WDFW_Opinion-RE__Shoreline_Substantial_Development_Permit_SD..._1_.pdf

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2. Published Studies-Netting
http://www.caseinlet.org/uploads/Bendell-Aquaculture-Netting_Study.pdf

http://www.caseinlet.org/uploads/Bendell-Aquaculture_GIS_Study.pdf

http://www.caseinlet.org/uploads/Bendell-Aquaculture-geochemical_study.pdf

http://www.caseinlet.org/uploads/Bendell-Aquaculture-Euspira-Predator_Study.pdf

Impact #4--Destruction of macroalgae beds and sand dollar beds that are considered essential fish habitat for both ESA listed species and non-listed species.

The following documentation clearly shows that the shellfish industry destroys marine vegetation (A, B,C), why marine vegetation is critical to both ESA listed and non-listed species (D,E) and the laws that regulators are required to enforce to protect Washington's marine vegetation.

A. Shellfish Industry Routinely Removes Native Vegetation and Species Essential to Nearshore Ecological Functions
http://washington.sierraclub.org/tatoosh/Aquaculture/Shellfish%20Industry%20Routinely%20Removes%20Na_tive%20Flora%20and%20Faun.pdf

B. Aquaculture—Destruction of Eelgrass by the Shellfish Industry-Marine Forage Fish Report-Dan Penttila-Page 16
http://www.pugetsoundnearshore.org/technical_papers/marine_fish.pdf

"Standard aquaculture practices may have profound effects on the benthic ecology of Washington State's tidelands and the conservation of forage fish spawning areas, especially for herring. In many areas, herring spawning grounds are now coincident with shellfish culture areas, particularly on tide flats occupied by beds of the native eelgrass. Pacific oyster (Crassostrea gigas) beds intended for the ground-culture and dredge harvest of oysters commonly become devoid of native eelgrass, either due to the cumulative effects of periodic dredging activities over time or by intentional destruction of the eelgrass beds before the start of culture activities (West 1997). Dredging operations routinely take place on or near tide flat areas containing herring spawn (WDFW unpublished data). Currently, the Washington Department of Agriculture (WDA) has regulatory authority over aquaculture activities that occur in intertidal areas

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of state waters. The Washington Department of Natural Resources (WDNR) has authority over state aquatic bottomlands and marine vegetation management. These agencies together with WDFW should seek a coordinated approach to the management of the growing aquaculture industry, with an eye toward modification of habitat-damaging culture practices and the mitigation of existing habitat degradation for which the industry has been responsible."

C. Geoduck Aquaculture as Perturbations to Eelgrass-SeaGrant Video
Ruesink and Powell

"Eelgrass density was depressed in summer by space competition with geoducks." When geoducks were harvested at the end of the experiment, eelgrass shoot density dropped by more than 70 percent."

D. The Role of Seagrasses and Kelps in Marine Fish Support
Derrick Blackmon, Tina Wyllie-Echeverria and Deborah J Shafer
http://el.erdc.usace.army.mil/elpubs/pdf/tnwrap06-1.pdf

"**Background:** The U.S. Army Corps of Engineers (USACE) has been involved in regulating certain activities in the nation's waters since 1890. Until 1968, the primary focus of USACE's regulatory program was the construction and maintenance of navigation infrastructure. Since then, the program has evolved to one that reflects national concerns for both protection and utilization of important resources. Activities that involve construction, excavation, fill, and certain other modifications of the "waters of the U.S." are regulated by USACE under the authority of Section 10 of the Rivers and Harbors Act of 1899, Section 404 of the Clean Water Act, and other regulatory policies. In estuarine waters, some of these regulated activities have the potential to impact sensitive aquatic resources such as seagrasses and kelps that provide important habitat for many commercially and recreationally important fish species."

"Many of these estuarine-dependent species are vulnerable to over-fishing, degradation of water quality, and loss of critical habitats. The 1996 Sustainable Fisheries Act amendments to the Magnuson-Stevens Act focus on essential fish habitats. The Act mandates identification and description of estuarine habitats used by managed species for spawning, feeding, breeding or growth, and identification of anthropogenic threats to these habitats (Rader and Davis 1997), and specifically targets managed species."

"This evidence highlights the need for detailed examination of seagrasses at a regional level to determine their role as habitat for ecologically and economically important species. Density, growth, survival, and movement need to be evaluated to determine the importance of a particular area/habitat as a nursery (Beck et al. 2001)."

"Forage fishes. Forages fishes are mentioned in this review due to their ecological role in the life histories of commercially important species such as salmon and rockfish. Surf smelt and sand lance spawn in the upper intertidal on sandy or sand/gravel beaches throughout Puget Sound (Lemberg et al. 1998, Pentilla 2000). Pacific herring spend most of their adult life in offshore waters. However, they spawn inshore, primarily on vegetated habitats, including red and brown algae, eelgrass, and rock kelp (Hay 1985) and feed on pelagic prey (Simenstad et al. 1988)."

E. WDF&W, Preferential Use of Nearshore Kelp Habitats by Juvenile Salmon and Forage Fish, Anne Shaffer
http://www.caseinlet.org/uploads/SalmonKelp_Shaffer__1_.pdf

"In summary, this study indicates that kelp bed habitats are important for, and preferentially used by, both juvenile salmon and surf smelt. Salmon appear to preferentially select the middle kelp bed areas, possibly due to optimal feeding and refuge conditions this area of the kelp bed may offer. Combined, these results indicate habitat partitioning between thee juvenile fish species. Further quantification of fish uses of kelp habitats, including radio tagging of fish, and defining juvenile salmonid and forage fish trophic relationship to kelp habitats, are compelling next steps in defining the relationship between juvenile salmon, forage fish, and their use of Nearshore kelp habitats. Such habitat and trophic information is a critical element for the success of future habitat and resource management of Nearshore habitat and the salmon and forage fish resources that depend on them (Stephenson 1996).

F. Magnuson-Stevens Act—Essential Fish Habitat—Algae Beds and Sand dollar Beds

These important resources are considered "essential fish habitat" in the EFH technical guidelines as shown below:

"Plan and design mining activities to avoid significant areas (such as consolidated sand ledges, sand dollar beds, or algae beds)."

Impact #5—Intentional Elimination of Puget Sound and Willapa Bay Aquatic Native Animal and Plant Species by the Shellfish Industry—Documented in the "Pest Management Integrated Plan for Bivalves in Oregon and Washington"
http://washington.sierraclub.org/tatoosh/Aquaculture/OR-WAbivalvePMSP.pdf

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It is astonishing that local, state and federal agencies continue to allow the shellfish industry to eliminate the long list of native aquatic plant and animal species shown on page 27. It is troubling to Washington citizens to see aquatic sea life routinely eliminated by the shellfish industry as "unwanted pests" as this industry expands along Washington shorelines.

The shellfish industry expands into habitats rich with native species, then adds "feed" in the form of cultured oysters, clams and geoducks. Growers eliminate the species that were there as well as the species that move in to feed as they are now "predators." There is no doubt that this is a "net loss" of native species and a degradation of the food web essential to a healthy Puget Sound.

Contrary to industry statements, the following email dated April 6, 2009, documents there are no Washington State protections that prevent the aquaculture industry from eliminating our native species.

"The primary rule is RCW 77.12.047(3). This exempts private commercial aquaculture from just about everything the WDFW does. The link is below. Let me know if you have any other questions." Russell

http://apps.leg.wa.gov/RCW/default.aspx?cite=77.12.047

After citizens started reporting industry destroying sand dollar beds, it is ironical that the WDF&W then passed a WAC 220-56-130 to "prevent the recreational take" of beach life---just for citizens

"Below is the WAC governing the take of unclassified marine invertebrates and fish for personal use fisheries. WAC 220-56... governs personal use (recreational) fisheries only. The intent of this law is to prevent the recreational take of marine organisms that are not actively managed and/or monitored by the department."

Impact #6—Shellfish growers dive harvest in the intertidal zone (shallower than -18ft MLLW) even though DNR prohibits this practice to protect juvenile salmon, their prey and eelgrass according to DNR SEIS (pages 82-83) and May 8, 1999 letter from Charles Simenstad

http://www.dnr.wa.gov/Publications/aqr_geo_lowres2001_final_SEIS.pdf

Charles Simenstad, a highly respected nearshore scientist with the University of Washington School of Fisheries, made the following recommendation regarding the DNR subtidal wild geoduck harvesting in 1999:

"You have obviously taken considerable time, effort and thought to evaluate the potential

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impacts from all aspects of geoduck harvesting, and I believe have incorporated this information into best management practices regulating leasing and harvesting criteria. Most of your considerations encompass mechanisms of impact to juvenile salmon during their initial stages of estuarine residence. Depending upon the methods, practices, and extent of geoduck harvesting, juvenile salmon migrating along Puget Sound and associated shorelines are potentially vulnerable to a variety of effects that could be associated with geoduck harvesting, including: (a) direct impact to salmon exposed to sediment plume, (b) alteration of migratory behavior when encountering the sediment plume generated by water jet removal of the clams, (c) sedimentation of intertidal habitat (e.g. eelgrass, Zostera marina) important to juvenile salmon, (d), cumulative loss of primary production due to turbidity shading by sediment plume, and (e) attraction or aggregation of potential predators on juvenile salmon…..I am restricting my evaluation of impacts to juveniles of ocean-type salmon (e.g. chum, Chinook and to some degree pink because during their early marine life history when migrating as fry (30-80mm FL) they are confined to estuarine and Nearshore shallow water habitats. As such , they are susceptible to Nearshore impacts that alter this behavioral mandate or reduce critical habitat attributes such as the composition and production of their prey resources and refugia from predation (e.g. vegetative structure provided by eelgrass, etc.).

The exclusionary principle of not allowing leasing/harvesting in shallower water than -18 ft. MLLW or 200 ft. distance from shore (MHW), 2 ft vertically from elevation of lower eelgrass margin, and within any region 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 (or are not allowed to?) enter the Nearshore zone, impacts to juvenile salmon habitat and prey resources should also be protected from impact by these policies if effectively regulated."

Dan Penttila stated in his expert report during the 2011 Pierce County Longbranch geoduck EIS hearing:

"The disparate policies of siting subtidal wild-geoduck harvest leases on bottomlands no shallower than -18 feet in tidal elevation for the benefit of juvenile salmonids (Simenstad, 1999) while allowing conceivably even more impacting geoduck farm operations to occur within this very important nearshore migratory habitat zone needs to be explained and justified, through an EIS."

Impact #7--Industrial Aquaculture Direct Impacts to Nearshore Habitat That

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Adversely Affects Wild Salmon and Whale Recovery in Washington

Puget Sound now has the unfortunate distinction of having the most listed endangered species in the United States. As documented in the following information, the nearshore and especially the mid intertidal area is the most critical to species and yet regulators are allowing it to be converted to high density aquaculture. Many of the following Washington Department of Fish and Wildlife list of species of concern depend on the mid intertidal nearshore area for survival that is now being converted to aquaculture. The following groundfish and rockfish management plans are further evidence of the efforts to save those dwindling populations that also use these same high value habitat areas that industrial aquaculture practices alter to grow geoducks, oysters and clams.

A. Documentation of Aquaculture Impacts on Fish Habitat
http://washington.sierraclub.org/tatoosh/Aquaculture/Fish_Habitat_Impacts--Overview--_Forage_fish,_eelgrass,_salmon-May_31.pdf

B. National Marine Fisheries Service (NMFS) Biological Opinion
http://www.coalitiontoprotectpugetsoundhabitat.com/uploads/090904-3-NWP_48_04-28-2009.pdf

Numerous citations of effects from shellfish aquaculture are included in this opinion as evidenced by the following examples:

Page 3 of the NMFS BO states: *"The proposed issuance of NWP 48 does not authorize or cover the effects of new operations"*. Therefore, the BO does not cover any other pending or future proposals or applications per the NMFS.

Page 25 of the NMFS BO states: *"The proposed action is likely to adversely affect CH (critical habitat) designated for PS (Puget Sound) Chinook salmon and Hood Canal summer-run Chum salmon".*

Also on page 72 of the NMFS BO it is stated: *"Review of the literature during consultation revealed divergent findings on many relevant issues such that there remains some uncertainty regarding the likelihood of the effects of these activities on the environment and whether or not likely effects would bear on EFH (essential fish habitat) and managed fish."*

The NMFS thus acknowledges that the addition of new, intertidal shellfish aquaculture operations will result in additional or cumulative adverse impacts to critical habitat for endangered salmon. This uncertainty lends itself to the requirement for the issuance of

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an EIS. The NMFS opinion is in general agreement with the findings published by the South Puget Sound Salmon Recovery Group fisheries scientists, which states on page 45:

"Shellfish aquaculture in South Sound alters plant and animal assemblages and results in loss of shallow nearshore habitat and 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."

C. United States Fish and Wildlife (USF&W) 2008 Biological Opinion

http://www.fws.gov/westwafwo/publications/Biological_Opinions/2008_F_0461_BO.pdf

The U.S. Fish and Wildlife Biological Opinion (USFW BO) states on page 2: *"The NWP does not authorize new operations or the expansion of the project area for an existing commercial shellfish aquaculture activity."* And on page 10: *"The NWP 48 only covers existing operations; it does not authorize new operations…."* The USFW opinion only addresses two specific species that may be present in Puget Sound under the Endangered Species Act (ESA): bull trout, and marbled murrelet. The BO does not address forage fish, flatfish, sand dollars, or any other species or their habitats.

Numerous citations of effects from shellfish aquaculture were included in this opinion.

C. Threats to Species, Biodiversity and Food Web Status in Puget Sound-Documented Threats to Abundance, Productivity, Spatial Distribution of Key Species-Puget Sound Partnership, July, 2008

"A recent review of the ecosystem-level effects of shellfish aquaculture determined that while more study was needed, the available literature indicates that intensive shellfish aquaculture may divert materials to benthic food webs, alter-coastal nutrient dynamics, and have cascading effects on estuarine and coastal food webs. In particular, the effects of geoduck aquaculture on the benthic environment and fauna, the food webs, water quality, and aesthetics are a current concern but very few studies have been conducted to examine them." "In addition, many species grown for aquaculture in Puget Sound are invasive species, such as Manila clams, Mediterranean mussels, Pacific oysters and Atlantic salmon." "Intertidal invertebrate communities can suffer from the effects of clam harvesting and trampling."

D. WDF&W—List of Species of Concern

http://wdfw.wa.gov/conservation/endangered/lists/search.php?searchby=StateStatus&search=SE&orderby=A nimalType,%20CommonName

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E. DEIS-Puget Sound Rockfish Conservation Plan
http://www.caseinlet.org/uploads/draft_rockfish_plan_19oct09.pdf

F. Puget Sound Ground Fish Management Plan-Palsson, Northrup, Barker, 1998 Revised
www.docstore.com/docs/37660304/WDFW-Puget-Sound-Groundfish-Management-Plan

Salmon Habitat, Diet and Prey Studies—Critical Issues for ESA listed species

The following studies document that the main sources of prey for Chinook salmon are insects, epibenthic crustaceans and polychaete annelids with juvenile Chinook salmon diets relying heavily on polychaetes and sand lance.

These sources of prey for both ESA listed and non-listed species are being put at risk by shellfish aquaculture operations that have been freely allowed to site their operations in Designated Critical Salmon Habitat, Documented Forage Fish Spawning areas and in or adjacent to eelgrass beds.

Salmon-Loss of Habitat-The Number One Reason for Salmon Population Decline

A. Puget Sound Salmon Recovery Plan--South Sound Salmon Recovery Group -- Chinook & Bull Trout Recovery Approach for Puget Sound, 2007

Aquaculture Stressor Chart--"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." Chapter 4, p. IV-13. Page 45.

"Cultivating shellfish in the South Sound results in the loss of shallow nearshore habitat and habitat diversity that is important to salmon." Ch 5. Pg 299.

B. Juvenile Chinook Salmon Distribution, Diet and Prey Resources Below the Locks Charles Simenstad, Kurt Fresh

http://www.seattle.gov/util/stellent/groups/public/@spu/@ssw/documents/webcontent/spu01_002667.pdf

"Diet composition of juvenile salmon indicated a strong influence of discharge from the

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Lake Washington system in the form of freshwater zooplankton (i.e., *Daphnia* spp.), and to a lesser degree pelagic marine/estuarine zooplankton. Insects and epibenthic crustaceans and polychaete annelids were more prominent in the diets of juvenile salmon in the outer Shilshole Bay and adjoining nearshore sites, and slightly more in unmarked than marked chinook salmon. Potential epibenthic prey (harpacticoid copepods, gammarid amphipods) are considerably more abundant at the outer Shilshole Bay sites than at the inner Bay sites."
Page 1.

"Foraging of most salmon is focused on either pelagic zooplankton, most of which originates from allochthonous freshwater production in the Lake Washington/Ship Canal system, and to a lesser degree drift/neustonic insects; autochthonous littoral production of epibenthic prey, and potentially input of riparian insects, do not appear to play a large role in supporting juvenile salmonids in the inner Bay, although these sources may be more important in the outer Bay and adjoining Nearshore." Page 2

C. Juvenile Salmonid Composition, Timing, Distribution, and Diet in Marine Nearshore Waters of Central Puget Sound in 2001-2002, dated August 2004.
http://your.kingcounty.gov/dnrp/library/2004/kcr1658/nearshore-part1.pdf

Salmonid Diet –page –iii

Stomach contents of 819 Chinook salmon, 89 coho salmon, and 56 cutthroat trout were analyzed to determine diet composition. Chinook diet samples were analyzed from 410 individual in 2001 and 409 from 2002 at 16 different sites. In both years, terrestrial insects numerically dominated Chinook diets. Gravimetric (weight) composition was similar between years in all ecological categories (benthic/epibenthic, planktonic/neritic, terrestrial/riparian) and varied by size fish and season. For juvenile Chinook salmon in the smallest size classes (90-149 mmFL) had dietary components that were more evenly distributed in the three ecological categories and insects became a more dominant prey item with increasing size, along with benthic and epibenthic prey. The largest size classes of salmonids fed on planktonic and neritic organisms. There were also distinct seasonal patterns in diet composition. Polychaete worms dominated the <90 and 90-149 mm size classes of juvenile Chinook prey early in sampling season (i.e. May), but were replaced by other prey organisms later in the season. For example, in September, insects made up over 50% of the prey weight in Chinook from 90-149 mm size class and over 980% of the >150 mm size classes. Diets were also similar between geographic locations, but some differences were detected. There was also a great deal of similarity between diets of juvenile Chinook classified as hatchery and "wild."

Stomach contents from a total of 56 cutthroat trout from 12 beaches were analyzed for diet composition, including 47 individuals from 2001 and 9 from 2002. Fish ranged in size from 130-441 mm (Fl). Cutthroat trout diets were dominated by fish (mostly non-salmonids) in both years. Other taxa found in significant numbers included insects, crab larvae, amphipods, copepods and isopods.

"The overall results presented here point to three general habitat types—terrestrial/riparian, shallow benthic/epibenthic, and pelagic—as the most important prey production/foraging areas for juvenile Chinook salmon in shallow marine nearshore areas of Puget Sound." P 4-7.

D. Per Washington Department of Ecology Website
http://www.ecy.wa.gov/programs/sea/pugetsound/species/sandlance.html

"The sand lance, also known locally as the "candlefish," is an ecologically important forage fish throughout Puget Sound. Sand lances are important food for young salmon; 35% of juvenile salmon diets are composed of sand lance. Juvenile chinook salmon depend on sand lance for 60% of their diet. Minke whales, other marine mammals, and many species of seabirds also prey on sand lance."

E. Salmon Behavior—Predator Avoidance in the Intertidal Benthic Habitats Acoustically derived fine-scale behaviors of juvenile Chinook salmon (Oncorhynchus tshawytscha) associated with intertidal benthic habitats in an estuary- Brice Xavier Semmens, Septemer 4, 2008
http://www.caseinlet.org/uploads/semmens_CJFAS_chinook_estuary_habitat.pdf

"**Abstract:** Given the presumed important of benthic and epibenthic estuarine habitats in Chinook salmon (Oncorhynchus tshawytscha) smolt growth and survival, resource managers would be well served by an improved understanding of how smolts use such habitats……
Model results indicated that smolts had a strong preference for remaining in native eelgrass (Zostera marina). Conversely, no such preference existed for other structured benthic habitats such as oyster (Crassostrea gigas) beds, non-native eelgrass (Zostera japonica), and non-native smooth cordgrass (Spartina alterniflora). There was a positive relationship between individual survivorship in the enclosure and the strength of behavioral preference for native eelgrass, suggesting that predator avoidance may be the evolutionary mechanism driving behavioral responses of smolts to benthic habitats." Page 1

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Impact #8--Restriction, disturbance and harassment of marine birds by the shellfish aquaculture industry

The shellfish aquaculture industry has expanded into areas which were historically feeding grounds for marine birds. The following statements taken from the "Pest Management Integrated Plan for Bivalves in Oregon and Washington—July 2010" documents how industry is trying to reduce our bird populations:
"Management of Seagulls, Crows, Ravens and Waterfowl

- Passive measures include substrate cover, fencing, and nets on Manila clams, geoducks and mussels (suspended culture)
- Hazing (harassing to disturb the animal's sense of security so it leaves) is used with some degree of success
- Timing farming activities when birds are most likely to be present has proven effective in scaring them away from the sites
- As a last alternative, hunting has been utilized when depradation permits can be obtained. At this time, Scoter populations are depressed; therefore depradation permits are not available."

It is also well documented in South Puget Sound, that large numbers of marine ducks have been massacred as they come into the inlets by hunters whose boats originated from shellfish industry docks. In fact, the massacre of ducks in Eld Inlet (2009) and Henderson Inlet (2010) resulted in citizens requesting that Thurston County Commissioners institute a no shooting zone ordinance. That ordinance is now being drafted after several public meetings.

"Some startling facts according to the Puget Sound Partnership—
Marine Birds
http://www.psparchives.com/our_work/species/marine_birds.htm:"

- 19 of the 30 most common marine bird species in northern Puget Sound decreased by 20 percent or more between 1978 and 2004.
- Since 1979, the total number of marine birds in the Puget Sound region has dropped 47 percent.
- Western grebe populations have declined by 95 percent over the last 20 years.

"Scientists do not fully know what is driving this decline but some likely factors include decreases in forage fish populations, including herring spawn at Cherry Point and Discovery Bay, changing migration patterns, predation, habitat loss, hunting, by-catch

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from fishing operations (including derelict fishing gear), and harm to breeding grounds in the Arctic."

Three Studies of Shellfish Aquaculture Noting Adverse Impacts on Marine Birds

A. Heffernan, et al., A Review of the Ecological Implications of Mariculture and Intertidal Harvesting in Ireland (1999)
http://protectourshoreline.org/studies/Review_Mariculture_Ireland.pdf

Some excerpts from this review:

1.3.4 Competition for space

Areas which would normally be available for birds and other animals may be occupied by shellfish culture. For intertidal culture, loss of habitat can arise from the presence of structures used for growing shellfish on intertidal feeding ground. These structures include frames used for holding small spat, bags held on trestles, and areas under netting. The farming operations are generally quite small in terms of area covered (1-2 ha.). However, the cumulative reduction of feeding grounds arising from the increasing number of operations can be substantial (O'Brian, 1993).

1.3.5 Disturbance to birds

Disturbance can be defined as any situation in which a bird behaves differently from its preferred behavior. Any overall reduction in birds feeding, as a result of this change in behavior, may increase energy requirements, and hence adversely affect survival (Davidson and Rothwell, 1993). The main cause of disturbance will be the service and maintenance of the culture structures.

B. Effects of Aquaculture on Habitat Use by Wintering Shorebirds in Tamales Bay, California—
John Kelly, Jules Evens, Richard Stallcup and David Wimpfheimer "Our results suggest a net decrease in total shorebirds in the areas developed for aquaculture."
http://www.caseinlet.org/uploads/0096-Kelly_et_al_1996_aquaculture_1_.pdf

C. Nearshore Birds in Puget Sound
http://www.pugetsoundnearshore.org/technical_papers/shorebirds.pdf

"Is Surf Scoter food availability influenced by exclusion from commercial shellfish operations?"

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Impact #9--Genetics, Disease and Parasites
Potential Impacts of Subtidal Geoduck Aquaculture on the Conservation of Wild Geoduck Populations.
http://www.dfo-mpo.gc.ca/CSAS/Csas/DocREC/2004/RES2004_131_e.pdf

- "However, there are several ways in which geoduck aquaculture could negatively impact natural stocks and the commercial fishery although none have been directly assessed. Potential impacts include genetic fitness, transmission of disease, increased number of predators, competition for food, and habitat impacts. Because of these unknowns, and to accommodate the risk and uncertainty related to the stock status of natural geoduck populations, aquaculture development should be controlled and fully integrated in the geoduck stock assessment and management frameworks. Geoduck are long lived animals and negative impacts on populations may be slow to detect." Page 15
- "If predator abundance increases after the seeding of an aquaculture tenure, there could be significant impacts on naturally recruited juveniles (geoduck) in the vicinity." Page 11
- "The possibility of loss of genetic fitness of wild stocks through interactions with hatchery-produced animals is of considerable concern, and highlights the importance of sound genetic protocols for broodstock collection and the management of the lineage of outplanted geoduck. Studies to investigate the range of larvae drift and therefore the range of potential genetic impacts should be a high priority." Page 10
- French May Bid Adieu to Oysters

http://www.dw-world.de/dw/article/0,,6174169,00.html

"Natural oyster producers believe that the main cause of the rampant spread of the virus was the introduction of laboratory manipulated and reproduced triploid oysters." Until peer reviewed studies are completed and made available for review, it is irresponsible for decision makers to allow expansion and put our wild stocks of geoducks at risk that are a vital part of the ecosystem in Puget Sound. Considering the preliminary findings in the SeaGrant report regarding parasites and now unforseen problems with the non-native triploid oyster, a precautionary approach should be required.

Impact #10--Ecosystem Effects and Assessment of Non-Native Invasive Species Used in High Density Aquaculture

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A. Introduction of Non-Native Oysters: Ecosystem Effects and Restoration Implications
Jennifer Ruesink, Hunter Lenihan, Alan C. Trimble, Kimberly Heiman, Fiorenza Micheli, James E. Byers, and Matthew C. Kay, September 9, 2005
http://www.caseinlet.org/uploads/07-04-EnvironmentalStudyOfIntroduced_Oysters_1_.pdf

"Ecological risk assessments associated with oyster introductions should place greater emphasis on ecosystem-level effects. Oyster introductions require that we advance our understanding of the functions and services provided by different marine species and assemblages. Major gaps in knowledge include how native and introduced species influence nutrient cycling, hydrodynamics, and sediment budgets; whether other native species use them as habitat and food, and the spatial and temporal extent of direct and indirect ecological effects within invaded and adjacent communities and ecosystems. Lack of information on community-level and ecosystem-level consequences of oyster introductions is surprising (but we see Escapa eta al 2004), given that these introductions have occurred worldwide for more than a century. Studies that compare the ecosystem functions and services provided by native and introduced oysters are important research priorities, and they provide the framework for recent research projects, such as that supported by the NOAA-Chesapeake Bay Program to examine C. ariakensis and C. gigas."

B. Assessing the Global threat of invasive species to marine biodiversity
Jennifer L. Molnar, Rebecca L. Gamboa, Carmen Revenga and Mark D. Spalding, 2008
http://www.caseinlet.org/uploads/InvSpc-MarBdv2008_1_.pdf

"Our assessment data can also be used by policy makers in specific regions (Table 1). For example, in the two eco-regions that extend along the coastlines of Oregon and Washington State, including the Puget Sound, aquaculture has been the most common pathway for introduction (71% of non-native marine species documented in these eco-regions were introduced by aquaculture). Most of these introductions probably occurred accidentally, through oyster farming (with introduced species hitchhiking on shells or equipment). Of the 33 species known to be associated with oyster farming, 55% are harmful, and most are difficult if not impossible to remove or control (26 of 28 species scored for management difficulty received a score of 3 or 4). In this region, policy makers, conservation practitioners, and the aquaculture industry should continue to work together to prevent any future invasions, by improving practices and perhaps limiting new operations." Page 491

"Our impact scores offer guidance on the merits of these intentional introductions. For example, oysters have been deliberately introduced into coastal waters worldwide, to be cultured for food. One species in particular, *Crassostrea gigas*, has been introduced in at least 45 eco-regions (Figure 4). Its high ecological impact score (3) should cause decision makers and regulators to reconsider plans for introduction of this oyster into new areas. While its harvest brings economic gains, the ecological impact of introductions of this species are potentially dramatic. Oysters play a role in many estuarine ecosystem processes; altering their abundance or distribution causes complex changes. Furthermore, when oyster populations are supplemented with alien oysters, other alien species can piggyback on their shells (Ruesink *et al*. 2005). Global information about distribution and impacts could inform risk assessments and decisions about whether, and how, species should be introduced in the future." Page 491

It is a major concern that South Puget Sound residents are reporting to the WDF&W of invasive tunicates "hitchhiking" to distant shorelines by plastic mussel discs and PVC tubes.

Impact #11--Pesticide and Herbicide Use in Willapa Bay, Washington

A. Carbaryl and Imidacloprid

Up to three tons of Carbaryl (Sevin insecticide) has been sprayed annually by shellfish growers in Washington State (Willapa Bay) on up to 800 acres of tidal flats to exterminate ghost shrimp. Since Carbaryl must be phased out by 2012, the shellfish industry is looking to replace Carbaryl with Imidacloprid. The use of Imidacloprid has raised concerns because of the known impacts to bee populations. The Coalition is concerned about the significant impacts on the ecological functions and affected native species of allowing pesticides to be used in our estuaries.

Neurobehavioral Effects of the Carbamate Insecticide, Carbaryl, on Salmonids

Jay Davis, U.S. Fish & Wildlife Service - Western WA*
Office David Baldwin, Jana Labenia, Barbara French,
Nathaniel Scholz NOAA Fisheries - Northwest Fisheries
Science Center
Keywords: carbaryl, cutthroat trout, salmonid, carbamate pesticide, acetylcholinesterase inhibition, neurobehavioral effects Willapa Bay is a coastal estuary in Washington State that provides habitat for cutthroat trout (Onchorhynchus

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clarki clarki) as well as other salmonids. Cutthroat trout forage throughout the estuary in the summer months when carbaryl, a carbamate insecticide, is applied to oyster beds at low tide to control burrowing shrimp populations. On the day of spray, carbaryl has been measured in the estuarine water column at concentrations >1,000 ppb. Carbaryl is a neurotoxicant that inhibits acetylcholinesterase, an enzyme that hydrolyzes the transmitter acetylcholine at neuronal and neuromuscular synapses. Previous studies determined that cutthroat trout do not show an olfactory response to carbaryl, do not avoid carbaryl-containing water, and that short-term (6 hour) carbaryl exposure rapidly (< 2 hrs) depresses brain and muscle acetylcholinesterase activity in a dose-dependent manner (IC50s of 213 ppb and 185 ppb, respectively) for approximately two days. The goals of this study were to determine the impacts of carbaryl exposure on the swimming behavior of cutthroat trout as well as their vulnerability to predation.

Results indicate that salmonids' swimming performance and ability to avoid predation are significantly affected at carbaryl concentrations >=750 ppb and >=500 ppb, respectively.

B. Glyphosate and Imazapyr Use In Washington Estuaries

Glyphosate and Imazapyr are sprayed in Washington State by growers directly in estuaries and on mudfats to kill Spartna, a form of cord grass. If it is necessary to remove spartina, pulling or mowing this grass should be the method used, not the spraying of herbicides in our estuaries.

The Need For Compliance With Federal Regulations

Section E-Water Quality Degradation

Industrial shellfish aquaculture degrades water quality as documented in the various sections of this report. The Army Corp of Engineers and the Department of Ecology are responsible for enforcing water quality standards and the counties must comply with local, state and federal law. For more detailed information, see:

Section F- National Environmental Policy Act (NEPA) Analysis Should Be Required When Permitting New Aquaculture Expansion—Applies to Army Corp and NOAA

NEPA regulations apply to both policy and program activities. A review of program actions under a policy is definitely within the guidelines of the NEPA Act. It is clear from reviewing information from our Chapters in Sierra Club around the country, that

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there are unique regional habitat and native species requirements in the Northeast, the Pacific Northwest (Puget Sound and the Straits of Juan de Fuca), The Gulf of Mexico and Hawaii. It is critical that there is meaningful public input from each region, that the smaller projects are reviewed for cumulative impacts, and that the scientists who are working on these projects are fully informed of the documented and potential impacts related to the projects. The documentation we have provided clearly demonstrates that there are significant impacts from shellfish aquaculture. Much of the science we have provided is peer reviewed. It is also very important that all of the steps taken by NOAA and the Army Corps be transparent in order to build public confidence. To be specific, the relevant NEPA requirements are described in the following excerpts from the CEQ document titled "NEPA's Forty Most Asked Question's:

Question #24a. Environmental Impact Statements on Policies, Plans or Programs. When are EISs required on policies, plans or programs?

A. An EIS must be prepared if an agency proposes to implement a specific policy, to adopt a plan for a group of related actions, or to implement a specific statutory program or executive directive. Section 1508.18. In addition, the adoption of official policy in the form of rules, regulations and interpretations pursuant to the Administrative Procedure Act, treaties, conventions, or other formal documents establishing governmental or agency policy which will substantially alter agency programs, could require an EIS. Section 1508.18. In all cases, the policy, plan, or program must have the potential for significantly affecting the quality of the human environment in order to require an EIS. It should be noted that a proposal "may exist in fact as well as by agency declaration that one exists." Section 1508.23.

Question #24b. When is an area-wide or overview EIS appropriate?

A. The preparation of an area-wide or overview EIS may be particularly useful when similar actions, viewed with other reasonably foreseeable or proposed agency actions, share common timing or geography. For example, when a variety of energy projects may be located in a single watershed, or when a series of new energy technologies may be developed through federal funding, the overview or area-wide EIS would serve as a valuable and necessary analysis of the affected environment and the potential cumulative impacts of the reasonably foreseeable actions under that program or within that geographical area.

Question #24c. What is the function of tiering in such cases?

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A. Tiering is a procedure which allows an agency to avoid duplication of paperwork through the incorporation by reference of the general discussions and relevant specific discussions from an environmental impact statement of broader scope into one of lesser scope or vice versa. In the example given in Question 24b, this would mean that an overview EIS would be prepared for all of the energy activities reasonably foreseeable in a particular geographic area or resulting from a particular development program. This impact statement would be followed by site-specific or project-specific EISs. The tiering process would make each EIS of greater use and meaning to the public as the plan or program develops, without duplication of the analysis prepared for the previous impact statement.

(b) NEPA procedures must insure that environmental information is available to public officials and citizens before decisions are made and before actions are taken. The information must be of high quality. Accurate scientific analysis, expert agency comments, and public scrutiny are essential to implementing NEPA. Most important, NEPA documents must concentrate on the issues that are truly significant to the action in question, rather than amassing needless detail.

(c) Ultimately, of course, it is not better documents but better decisions that count. NEPA's purpose is not to generate paperwork--even excellent paperwork--but to foster excellent action. The NEPA process is intended to help public officials make decisions that are based on understanding of environmental consequences, and take actions that protect, restore, and enhance the environment. These regulations provide the direction to achieve this purpose. (Source: NEPA Section 1500.1 Purpose)

Section G. Dan Penttila-Forage Fish Relevant Research (see Impact #1)

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2. Penttila, D. 1995a. The WDFW's Puget Sound intertidal baitfish spawning beach survey project. Proceedings of the Puget Sound Research-95 Conference, PSWQA, Olympia, WA, vol 1, p. 235-241.
3. Penttila, D. 1995b. Investigations of the spawning habitat of the Pacific sand lance (Ammodytes hexapterus) in Puget Sound. Proceedings of the Puget Sound Research-95 Conference, PSWQA, Olympia, WA, Vol. 2, p. 855-859.
4. Penttila, D., 2007. Marine Forage Fishes in Puget Sound. Puget Sound Nearshore Partnership Tech. Rep. 2007-03. Seattle District, ACOE, 22 p. potential impacts of aquaculture practices within the text. www. pugetsoundnearshore.org

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5. Moulton, L. and D. Penttila. 2001, rev. 2006. Field manual for sampling forage fish spawn in intertidal shore regions. San Juan County Forage Fish Assessement Project. P. 23.
6. WDFW Salmonscape Forage Fish database charts showing the currently documented surf smelt and sand lance spawning habitat polygons in the Longbranch project area.
7. Penttila, D., 1995. Known spawning beaches of the surf smelt (Hypomesus), and the sand lance (Ammodytes) in southern Puget Sound, WA (Pierce, Thurston and Mason Counties), as of March 1995. WDFW unpub. report, 50+ p.
8. Penttila, D. 11/23/92. "S. Carr Inlet-Drayton Pass". WDF Forage Fish Unit field/lab report (13 p.) of first-ever survey through the Longbranch project area, at which time surf smelt spawn was found near the project site.
9. Penttila, D., 1/5/96. "S. Case Inlet-W. Nisqually Reach" WDF Forage Fish Unit field lab report (11 p.) of forage fish spawning habitat survey conducted through the project area at which time sand lance spawn was found on the project site.
10. Penttila, D., 1/19/07. "Drayton Passage, Pierce Co.", WDFW Puget Sound Action Team Forage Fish Project field/lab report (11 p.) documenting a forage fish spawning habitat survey conducted through the project area, in which surf smelt spawn was again documented near the project area.
11. Penttila, D. 2000. Grain-size analyses of spawning substrates of the surf smelt (Hypomesus) and Pacific sand lance (Ammodytes) on Puget Sound spawning beaches. WDFW unpublished report.

Section H. Charles Moore Marine Plastic Debris Relevant Research (See Impact #3)

1. Fatal ingestion of floating net debris by two sperm whales. Jeff K. Jacobsen, Liam Massey, Frances Gulland
2. Transport and release of chemicals from plastics to the environment and to wildlife.
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3. Invasion by marine life on plastic debris. Nature/Vol 416/25 April 2002/www.nature.com http://www.caseinlet.org/uploads/Moore-Invasion_of_Debris-Barnes_article_1_.pdf
4. Plastic Ingestion by planktivorous fishes in the North Pacific Central Gyre. Christiana M. Boerger, Gwendolyn L. Lattin, Shelly L. Moore, Charles J. Moore; Marine Pollution

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5. Plastic resin pellets as a transport medium for toxic chemicals in the marine environment. Yukie Mato, Tomohiko Isobe, Hideshige Takada, Haruyuki Kanehiro,
Chiyoko Ohtake and Tsuguchika Kaminuma
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Charles Moore and Urja V. Narayan; The Royal Society of Chemistry 2010 http://www.caseinlet.org/uploads/Moore-Rios_et_al__2010_1_.pdf
7. 7. Synthetic polymers in the marine environment: a rapidly increasing long-term threat. Charles James Moore, Fernanda E. Possatto, Mario Barletta, Monica F. Costa, Juliana A.
Ivar do Sul, David V. Dantas; Marine Pollution Bulletin Envir. Res. Plastic Oceans 2008 http://www.caseinlet.org/uploads/Moore--_Env_Res_Plastic_Oceans_2008_1_.pdf
8. The Pollution of the Marine Environment by Plastic Debris: a review. Jose G.B. Derraik; Marine Pollution Bulletin
http://www.caseinlet.org/uploads/Moore--Derraik_1_.pdf
9. Biological Performance Bio Plastic: Mirel. Barry E. DiGregorio; Chemistry and Biology 16, January 30, 2009

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10. Plastic debris ingestion by marine catfish: An unprecedented fisheries impact. Fernanda E. Possatto, Mario Barletta, Monica F. Costa, Juliana A. Ivar do Sul, David V. Dantas,
Marine Pollution Bulletin, 2011
http://www.caseinlet.org/uploads/Plastic_debris_ingestion_by_marine_catfish_An_unexpected_fish_eries_impact_1_.pdf

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October 2011
Updated March 2013