SIERRA CLUB
FOUNDED 1892

Cascade Chapter
180 Nickerson St, Ste 202
Seattle, WA 98109
Phone: (206) 378-0114
Fax: (206) 378-0034
www.cascade.sierraclub.org

January 5, 2010

US Army Corps of Engineers
Regulatory Branch
PO Box 3755
Seattle, WA 98124-3755
Attn: Pamela Sanguinetti

WA Department of Ecology
SEA Program
PO Box 47600
Olympia, WA 98504-7600
Attn: SEA Program, Federal Permit Coordinator

Regarding:
Reference Number: NWS-2009-88
Name: Allen Shellfish, LLC

Dear Ms. Sanguinetti:

The Sierra Club Cascade Chapter is submitting the following comments pursuant to the Allen Shellfish, LLC's NWP48 application request. In preparing our comments for this application, we have reviewed the Army Corps NWP48 Biological Assessment (NWP48 Bio), the NWP48 National Marine Fisheries Service Opinion (NMFS Opinion), the NWP48 USF&W Opinion (USF&W Opinion), various correspondence to the Army Corps, the two reports written by Jeffrey Fisher (Environ), the Entrix/Fleet et al. report and the data from Dr. Chris Pearce (Pearce-DFO).

In addition, we are requesting a public hearing so all of the issues we have presented can be discussed.

The Issue

The Army Corps of Engineers issued a NWP48 that covers existing aquaculture operations in Washington State. The application to the Army Corps and WS Dept. of Ecology to approve a new Department of Natural Resource (DNR) site for the expansion of 4.5 acres of geoduck aquaculture should be denied for the following reasons:

1. The site is a pristine gravel and sand beach of high value as essential fish habitat which includes aquatic vegetation and sand dollar beds. The site fronts a documented forage fish spawning area.

2. The site is adjacent to over ten homes and is not in compliance with the DNR criteria for their intertidal geoduck program as follows:

    - No upland residential development or high bank with low development
    - Absence of eelgrass
    - Low natural stock densities of shellfish

- Low recreational or tribal shellfish use
- No established DNR monitoring study sites

3. Cumulative impacts of additional aquaculture in South Puget Sound, especially geoduck aquaculture, have not been provided. The attached map shows the high number of aquaculture sites in the South Puget Sound area, particularly in Mason County. The two charts presented in the NMFS Opinion document that Totten Inlet and Hood Canal are used for more commercial shellfish operations than other South Puget Sound Inlets, and are coincidentally also in the most ecological trouble as well. The density impacts from the large numbers of shellfish added to these inlets (Totten Inlet -- 2,150 farmed acres, and Hood Canal -- 1,677 farmed acres) should be studied prior to expansion to determine if high shellfish densities are contributing to existing eutrophic and anoxic/hypoxic conditions.

4. The Army Corps NWP 48 relied on literature reviews, preliminary data and anecdotal industry observations in the most critical aspects. For the reasons outlined below, an independent scientific assessment/Environmental Impact Study should be required prior to further aquaculture expansion.

   The data that was relied upon to justify critical aspects of the Army Corps NWP48 for existing operations included a clear preponderance of preliminary, non-peer reviewed, unpublished and non-statistically analyzed results. This preliminary data, in each case supported positive results from Fisher, Pearce-DFO and Entrix, and dominated the findings for the following critical aspects in the Geoduck Culture Section: Habitat-Forming Processes, Chemistry and Turbidity, Nutrient Status, Prey Base, Vegetation Community, Benthic Invertebrate Community, Fish Community, Bird & Mammal Communities. We have provided Exhibit A, B and C which clearly establishes this fact.

   Fisher (Environ)

   The Environ study's principal author is Jeffrey Fisher, one of the shellfish industry's own as a geoduck farm owner/operator, a frequent collaborator with the shellfish industry and with the Army Corps. He is also retained by Taylor Shellfish Company to write reports that ostensibly promote aquaculture expansion in Puget Sound. Although Fisher is certainly aware that Chris Pearce publically stated in 2007 to the Canadian BC legislature that his data was "not really commercial size," Fisher continued to promote this information to benefit the shellfish industry, even when the data is clearly not consistent with Pearce's statements or study results. On November 13, 2008, Pearce stated in a letter to Taylor Shellfish Company that: "While the final results are not yet known, I can comment on what our preliminary analyses have shown ... It should be noted that these are preliminary results. The dataset has not been fully analyzed and conclusions may change slightly based on further analyses of the data. It should also be noted that the area of culture/harvest was relatively small (3 x 20 m = 60 m^2) in comparison to some of the commercial-scale aquaculture that is taking place."

   Pearce has repeatedly tried to point out that his study (60 m^2) is a 196.8 sq ft site with 240 PVC tubes compared to the standard 43,560 sq ft commercial site with 43,560 PVC tubes (1 per sq ft). Fisher has not disclosed other important facts that render the Pearce study unsuitable for comparison to commercial aquaculture, and decision makers should consider if bias is affecting the information presented.

Entrix

The Entrix et al (Fleece- 2004) Draft Programmatic Biological Evaluation of Intertidal Geoduck Culture was paid for by the shellfish industry and the principal author is Gregg Reub. Mr. Reub was a geoduck farm owner/operator when this report was written. The 2004 report is still in draft form and the study results were not published or peer reviewed.

5. No monitoring, enforcement/adherence to the minimal NWP48 Conservation Measures is evident for existing sites, much less for expansion. It is not known how many additional acres and shoreline miles are being added to existing sites since the NWP48 was approved in 2007.

6. In a comment letter from the Chief, Division of Habitat and Resource Conservation, dated January 23, 2008, stated that "Most of the Department's comments were not adopted by the Corps in the final permit."

   In the Nationwide Permit for Shellfish Aquaculture, US Fish and Wildlife Service comments, dated November 21, 2007, Andrea LaTier made statements on Section 7(a)(2) of the ESA as follows:

> Statement (3)
> *Too often only one citation is provided which paints a positive picture of the effects of shellfish aquaculture on the environment. We do not deny that there are positive environmental aspects of this activity on the environment, however, there are negative effects as well, and these appear to be glossed over in this analysis. We expect the Corp's information to provide an evaluation of the activities under consultation which considers all potential effects.*
>
> Statement (34)
> *Is there any grey literature or non-peer reviewed studies available? Since it is plausible that geoducks will compete for prey resources (particularly in sheltered bay and coves and when they are planted in high densities) and dominate as a consumer of the local food web, and then you must assume that juvenile salmonids and forage fish will have less to eat which will lower their growth and survival. This translates into a reduction in prey for bull trout and marbled murrelets and may constitute an adverse effect. I think it would be prudent to alleviate this uncertainty (Line 6) prior to the Corp allowing more widespread geoduck culture given the tenuous condition of salmonid and bull trout populations in Puget Sound. It is difficult to see how given the substantial uncertainty how issuance of the NWP#48 would result in minimal individual adverse environmental effects either separately or cumulatively on the aquatic environment.* (see Page 5-35 starting on Line 10)

A response in the Jones & Stokes Letter dated January 10, 2008, line 3, p. 17 is as follows:

> *The Corps is not proposing to allow more widespread geoduck aquaculture. The proposed action, issuance of NWP48, covers only existing aquaculture operations. This action does not entail any increase in geoduck farming beyond the minor changes that may result on a year-to-year basis as areas within an existing lease are cultured or allowed to remain fallow.*

We have attached the two comment letters and the Jones and Stokes letter and it does not appear that important USF&W comments were incorporated.

7. Even though the stated intent of the NWP was not to "increase geoduck farming" as stated in the previous section, industry representatives are using the NWP 48 biological opinion to advance their agenda as shown below:

    a. "Shellfish farming, which is regulated by the Army Corps of Engineers, has just undergone an extensive formal Endangered Species Action and Essential Fish Habitat Consultation with U.S. Fish and Wildlife Service and the National Marine Fisheries Service (NOAA). The Services concluded that shellfish farming activities - including geoduck farming - do not result in a 'take' of threatened or endangered species." - Robin Downey- September 8, 2009, in a letter to the Jefferson County Commissioners

    b. "After this initial assessment, the U.S. Army Corps of Engineers conducted a detailed analysis and released a 150 page biological evaluation of activities under NWP48. This analysis was also followed by an eight month in-depth investigation by NMFS to determine the likely impacts of the shellfish farms authorized under NWP48. At the conclusion of what has been one of the most exhaustive reviews of the environmental impacts of shellfish farming conducted to date, NMFS concluded, in an analysis of just under 100 pages, that activities authorized by NWP48 are not likely to adversely affect any threatened or endangered species, or result in any adverse modification of their critical habitat." - Robin Downey-November 23, 2009, in a letter to David Dicks (Puget Sound Partnership)

    c. "There is evidence that shellfish beds, including geoduck farm sites, enhance habitat values and functions and serve to mitigate impacts resulting from other activities that may occur in the vicinity. Additionally, NOAA's National Marine Fisheries Service conducted a formal consultation on shellfish activities, including activities that may occur at this site, and concluded that these operations are not likely to adversely impact salmonids, their prey, or essential fish habitat." - Diane Cooper, SEPA Environmental checklist, November 3, 2009, Taylor Shellfish North Bay trespass and SEPA Environmental checklist, November 6, 2009, Mussel Farm/Geoduck Nursery Amendment.

It is obvious that Downey, Cooper and the shellfish industry are intent on using the NWP 48 and the NOAA opinion to influence the process of expanding aquaculture in Puget Sound; and to make it appear that the opinion is somehow "conclusive", or scientifically legitimate, when, in fact, the opinion is neither conclusive nor scientifically legitimate. An opinion is never "conclusive". Data without peer review is not science.

8. The ruling by Judge Martinez on the Maury Island case is relevant to the issue of aquaculture's direct impacts to the Nearshore. The NWP48 is not adequate to protect Puget Sound and native species.

   "After 11 years of political and legal wrangling, U.S. District Court Judge Ricardo Martinez ruled the Army Corps of Engineers erred by not thoroughly assessing how noise and shading from construction and operation of the pier might harm Puget Sound's Chinook salmon and orcas, which are protected by the Endangered Species Act.

   By ordering a longer, more stringent review, the judge ensured it would be at least a year, more likely several, before the project would be built — if ever.

   In so doing, both sides agreed, the judge also appears to have set the stage for stricter environmental review on future construction that affects the Sound's sensitive nearshore environment.

   It's no longer good enough, Martinez ruled, to merely consider how building a single dock may harm the Sound. The federal government must do a better job evaluating the cumulative impact of hundreds of small changes to the region's signature waterway.

   "Which raindrop caused the flood?" Martinez wrote in his ruling. "No single project or human activity has caused depletion of the salmon runs or the near-extinction of the SR [southern resident]orca, or the general degradation of the marine environment of Puget Sound. Yet every project has the potential to incrementally increase the burden upon the species and the Sound." - Seattle Times, Link: http://seattletimes.nwsource.com/html/localnews/2009658825_mauryisland14m.html

   Judge Martinez Decision http://preserveourislands.org/blog/wp-content/uploads/2009/06/federal-brief-fnal.pdf

Conclusion

A preponderance of the data used for the NWP48 cannot justify expansion of aquaculture in Washington State. Minimal Conservation Measures were recommended and industry is allowed to operate existing sites without environmental monitoring and little enforcement. With the health of Puget Sound at stake, we respectively request that the information we have presented will be considered in this, and future expansion applications. We have provided the following links to study results that have not been included in the NWP48 should be considered for a more balanced policy.

The Social and Environmental Impacts of Industrial Aquaculture in Washington State
http://www.coalitiontoprotectpugetsoundhabitat.com/uploads/Aqua_Sum-12-Dec-R04.pdf

The Association for Responsible Shellfish Farming Aquaculture Studies Report
http://www.coalitiontoprotectpugetsoundhabitat.com/uploads/Aquaculture_Ecology_Summaries_R04.pdf

Sincerely,

Laura Hendricks, Chair
Aquaculture Sub-committee
Sierra Club, Cascade Chapter

Exhibit A

Following is an analysis of the Army Corps Nation Wide Permit 48 Biological Opinion dated October 2007. The names of Environ, Fisher, Pearce (DFO) and Entrix have been highlighted to show the reliance on preliminary science that should not be used for decision making on such an important issue as the health of Puget Sound habitat and all native species. In addition, we have added relevant information that should be considered.

5.1.5. Geoduck culture

Habitat-Forming Processes

Ongoing studies in Canada and Washington are evaluating the effects of intertidal geoduck aquaculture on habitat-forming processes. Recent talks by Chris Pearce of the Department of Fisheries and Oceans in Canada at the B.C. Shellfish Growers Association, and Jeff Fisher, of ENVIRON International at the South Sound Research Conference (http://www.ecy.wa.gov/puget_sound/S4_mar2008/JeffFisher_S4l.pdf) have highlighted the preliminary work from their efforts. (The presentation by Fisher cited, also includes the summary results slides of Dr. Pearce). Prior to the presentation of these efforts, several speakers at the Northwest Workshop on Bivalve Aquaculture and the Environment (Seattle, WA, 13-14 September 2007) remarked that it is hydraulically plausible that the placement of geoduck culture tubes and use of anti-predation netting alters local patterns of sedimentation and erosion, and may alter grain size as well. While anecdotal observations of growers, and the work of Pearce and Fisher have also documented some of these localized effects, they were not considered a significant impact at the level of analysis considered under Washington State's Environmental Protection Act (SEPA) because of the transient and highly localized nature of the effect—lasting only during the period of tube placement, and not resulting in the displacement or degradation of existing habitat important for forage fish, salmonids, or the habitat upon which they depend (Fisher et al. 2008). Notwithstanding, studies in Europe and Canada have examined the effects of anti-predation netting on sedimentation in Manila clam culture and have found varying results; Spencer et al. (1996) found sedimentation four times higher on netted Manila clam plots than on non-netted Manila clam plots, but Munroe and McKinley (2007) found no significant differences in sedimentation or gravel accumulation on paired netted and non-netted Manila clam plots in British Columbia. Kaiser, in a presentation at the bivalve workshop (2007), reported measuring aggradation of up to 10 cm in areas netted for hard clam culture. He experimentally netted some areas with no clam culture and found the same aggradation, indicating that the aggradation is due to the nets, not the clams. In this connection it is worth noting that the use of culture tubes and large nets has attracted unwelcome attention to the industry on aesthetic grounds, and growers are actively seeking less visually conspicuous strategies to protect young clams from predation, such as use of small biodegradable tubes in lieu of reusable PVC tubes and area nets. Thus it is likely that effects on beach topography and water circulation attributable to tube and net use will diminish in the future.[1]

[1] Army Corps Nation Wide Permit 48 Biological Opinion, October 2007, p 5-32.

Comment on Above

In peer reviewed research by L.I. Bendell[2], the following statement is made:

> *The intertidal regions that had been used for farming for 3-5 years had lower species richness, different bivalve composition, abundance and distribution and a foreshore community dominated by bivalves as compared to the intertidal region where no active farming occurred. Beaches that were actively farmed also had a greater accumulation of organic matter and silt.*

To harvest the mature geoduck clam, low pressure, high volume water is injected from 2" diameter hoses which are reduced to 1/2" - 5/8" diameter pvc pipe nozzles which are about 2.5 feet long through small 1/2 to 5/8" diameter hoses (diameter = 1/2 to 5/8") into the sediment The pressure at the nozzle is approximately 20 psi (similar to pressure of a garden hose) and the volume is approximately 40 gallons per minute). This procedure loosens the sediment around the clam and permits retrieval of the clam by hand. It also creates a localized source of turbidity and can dislodge benthic infauna—some of which may perish or be consumed by nearby fish and other organisms, some of which may simply be dislodged and re-embed. It should be recognized that the localized sediment disturbance during an intertidal geoduck clam harvest lasts only during the accessible low tide period—a work window that generally does not exceed 6 (six) hours, and is usually less. Further, given the labor required for this type of harvest, only a small portion of beach can be harvested in a single day —generally no more than about a 10th of an acre at most, assuming a *maximum* sized crew of 6 six harvesters (typical harvest crews are half this number). Usually the area of beach disturbed is significantly less. This level of sediment disturbance is consistent with many types of shellfish harvest techniques that require sediment movement to dislodge the cultured product (e.g., oyster raking, Manila clam digging, etc.). [3]

Comment on Above

A volume of 40 gallons per minute is equivalent to a fire hose used by firefighters and is not considered low impact.

[2] *Contrasting the community structure and select geochemical characteristics of three intertidal regions in relation to shellfish farming*. L.I. Bendell-Young, 2006.
[3] Army Corps Nation Wide Permit 48 Biological Opinion, October 2007, p 5-33.

> Temporarily loosening the substrate might also change the vertical distribution of sediment size classes as found in other studies of experimentally disturbed sediments (Sharma et al. 2000; Dernie et al. 2003); however, in preliminary work by ENVIRON and independently by the DFO the grain size of sediments analyzed after a harvest relative to before harvest did not show a significant loss of fine grained sediments, but rather a slight, but statistically significant increase in the finer grained sediments; this result was contrary to what was expected from the harvest process. The sediment disturbance from a geoduck harvest may share some similarities to suction-dredge excavations used to harvest cockles in Great Britain, as investigated by Kaiser et al. (1996). During suction dredge excavations the sediment structure and grain size distribution were altered, but no such effects were detected 7 months after harvest. Unlike suction-dredge harvesting, however, there is no directed removal of sediments with geoduck harvesting, just a loosening action to permit the removal of clams *without* associated sediment. Anecdotal reports by growers in the action area report that visible effects on beach topography after geoduck harvest are much shorter, disappearing within a few days of harvest due to reworking of surface deposits by waves and tidal currents. These anecdotal reports are supported by tests of sediment firmness conducted by ENVIRON, in which no statistically significant differences were observed in sediment firmness between results obtained directly before a harvest, and the following day, two tide cycles after the harvest (*see* http://www.ecy.wa.gov/ puget_sound/S4_mar2008/ JeffFisher_S41.pdf; Fisher et al. 2008).[4]

Comments on Above

In the 2000 Sharma et al. 2000 paper cited it was stated under "Sources of Error and Limitations" that "Many sources of error are evident in the previously outlined method. [Describing use of the Penetrometer]. The most significant are related to the measurement of the indentation and the variability due to the initial release of the indentor. Normally, the diameter of the indentation can be measured to within +/- 0.25 mm."

In Dr. Fisher's paper, he states: "The diameters of the impressions or indents left by the indentor were measured to the nearest 0.05 mm using Vernier calipers." In addition, Dr. Fisher states: "...we observed that the geoduck clam aquaculture site had firmer substrate..."

However, not pointed out is that, per Sharma et al, the only "substrate" the test - as conducted - would measure is the upper few inches of the sediment. It says nothing about the substrate below the upper few inches. Is this an accurate reproduction of sediment density as described in the Sharma et al paper?

[4] Army Corps Nation Wide Permit 48 Biological Opinion, October 2007, p 5-33.

Water Quality

Chemistry and Turbidity

No peer-reviewed studies have been published that address the water quality effects of geoduck culture, but peer-reviewed results that have received local regulatory review are in the public domain (Fisher et al. 2008). As indicated, the operational effects of geoduck culture on water quality are conceptually similar to littleneck, Manila, and butter clam culture, described above. It is also likely that water quality effects result from the activities of bed preparation and harvest. [5]

Comment on Above

No peer reviewed studies have been published that address the water quality effects of geoduck culture.

Harvest is normally performed at low tide, and less frequently, at high tide by divers. Observation of harvest operations indicates that some turbidity is generated, but that due to the tidal exposure of the work site, there is little direct delivery of runoff to the water column. Measurements of this phenomenon were performed during a geoduck harvest reported by Entrix, Inc. (2004). Those data are reproduced in Table 5-3.

Table 5-3. Water Quality Data Collected During Geoduck Harvesting

	Total Suspended Solids (mg/L)			Turbidity (ntu)		
Distance From Shoreline	Up Current	Below Active Harvesting	Down Current (~100 feet)	Up Current	Below Active Harvesting	Down Current (~100 feet)
5 feet	4.2	266.0	8.5	0.8	75	1.4
25 feet	5.8	48.0	10.4	0.9	35	1.5
50 feet	5.0	7.3	8.0	0.7	1	1

Source: Entrix, Inc. 2004

ntu = nephelometric turbidity units; mg/L milligrams per liter

The data in Table 5-3 indicate that increases in suspended solids concentrations and turbidity are elevated over background close to the harvest activity, but diminish to near background levels at approximately 50 feet down current. These earlier data are consistent with more recent monitoring conducted at two different farm sites (*see* http://www.ecy.wa.gov/puget_sound/S4_mar2008/JeffFisher_S41.pdf; Fisher et al. 2008). In this later monitoring, the total suspended sediment concentrations [6]

Comment on Above

According to the Entrix report, "Because the sampling occurred during the darkness, it was not possible to visually observe the full extent of the sediment plume." This statement be included in the NWP48 analysis.

---

[5] Army Corps Nation Wide Permit 48 Biological Opinion, October 2007, p 5-34.
[6] *ibid*.

> Since the harvest process disturbs anoxic sediments, it could be anticipated that runoff from the harvest area would increase concentrations of fine organic matter, dissolved nutrients, and perhaps some toxic constituents such as hydrogen sulfide. To address this concern in part, ENVIRON examined water quality following the sediment disturbance created during a harvest and found that the harvest resulted in a localized and significant increase in total phosphorous at the point of harvest, but an unexpected and significant reduction in total nitrate and nitrite measurable in the water column relative to upgradient and downgradient background results (*see* http://www.ecy.wa.gov/puget_sound/S4_mar2008/JeffFisher_S4l.pdf). Further studies are needed to explore these water chemistry effects from a mock harvest in locations where no geoduck culture is ongoing in order to determine whether such results are simply typical of *any* sediment disturbance, or are typical of a geoduck harvest. Further, laboratory error resulted in an inability to conclude how ammonia levels might change following a harvest. Regardless, if liberated during a harvest, these constituents should be diluted to background levels at a few tens of feet down current from the harvest location, and this was found to be the case in the recent results of ENVIRON (*see* http://www.ecy.wa.gov/puget_sound/S4_mar2008/JeffFisher_S4l.pdf). Since harvesting impacts occur infrequently (approximately once every 4 to 7 years) and the surrounding habitat is generally mud and silt, the water quality changes associated with harvest are unlikely to adversely affect listed species or their habitat. [7]

Comment on Above

Even though the laboratory results were not available, a positive conclusion was presented.

> infaunal detritivores. Pelagic nutrients in the form of phytoplankton, etc. that are deposited to the benthos as a byproduct of filtration activities as feces and pseudofeces have the potential to lead to a localized depression of oxygenated sediments below the sediment surface (i.e., sediment anoxia) if the site-specific rate of denitrification is exceeded. However, preliminary results from DFO-Canada (*see* http://www.ecy.wa.gov/puget_sound/S4_mar2008/JeffFisher_S4l.pdf) documented no statistically significant differences in sediment redox potential (a measure of sediment anoxia), total nitrogen, sulfides, or organic carbon content of the sediments when compared before and after a harvest; only the percent organics were found to be significantly different after harvest (reduced, as might be expected). Similar studies are ongoing at other farm sites in Washington State, but regardless, such sediment impacts likely have no adverse effects on listed species because of the highly localized and temporal nature of harvest activities. [8]

---

[7] Army Corps Nation Wide Permit 48 Biological Opinion, October 2007, p 5-35.
[8] *ibid*.

> zooplankton and benthic filter feeders (Gibbs 2004). There are no available peer-reviewed studies on geoduck carrying capacity or on bivalve carrying capacity in Puget Sound, nor are there studies of analogous systems that would facilitate our understanding of the potential risk that geoduck productivity may alter Puget Sound food webs in ways that affect listed species. However it is appropriate to recognize this uncertainty and to work toward alleviating it as geoduck culture becomes more widespread in the action area.
>
> The question of geoduck diet is also unresolved. It is known that geoduck primarily filter phytoplankton, but it is expected that other seston, including small fish eggs and certain fish larvae, could also be taken in by the geoduck siphon and perish. If so, then the geoduck, and for that matter all filtering bivalves, could consume the prey of juvenile salmon and forage fish.. There are no data to support this contention, and the question has not been addressed in the literature to our knowledge, but may be relevant, especially since geoduck farms are sometimes sited on beaches below the upper intertidal areas used for sand lance and surf smelt spawning.. It is also worth noting though, that the product of shellfish spawning, the free-swimming veliger larvae of all bivalves--including geoduck, are part of the zooplankton prey base consumed *by* forage fish and (likely) juvenile salmon. These contributions to the planktonic forage base of juvenile marine and anadromous fishes represent an important food source. Similar to the question of whether geoduck compete for planktonic food with juvenile salmonids, the degree to which shellfish plankton is consumed by juvenile salmonids is not fully understood.

[9]

Comments on the two Quotes Above

Citations in the geoduck section often contain information on other shellfish species for comparison purposes due to the limited research available. In published research by McKindsey[10], it is stated that

> *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.*

[9] Army Corps Nation Wide Permit 48 Biological Opinion, October 2007, p 5-37.

[10] *Effects of Shellfish Aquaculture on Fish Habitat*, C. W. McKindsey, 2006 Canadian Science Advisory. Pages 25-26.

Vegetation Community

Evidence indicates that geoduck nets and tubes alter vegetation patterns. Geoduck culture normally occurs on sandy beaches where wave energy is sufficiently high to preclude eelgrass growth. Further, geoduck farms are not planted in eelgrass beds as standard practice. However, Bill Dewey of Taylor Shellfish (Shelton, WA), speaking from the audience at the bivalve workshop (2007), reported a site in Samish Bay where eelgrass began to grow in a geoduck field after tubes and netting had been placed. His inference was that the reduction in wave energy caused by tube and netting placement could permit eelgrass to colonize the site. If eelgrass happens to colonize a previously planted geoduck bed, harvesting will still take place. Under such conditions, the harvesting will more than likely displace individual eelgrass plants. Growers have also anecdotally reported that the tubes and nets are colonized (fouled) by a variety of organisms (such as barnacles and anemones) and macroalgae (chiefly *Ulva*). These biological substrates, by increasing ecosystem structural complexity, probably increase the utility of the tubes and nets as foraging sites for juvenile salmonids and forage fish, but there are no studies supporting this assertion.[11]

Comment on Above

The industry practice of clearing essential marine vegetation is not mentioned in this section. The following pictures document this standard practice by the largest shellfish company in Washington.

North Bay--Case Inlet--Mason County

Aquaculture impacts ecological functions by vegetation removal and elimination of starfish

Shellfish industry workers remove natural vegetation from intertidal zones prior to planting.

Starfish, considered 'predators' by industry, are piled up and killed by being covered with lye.

[11] Army Corps Nation Wide Permit 48 Biological Opinion, October 2007, p 5-38.

> **Benthic Invertebrate Community**
>
> To date there have been no studies of benthos recovery following geoduck harvest. However other studies have examined the effects of activities such as scallop dredging which, like geoduck harvest, disturbs the substrate to a depth thicker than the aerobic sediment layer. Kaiser et al. (2006), reporting on scallop dredging, found that "The biota of soft-sediment habitats, in particular muddy sands, [a]re surprisingly vulnerable, with predicted recovery times measured in years. Slow-growing large-biomass biota such as sponges and soft corals took much longer to recover (up to 8 yr) than biota with shorter life-spans such as polychaetes (<1 yr)." Although areas harvested for geoduck do not contain sponges and soft corals, nonetheless the same principle applies, which is that effects would be most strongly expressed on relatively long-lived sessile benthic organisms. However, this does not include organisms crifical to the life history of listed species, which primarily treat the benthos as a food resource and exploit abundant short-lived organisms residing therein.

[12]

> The above studies examined sediment recovery of benthos in other forms of shellfish aquaculture and point out that no such studies of intertidal geoduck aquaculture have been completed. However, it should also be noted that there are significant data that provide information on how existing beds affect benthic biodiversity *during* the culture operation. In dive studies conducted by Entrix (2004) over three different farms at high tide, intertidal geoduck beds with tubes in place were found to support higher or equivalent macroinvertebrate epifaunal species richness than all control transects, and higher abundance than all but one control transect (*see* http://www.ecy.wa.gov/puget_sound/S4_mar2008/JeffFisher_S41.pdf). They also supported higher richness and abundance than nearby transects over eelgrass beds. Later studies conducted by ENVIRON and independently by DFO have shown effects in infaunal abundance to be similar to epifaunal results: increases in both abundance and diversity during the culture cycle (*see* http://www.ecy.wa.gov/puget_sound/S4_mar2008/JeffFisher_S41.pdf). Not surprisingly, ENVIRON found a reduction in annelid (polychaete) infaunal abundance after a harvest, but all other benthic infauna recorded were still more abundant or comparatively abundant in a recently harvested plot than in the nearby reference sediments (Fisher et al. 2008).

[13]

Comments on the two Quotes Above

Industry continues to actively discourage any mention of the "preliminary" results of the SeaGrant geoduck research funded by taxpayers in HB2220 that could be considered unfavorable to industry, but have at the same time been actively providing other "preliminary" research for the Army Corp NWP48 and other decision makers that justifies intertidal geoduck expansion. While these preliminary, non- statistically analyzed results should be reviewed for comparison purposes, only peer reviewed science should be used when making permit decisions.

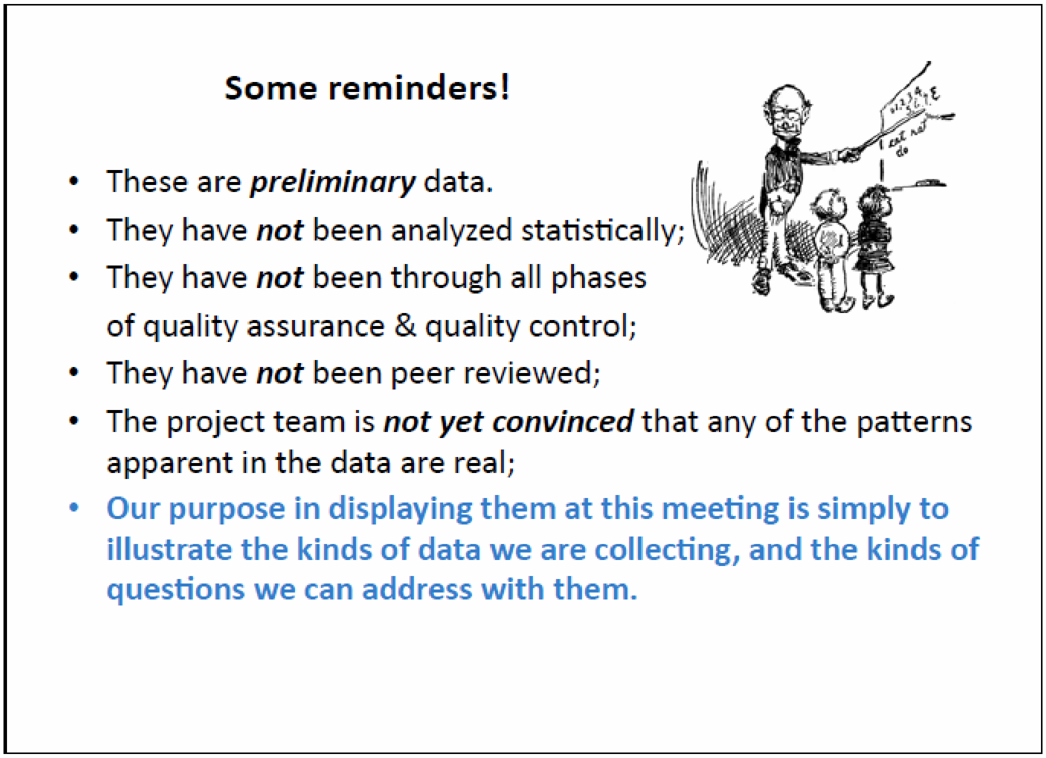
In the "Sound Science Seminar on Geoduck Aquaculture"[14] held in February, 2009, presentations were made by Micah Horwith ("Local effects of geoduck aquaculture on a meadow of intertidal

---

[12] *ibid*.
[13] Army Corps Nation Wide Permit 48 Biological Opinion, October 2007, p 5-39.
[14] http://www.wsg.washington.edu/research/geoduck/soundscience/SeaGrantPlayer.html.

eelgrass in Samish Bay, Washington")[15] and Glenn R. VanBlaricom ("Geoduck aquaculture investigations in Puget Sound: Digging deep for answers").[16]

Professor VanBlaricom qualified his results as follows:



[17]

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, VanBlaricom found a reduction in all densities of infauna, including Corophium and polychaetes (both important food sources for endangered Chinook). Sand dollar size and density were also reduced by geoduck harvest activities. The presence of Sand Lance was also noted in the geoduck site at Foss.

[15] http://www.wsg.washington.edu/research/pdfs/seminars/Horwith_SoundScience_022609.pdf.
[16] http://www.wsg.washington.edu/research/pdfs/seminars/VanBlaricom_SoundScience_022609.pdf.
[17] *ibid*, Slide 10.

Fish Community

Trampling during harvest could impact the eggs of herring, sand lance, and surf smelt, all of which deposit eggs in the intertidal zone. In the Puget Sound region, herring typically spawn between 0 and –10 feet (WDFW 2004a). Eggs adhere to rocks, eelgrass, or other solid surfaces including the protective geoduck tubes. Spawning peaks in February and March (WDFW 2004a). Sand lance spawning occurs from early November through mid-February (WDFW 2004b). Sand lances deposit their eggs in the sand in the high intertidal between +5 feet to about the mean higher high water line (WDFW 2004b).

Surf smelt spawn in the fall and winter months in the Southern Puget Sound and Hood Canal (WDFW 2004c). These fish tend to spawn even higher in the sandy intertidal than other local forage fish, between +7 feet and the mean higher high water line (WDFW 2004c). Thus, the intertidal habitat utilized by sand lance and surf smelt for spawning is higher in elevation than where geoduck beds are planted. Since beds are usually accessed from the water rather than from the shore, impacts related to planting or harvest should be minimal. Herring spawn within the tidal range utilized for geoduck culture. There have been anecdotal reports of herring eggs attached to the protective tubes placed for planting the geoduck spat (Dave Robertson

of Taylor Shellfish, per. comm.). In such cases, tubes are not disturbed in order to avoid adverse impacts to egg development.

Geoduck tube placement, seeding and net installation primarily occurs during low tides between April and September, and thus do not occur during the times of forage fish spawning and egg maturation. Thus geoduck harvest is the only geoduck culture activity potentially affecting forage fish. [18]

Comments on Above

According to the Shellfish Aquaculture Regulatory Committee meeting notes in 2008[19], the following quotes are not consistent with the research conclusions in the above Fish Community section. These statements should be considered if forage fish areas are to be protected.

Brian Phipps, Taylor Shellfish geoduck project farm manager stated when questioned:
(Q): Are they forage fish areas? Brian Phipps (A): I know our plantings don't go above +4 or +5. I don't know. I just plant where they tell me to.[20]

---

[18] Army Corps Nation Wide Permit 48 Biological Opinion, October 2007, pp 5-39-40.
[19] http://www.ecy.wa.gov/programs/sea/shellfishcommittee/index.html.
[20] http://www.ecy.wa.gov/programs/sea/shellfishcommittee/pdf/mtgs/sarc_meetingnotes_may_08.pdf, p 4.

According to Dan Penttila, WDF&W forage fish expert. (Q): Since the protected bays and estuaries are essential for most species, would it be a concern if aquaculture also used those areas? Dan(A): Yes, the intrusion of nearshore/intertidal aquaculture practices into these types of sensitive habitats would be of "concern," since the industry has not paid particular attention to minimizing negative impacts in the past, in my opinion. [21]

In addition, the following statements were made in the report titled Marine Forage Fishes in Puget Sound[22].

> *Adjacent habitats are used as nursery grounds by all three (forage) fish species.* (Page v)
>
> *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.....(WDA) has regulatory authority over aquaculture activities that occur in intertidal areas 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.* (page 16)

Bird and Mammal Communities

There have been no studies to date of the effects of geoduck culture on the bird and mammal communities. However, unconfirmed anecdotal reports record at least three instances of bald eagles having become entangled in anti-predation nets on geoduck culture areas (Coalition to Preserve Puget Sound Habitat 2007). The same source notes an instance of an otter snared by a rubber band used to hold a net on top of a PVC culture tube, and also notes instances of derelict gear including PVC tubes and fragments of netting. The netting, at least, represents a potential hazard to marine birds or mammals that may become entangled or may ingest fragments of the plastic netting material. The WDFW responded to the report of entanglement to indicate that it was an isolated incident and not a concern to the agency.

The principal listed species potentially at risk from entanglement in nets or derelict gear is the marbled murrelet. Other species that could become entangled, such a brown pelican, are unlikely to be exposed to the hazard because almost all geoduck culture is currently performed within the sheltered waters of south Puget Sound, where most listed species, other than fish, are not observed in shallow intertidal environments. [23]

[21] http://www.ecy.wa.gov/programs/sea/shellfishcommittee/pdf/draft_MeetingNotes_03-10-08.pdf, pp 5-6.
[22] http://www.pugetsoundnearshore.org/technical_papers/marine_fish.pdf.
[23] Army Corps Nation Wide Permit 48 Biological Opinion, October 2007, p 5-40.

Comments on Above

The following studies clearly document aquaculture impacts on birds and should be included in future reports:

A Review of the Ecological Implications of Mariculture and Intertidal Harvesting in Ireland , M. L. Hefernan, 1999. Pages 75-92 are most relevant as they outline the impacts of clam and oyster culture on marine birds in particular.

Potential impacts of mechanical cockle harvesting on shorebirds in Golden and Tasman Bays, New Zealand, DOC SCIENCE INTERNAL SERIES 19, Frances Schmechel, 2001. This paper states (on page 17):

> *…there are two main types of impacts likely from harvesting-direct, through removal of cockle biomass and thereby a direct food source of shorebirds and indirect, through impacts on non target species which provide food, or from disturbance to birds of the harvest activity.*

Effects of Aquaculture on Habitat Use By Wintering Shorebirds in Tomales Bay, California, California Fish and Game . This report found that (page 160):

> *Pacific oyster, Crassostrea gigas, culture alters spatial habitat structure by introducing shellfish, racks, stakes, culture bags, marker poles, and other equipment onto open flats.*
>
> *Our results suggest a net decrease in total shorebird use in areas developed for aquaculture.*

> *Habitat-Forming Processes*
>
> Currents, sedimentation, and topography in shellfish culture areas are subject to only minor and short-term changes in response to support activities. Such changes can occur from the operation of motor vessels, which produce temporary changes in water flow; grounding of such vessels during offloading and loading of shellfish, equipment and personnel; and sediment compaction from personnel walking on the beds and equipment being placed or operating on the beds. Although excessive activity of this kind could impair benthic productivity and harm eelgrass or shellfish beds, operators take care to minimize the potential for such impacts by beaching vessels on barren mud whenever possible and by taking care to avoid propeller contact with substrate or eelgrass. Consequently these activities appear to have a minor effect on habitat forming processes.

[24]

Comment on Above

Pictures on websites of Protect Our Shoreline, Case Inlet Shoreline Association and the Coalition to Protect Puget Sound Habitat contradict the statements that "operators take care to minimize the potential for impacts."

[24] *ibid*.

Chapter 6. Conservation Measures

Operations under this permit will comply with the general conditions specified in NWP 48 (Appendix A). Conditions contributing to effect avoidance and minimization are listed below.

- No activity may substantially disrupt the necessary life cycle movements of those species of aquatic life indigenous to the water body, including those species that normally migrate through the area
- Activities in spawning areas (e.g., forage fish spawning areas) during spawning seasons must be avoided to the maximum extent practicable. Activities that result in the physical destruction (e.g., through excavation, fill, or downstream smothering by substantial turbidity) of an important spawning area are not authorized.
- Material used for construction or discharged must be free from toxic pollutants in toxic amounts.
- If any listed species or designated critical habitat might be affected or is in the vicinity of the project, or if the project is located in designated critical habitat, for non-Federal applicants the PCN must include the name(s) of those endangered or threatened species that might be affected by the proposed work or utilize the designated critical habitat that may be affected by the proposed work.

One additional conservation measure is needed. All gravel or crushed rock applied to shellfish beds should be washed prior to use. Washing should occur at an upland location and the wash water not discharged to surface waters unless treated in accordance with applicable regulations for point discharges. The purpose of this conservation measure is to minimize transient turbidity increases that have sometimes been observed during graveling operations.[25]

Comment on Above

These minimal conservation measures allow ongoing direct impacts to the Nearshore where protection and restoration efforts are a main focus of the Nearshore Partnership and Puget Sound Partnership.

[25] Army Corps Nation Wide Permit 48 Biological Opinion, October 2007, p 6-1.

8.6. Direct Effects

The proposed action will modify nearshore habitat within the action area via the following mechanisms:

- Altered substrate distribution including reduced cover of muddy bottom, reduced cover of eelgrass, increased cover of shelly bottom, increased cover of eelgrass/shell bottom, increased cover of shellfish beds, increased cover of eelgrass/shellfish beds, increased cover of sandy bottom, and increased cover of sand/eelgrass beds.
- Placement of raft and suspended culture anchors on subtidal estuarine bottoms.
- Continued operation of existing shellfish culture equipment, including FLUPSYs, mussel rafts, oyster suspended culture systems, oyster longlines, oyster stake systems, oyster rack/bag systems, clam bag systems, geoduck culture tubes, and anti-predator nets on clam ground culture and geoduck culture areas.

Although these effects include localized removal of eelgrass, the proposed action is not likely to result in any long-term change in eelgrass cover. The variations in [26]

Comment on Above

The modification and related direct impacts on the Nearshore in Puget Sound's most sensitive coves, bays and pocket estuaries are contradictory to the goals to improve the health of Puget Sound.

8.8. Conclusions

EFH for Pacific salmon, Pacific coastal groundfish and coastal pelagics may be affected by the proposed action. The proposed action, in conjunction with the conservation measures described in Section 6, would not adversely affect EFH for Pacific salmon, Pacific groundfish, or coastal pelagics. [27]

Comment on Above

The proposed action with conservation measures that are not monitored or enforced cannot be considered to protect EFH.

---

[26] Army Corps Nation Wide Permit 48 Biological Opinion, October 2007, p 8-5.
[27] Army Corps Nation Wide Permit 48 Biological Opinion, October 2007, p 8-7.

Exhibit B

This exhibit has been provided to show how the same preliminary, non-peer reviewed and unpublished research results based on the NWP48 preliminary research also dominate the National Marine Fisheries Service Opinion. Relevant comments on this preliminary data was included in most instances in reviewing the NWP48 Biological Opinion provided in Exhibit A.

The following sections of the NMFS Opinion basically restate what the ACOE Biological Opinion already cited. While it is not a literal "cut-and-paste", it certainly parrots the original unpublished and non-peer reviewed material provided by Environ (Fisher) and Pearce.

> areas. ENVIRON 2008a also found that Pearce et al. (2007) reported similar results in species richness of benthic infauna two months after geoduck were seeded in an aquaculture site in British Columbia, Canada. Increased densities of benthic infauna at intertidal geoduck clam aquaculture sites may persist even after removing the protective PVC tubes and netting. For example, at one aquaculture site in Southern Puget Sound, ENVIRON 2008a, found the average number of infaunal benthic organisms per sediment core from an unprotected seeded area was greater than the density of infaunal benthic organisms found in a reference area located outside of the aquaculture site.

[28]

> recover fairly quickly. Preliminary data developed by Chris Pearce (DFO Canada), as reported by ENVIRON (2008a) suggests that species richness and relative abundance of benthic fauna at a geoduck aquaculture site in British Columbia, Canada were restored to pre-harvest levels within six months.

[29]

> than in unseeded areas. The ENVIRON 2008a also found that Pearce et al. (2007) reported similar results in species richness of benthic infauna two months after geoduck were seeded in an aquaculture site in British Columbia, Canada. Increased densities of benthic infauna at intertidal geoduck clam aquaculture sites may persist even after removing the protective PVC tubes and netting. For example, at one aquaculture site in Southern Puget Sound, ENVIRON 2008a, found the average number of infaunal benthic organisms per sediment core from an unprotected seeded area was greater than the density of infaunal benthic organisms found in a reference area located outside of the aquaculture site.
>
> Some of the various hand or mechanical harvest methods used in shellfish aquaculture each involve a physical disturbance of the bottom that effect sediment and benthic fauna (Johnson 2002). In most cases, bottom disturbance reduces the number and abundance of benthic species in the disturbed area, although the extent of such reductions has been reported variously, including no effect at all. For example, hand raking and digging for various shellfish in Yaquina Bay, Oregon, did not impact infaunal species number and abundance (Straus et al. 2008). Furthermore, while post-harvest reductions of some taxa have been observed at intertidal geoduck aquaculture sites in Southern Puget Sound, sites generally recover after harvest. The recovery rates of benthic communities following physical disturbance depend on a variety of physical, chemical, and biological factors (Dernie et al. 2003), but in general, they recover fairly quickly. Preliminary data from Chris Pearce, of Canada's DFO, suggests that species richness and relative abundance of benthic fauna at a geoduck aquaculture site in British Columbia, Canada were restored to pre-harvest levels within six months (*as cited in* ENVIRON 2008a).

[30]

---

[28] NMFS Opinion, April 28, 2009, p 50.
[29] *ibid*.
[30] NMFS Opinion, April 28, 2009, p 81.

subject to shellfish culture. Growers practice avoidance of these areas until the herring eggs have hatched as noted in PCSGA's Environmental Codes of Practice. Herring spawn in shellfish culture areas is rare in many shellfish areas (e.g., South Sound) and obvious where it does occur (masses of sticky adhesive eggs (Fisher, pers. comm. 11/19/08). Avoidance is a simple matter that does not inconvenience the growers. Therefore, the proposed action is unlikely to reduce the availability of forage at the local or Fifth Field HUC scales, and is unlikely to appreciably reduce the conservation of designated CH. [31]

The harvest of geoduck sites also has the potential to generate a turbidity pulse to the aquatic environment. Harvesting of geoducks by pumping sea water into the substrates to loosen and allow the geoduck to be removed has the surface appearance of creating a considerable sediment plume to adjacent waters. To test this effect Entrix, Inc. (2004) collected water samples during a harvest operation. Harvesting was conducted at different distances from the water's edge and samples were collected up current, at water's edge, and down current from the harvest site. There was a definite increase in TSS or NTU measurements immediately adjacent to the harvest sites when harvest was measured at five feet from the water's edge. When harvest occurred further landward or samples were collected as little as 50 feet down current, however, TSS/NTU measurements were found to be at or near to background (up current) levels. [32]

Comment on Quote Above

The Entrix report quoted above is titled *Programmatic Biological Evaluation of Potential Impacts of Intertidal Geoduck Culture Facilities to Endangered Species and Essential Fish Habitat*, prepared by Cody Fleece, Darin Waller, Jeff Fisher, Jeff Vanderpham, Greg Reub, prepared for Taylor Shellfish, Seattle Shellfish, and Chelsea Farms.

Gregg Reub owned and operated a geoduck farm and was retained by Taylor Shellfish at the time this draft report was written. This 2004 report remains in draft form and was not peer reviewed. The following quote is relevant but missing in the NWP48 conclusion:

> *A visible sediment plume was observed to extend away from the site. Because the sampling occurred during the darkness, it was not possible to visually observe the full extent of the sediment plume.* (see page 4-5)
>
> *Some direct modification of EFH and ESA-critical habitat will arise from the placement of protective tubes and the additional biomass of the planted geoducks.* (see page 5-5)

[31] NMFS Opinion, April 28, 2009, p 58.
[32] NMFS Opinion, April 28, 2009, p 73.

Exhibit C

The Army Corp NWP48 relied heavily for permitting statewide aquaculture on preliminary research provided by Jeff Fisher in response to a SEPA submission for intertidal geoduck aquaculture. The following provides further details.

higher abundance at lower intertidal areas on farm sites compared to reference sites. Given the similar abundance and variety of bivalves at farm and reference sites, it is reasonable to interpret Whiteley and Bendell-Young's (2007) findings as an indication of no loss in ecosystem function at the farm sites during the period they were studied. [33]

Comment on Above

The Whiteley and Bendall-Young study should be reviewed in detail, as it does not support Fisher's conclusion as stated above. The report states

> *Our findings support the hypothesis that predation and competition play minor roles in structuring communities in soft-bottomed environments. Given the potential for cumulative effects of seeding and netting at large scales, a precautionary approach is recommended in future development of intertidal clam aquaculture.*[34]

PVC tubes. Regardless of the type of predator protection, the density of clams planted is approximately 14 clams per m2 and is similar across the site. Of these 14 clams per m2 approximately 66% survive to harvest (9 clams per m2). This density is indeed higher than the average density of geoduck clams calculated from DNR's subtidal census work (2.2 mature clams per m^2), but well within the range of densities that have been found in wild geoduck clam beds. In this case, if geoduck clam seed was added to the PVC tubes and if predator netting was also added, the final yield at harvest would approximate at least 35,000 harvestable (800 g) clams per acre over the four- to six-year growout cycle. This represents a biomass at harvest of [35]

For geoduck clams, very little information on feeding rates exists in the literature. In 2007, through a contract with the Hood Canal Salmon Enhancement Group, J. Davis made some preliminary estimates of geoduck clam feeding rates based on the quantitative biodeposition approach. These studies remain underway through 2008, but provide some preliminary information for both filtration and biodeposit production rates as described below.

Medium Pacific Oysters:	70 L filtration per individual/day 187 mg biodeposit per individual/day
Geoduck Clams (800g live wt)	100 L per individual per day 500 mg biodeposit per individual per day

[36]

Comments on Above

According to Goodwin and Pease, "The average density on un-fished tracts in Washington is 1.7 geoducks/m2, which is equivalent to 6,880 geoducks/acre."[37]

---

[33] *An Analysis of the Environmental Concerns Associated with Intertidal Geoduck Clam Aquaculture*, Fisher, et al, Environ, April 14, 2008, p 12.
[34] http://www.crmc.ri.gov/aquaculture/riaquaworkinggroup/ecological_mariculture.pdf.
[35] *An Analysis of the Environmental Concerns Associated with Intertidal Geoduck Clam Aquaculture*, Fisher, et al, Environ, April 14, 2008, p 14.
[36] *ibid*, p 15.

An unpublished report,[38] states that "The average South Sound subtidal wild geoduck density is .19 per square foot (8,276 per acre). Geoducks are found in the low intertdal to subtidal waters. Existing evidence of deepwater stocks in Puget Sound is limited to two pilot studies of a single area in Case Inlet (South Puget Sound). Although not subjected to peer-review, the video surveys conducted in these studies revealed what appear to be substantial aggregations of geoduck clams starting below the 18-m mean lower low water (MLLW) fishing limit to a depth of 110 m)."

A Washington Sea Grant report[39] states that:

> Cultured geoducks are typically planted in higher densities than the average density in the natural environment: densities in wild aggregations in Puget Sound average 1.7 geoducks per m^2 with a range of 0–22 geoducks per m^2 (Goodwin and Pease 1991), while intertidal culture densities average about 13.5 geoducks per m^2 (J.P. Davis, Taylor Resources, Inc., Quilcene, Washington, pers. comm.). Proximity and spawning synchrony are the [40]

These industry figures are significantly greater than the 35,000 harvestable geoducks that Fisher used to base the filtering and biodeposit figures shown above.

[37] Goodwin, C.L. and Pease, B.C., 1991, Geoduck, *Panopea Abrupta* (Conrad, 1849), size, density, and quantity as related to various environmental parameters in Puget Sound, Washington. J. Shellfish Res. 10:65-77.
[38] (Jamison et al. 1984, Goodwin unpublished. data,
[39] http://www.wsg.washington.edu/research/geoduck/Geoduck_LiteratureReview.pdf.
[40] *ibid*, p 38.

Overall, what we have determined from extensive review of the literature, and preliminary studies completed at several geoduck aquaculture sites in southern Puget Sound, is that recovery of infauna biota from geoduck harvest aquaculture practices occurs within one year of harvest or less, and no significant impacts were observed to aquatic biota or diversity. Some of the main findings from these studies included:

- Biological community effects:
    - After one year of aquaculture activities, annelid densities increased within the harvest vs. reference area at the Foss Farm site in southern Puget Sound.
    - Crustacean densities, though lower compared to the references area, were higher after one year of operations.
    - Overall, diversity was maintained throughout the harvest and seeded areas compared to the reference area after one year of operations.
- Effects on habitats:
    - We found no statistically significant differences between sediment firmness (compaction).
    - Evidence of heterogeneity of grain size, which accurately reflects the dynamics of an intertidal system.

The most consequential study completed in regard to benthic invertebrate recolonization, as a result of intertidal geoduck clam aquaculture, is from Pearce et al. (2007) in British Columbia, Canada. The main conclusions from this study included:

- Two months post-seeding, there was a spike in species richness and density of benthic infauna in sediment cores.
- Six months post-seeding, there was a slight reduction in species density and diversity, which was likely attributable to the different seasons during which the samples were taken (June vs. January).
- Six months post-harvest, there was a return to baseline conditions of species richness, although overall number of individuals per core was slightly lower.
- Overall, the recovery rate varies in response to the timing and magnitude of the disturbance as well as the location of the site to populations of organisms and the mobility of organisms affected.

[41]

Comment on Above

These two reports are filled with preliminary, non-peer reviewed, and unpublished research results. For that reason, it is prudent to determine if bias is present when this preliminary data is used by Fisher for the basis of his following statement: "no significant impacts were observed to aquatic biota or diversity."

[41] A Supplemental Analysis of the Environmental Concerns Associated with Intertidal Geoduck Clam Aquaculture: Effects on Wild Geoduck Genetics, Potential for Toxin Resuspension, and Effects on Soft-Sediment Associated Communities, Environ, Fisher, et al, October 22, 2008.

The following comments were made by Jones and Stokes[42] as they prepared the "Draft Biological Assessment and Essential Habitat Analysis: Nationwide Permit 48 in Washington" Their comments are not consistent with published information that we have provided as shown below.

> *Comment 8:* We look forward to a discussion of the cumulative effects of multiple small impacts, as well as the evidence or lack thereof for long-term effects of shellfish culture on ecosystem services.
>
> *Response:* There is essentially no evidence for additive effects of multiple small impacts attributable to shellfish culture. Shellfish culture, specifically oyster culture, has been a well established activity in Willapa Bay since the 1850's, and for nearly as long in Humboldt Bay, California. Both estuaries have remained highly functional throughout that time period. In particular, both have retained exceptional value as rearing habitat for juvenile salmonids, and Willapa remains one of the most productive rearing areas in Washington. Shellfish growers attribute this to their zealous defense of water quality; excellent water quality is an absolute prerequisite for successful shellfish culture. Consideration of the historical record reveals that shellfish culture has had some notable adverse impacts on the Willapa Bay ecosystem, primarily the introduction of the aquatic weed Spartina (introduced in the late 19th Century as a packing material for introduced oyster seed) and the replacement of the native Olympia oyster with non-native oyster stocks. However, these are not cumulative effects but major discrete events, and mechanisms have been created (discussed in Chapter 2 of the BA) to prevent recurrence of such events.
>
> There remains the possibility of additive effects of small actions altering habitat in areas subject to other types of shellfish culture, such as clam and mussel culture. Such practices have been performed continuously for a century or more in various waters of eastern North America and northwest Europe that are comparable to the marine environments of western Washington. However, we have not identified any literature addressing the question of cumulative long-term

[43]

Comment on Above

The published information below is not consistent with the information above. The change in the ecology of Willapa Bay and change in ecological functions in Puget Sound are not necessarily beneficial.

> *Willapa Bay is locally proclaimed a pristine estuary. This claim undoubtedly stems in part from relatively low development of its shores – only about a third of the high marsh has been lost to diking and filling. Few chemical pollutants enter the bay, which has no major industrial ports. The "pristine" moniker fails, however, when it comes to introduced species. About 40 new species of algae and invertebrates inhabit the bay, some of which were purposely introduced, but most entered accidentally with shellfish or ships. In fact, these species include several that have wholly transformed the biological habitat of the bay: Pacific oysters, which can form large reefs of hard substrate in the midst of vast mudflats; smooth cordgrass, which has extended the salt marsh down a vertical meter or so; and Japanese eelgrass, a*

[42] Jones and Stokes Letter to Corrie Veenstra, USACE, Subject: Response to Services Comments on NWP48 BA for Washington, January 10, 2008.
[43] ibid, p 4.

small eelgrass species that has vegetated mudflats below the cordgrass. Willapa Bay is clean, certainly, but also biologically transformed.[44]

The following information on Salmon Recovery contradicts the statement in Jones and Stokes.

Shellfish aquaculture in South Sound alters plant and animal assemblages and results in the loss of shallow nearshore habitat and habitat diversity important to salmon resources.

We hypothesize that shellfish aquaculture reduces productivity, abundance, spatial structure, and diversity of salmon populations.[45]

> *Comment 19*: Include a summary of shellfish culture effects on plankton productivity.
>
> *Response*: Shellfish culture effects on plankton productivity are described briefly on page 5-8 of the BA. It is possible to go into considerable detail on this subject. One beneficial effect of shellfish culture appears to be to dampen otherwise extreme natural fluctuations in plankton productivity. Estuaries that have lost a large fraction of their shellfish populations, such as Chesapeake Bay, are vulnerable to short, intense phytoplankton blooms followed by mass mortality of the phytoplankton and the zooplankton that feed upon them. Healthy bivalve populations prevent that outcome by consuming a portion of the phytoplankton and recycling some of the nutrients back into the environment.
>
> Shellfish effects on plankton productivity can be measured. In 2003, the Pacific Shellfish Institute completed a comprehensive two-year study to evaluate phytoplankton abundance and seasonal change within and surrounding a mussel raft farm in southern Puget Sound. This farm has 8 multiple suspended culture units with a total surface area of one acre and a stocking density at harvest size of 240 tons. While phytoplankton abundance was on average 56.3% lower in the center of the raft units, the feeding effects on phytoplankton were localized and contained in the immediate raft system. Despite reductions in phytoplankton abundance within the mussel unit, phytoplankton concentration and community composition outside the raft system did not differ from reference conditions (PSI, 2003).
>
> In a mesocosm study in Rhode Island, Pietros and Rice (2003) specifically investigated the "overgrazing hypothesis" that oyster populations can deplete phytoplankton. They found that "based on rates of ammonia excretion by oysters and observed steady states of ammonia and other forms of inorganic nitrogen in mesocosm tanks, it can be hypothesized that ammonia generated by oysters is taken up by rapidly regenerating phytoplankton in the water column." They concluded that oysters had no net effect in terms of depleting phytoplankton populations, but that oysters can produce changes in the relative abundance of different phytoplankton species.

[46]

---

[44] http://depts.washington.edu/jlrlab/historical.php

[45] The South Puget Sound Salmon Recovery Group, review for Shared Strategy for Puget Sound, 2004, pg. 48(45). See Chart: http://www.protectourshoreline.org/articles/ChinookBullTrout_Recovery_SPS_Draft2_ShellfishAquacultureStressors.pdf

[46] Jones and Stokes Letter to Corrie Veenstra, USACE, Subject: Response to Services Comments on NWP48 BA for Washington, January 10, 2008, p 7.

Comment on Above

The majority of aquaculture in Puget Sound are located in the intertidal areas. Using one subtidal study on a group of mussel rafts does not adequately answer the question of phytoplankton depletion especially in coves, bays and pocket estuaries. Also, it was not mentioned that the draft Totten Inlet/Taylor mussel raft EIS showed low dissolved oxygen under these rafts which is a direct impact.

In the interview described above, when asked how common this situation is, Dr. Newell replied that it has often been seen in experimental situations where the experimental chambers do not contain populations of denitrifying bacteria, and that the situation might be encountered in natural settings with extremely high shellfish biomass loadings.

The shellfish biomass loadings encountered in western Washington are of the same order as the loading created by natural oyster reefs observed in early historical time, so the phenomenon would not be expected in western Washington waters.

Comment 57: 30) Page 5-16, Lines 34 -39: This is perhaps true for the regions where the Olympia oyster was found. However, oyster culture occurs all over the Puget Sound region and so aerobic/anaerobic sediment stratification is likely occurring on a much greater scale. This is one reason why it is critical that we know the scale of the action under consultation.

Response: See response to comment 3 in regard to the spatial scale of the analysis. Nonetheless, the great majority of oyster production in Washington waters is from Willapa Bay, Grays Harbor and south Puget Sound, areas where the Olympia oyster was formerly very abundant.[47]

Comment on Above

According to WDF&W, there are no published reports that support the statement "The shellfish biomass loadings encountered in western Washington are of the same order as the loading created by natural oyster reefs observed in early historical time."

[47] *ibid*, p 15