PROTECT HENDERSON INLET
*Preserve and restore*

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July 20, 2023

Thurston County Planning Office
Attention: Abbie Adams Assistant Planner
Brett Bures Building and Planning Manager

RE: Aquaculture project # 2022103702

Mr. Bures and Ms. Adams:

Please note that both the non-profit organization Protect Henderson Inlet (PHI) is registered with your office as interested parties concerning the above-noted aquaculture permit application. PHI is an alliance of interested citizens, environmentalists, scientists, and recreational users who are concerned about current and expanding aquaculture in both the nearshore environment and public waters, and its impact on aquatic plants, animals and ecological function. Please enter this document into the public record and consider it the opinion of the organization.

This response to the 10-page letter from Taylor Shellfish dated 31 January, 2023 is delayed because I received it only by public records request on June 2nd, 2023. This letter was not uploaded to your public website until sometime in mid-June. Several prior records requests did not disclose the Taylor letter.

## Summary

This is a response to Taylor Shellfish's letter to the Thurston County Planning Office of 31 January, 2023. In that letter, Erin Ewald of Taylor Shellfish repeats assertions that scientific research supports their method of geoduck aquaculture. In fact, science does not support their claims. The environmental impacts of geoduck aquaculture vary from highly significant to unknown, but never insignificant as Taylor would have you believe. This document outlines the campaign of Taylor Shellfish to mislead the permitting authorities about the environmental impact of their geoduck methodology; Taylor has previously been highly successful in convincing the Planning Department to allow its substantial developments. Their past administrative successes should not prevent the Planning Department and Hearing Examiner from taking a fresh look at the science and making an independent assessment.

Before delving into the details, consider this: in the "big picture", the ideal benefits of allowing this permit could be jobs, food for the locals, tax revenue, and profit for the business. Unfortunately, Taylor hires **mainly low-wage employees** for this back-breaking beach work and even had to settle a case of racial discrimination in 2017.
https://www.eeoc.gov/newsroom/taylor-shellfish-pay-160000-settle-eeoc-racial-harassment-suit
Taylor will pay almost **no local taxes** for this site. They will **produce virtually no local food** now that they have removed Manila clams and oysters from the permit application; the entire geoduck crop will be exported. The owners do stand to make a **profit of somewhere between 1 and 2 million dollars per acre every 5-7 years**. That's not illegal, but what do the citizens get for the use of their public resource, the nutrient-rich water of Henderson Inlet? The answer is **virtually nothing**. Worse than that, we the citizens bear the risk of damage to our ecosystem from Taylor's actions.

There are many more arguments that can be made against the granting of this permit. Pyke Johnson, a local resident near the proposed site makes an eloquent argument based on human needs in this King 5 news report from 11 July 2023:
https://www.king5.com/video/tech/science/environment/olympia-homeowners-raise-environmental-concerns-over-proposed-geoduck-farm/281-2ddab705-334a-47cb-945b-741f56eb9635

David Hall will lose access to the beach where he has sponsored natural marine education for thousands of students, as outlined in this article in The Olympian on 10 July, 2023
https://www.theolympian.com/news/local/article277117643.html

There are many conflicts with the goals of the Shoreline Master Program that have been pointed out by citizens in letters to the County. There is a significant conflict between the existence of the special taxation district of Henderson Inlet and the granting of unlimited utilization of our clean water by Taylor Shellfish, which does not participate in our financial obligation to ensure clean water. Arguments against this permit are being made by many citizens, and I urge you to give consideration to all of them.

This response will focus on the specific errors that Taylor Shellfish makes in the use of science to try to substantiate their arguments. Especially important in this regard is an analysis of the Geoduck Aquaculture Research Project report and the environmental concerns raised by that report.

## Introduction

The Taylor letter attempts to rebut the many citizen comments that have been filed with the county opposing the geoduck aquaculture project 2022103702. In Taylor's Section A., purported to be based on research, they have used many of the same false claims as on

multiple previous permit applications. Taylor has habitually misrepresented the scientific data to the County, and I believe that the County has not realized the extent of this influence. This misrepresentation of scientific facts has also very likely influenced prior Shoreline Hearing Board rulings. This document will explain why the Planning Office and the Hearing Examiner should take a fresh, independent look at the scientific data and consensus reports; indeed, these comments are based on the same documents that Taylor falsely uses to try to justify its actions.

Protect Henderson Inlet (PHI) does not oppose all aquaculture; however, more environmentally safe methods are needed in commercial aquaculture to protect our marine waters, and these methods will certainly be found when commitment is made towards proper research. PHI recognizes that oysters and other non-geoduck clams have been cultivated in northwest waters for thousands of years; we recognize the rights of indigenous peoples to continue that tradition. Likewise, there is a 100+ year history of non-tribal oyster cultivation in Puget Sound that should be allowed to continue, with recognition of cumulative impacts and the limits of our ecosystems as well as the ongoing investigation of more environmentally friendly practices.

PHI is not opposed to the cultivation of geoduck for sale, but is strongly opposed to the current methodology. Cultivation involves massive implantation of plastic tubes into the beach, dense planting of hatchery stock, and liquification of the beach for harvest. Based on review of the available science, we believe this methodology to be unsound and sorely understudied. There simply is not enough *quality* science to justify this very new and explosively expanding cultivation method.

I am a scientist. I have a Bachelor of Science in Biology which included marine studies and a Doctorate of Medicine. Based on my decades of experience in evaluating scientific studies, I will describe in detail the reasons why Taylor's claim that "impacts from geoduck farms would be insignificant" is a false claim made by lawyers and business administrators, not scientists. Look for the science in section B.

**Section A:** specific comments about the Taylor letter:

- The first paragraph states that the Bush Act was passed by the State of Washington "for the express purpose of *shellfish* cultivation". **Untrue.** The Bush Act of 1895 was passed for the express purpose of **oyster** cultivation – no other shellfish were included for over 100 years. The Act underwent revisions during the next century, even repealed in 1935, and was only modified in 2002 to allow geoduck cultivation, solely because of lobbying by the shellfish industry. It is very interesting to read the notes from the legislation. https://lawfilesext.leg.wa.gov/biennium/2001-02/Htm/Bill Reports/House/2819-S.HBR.htm?q=20210422040439
  There was testimony from three commercial shellfish growers in favor (Bill Dewey of Taylor Shellfish, Brett Bishop of Little Skookum Shellfish, and Jim Gibbons of Seattle Shellfish) plus one DNR manager – there was no opposition. Did anyone outside the industry understand that a major revision was taking place?

There were certainly problems with the implementation of the various revisions of the Bush Act which adversely affected shellfish growers (see this Seattle Times news article https://archive.seattletimes.com/archive/?date=20020203&slug=tidelands03m), and clarification needed to be made. However, I submit that only the growers knew that the result of the revision would be opening the floodgates for geoduck aquaculture – they took advantage of the situation and made plans for a highly profitable future in geoduck farming. It must be remembered that when the code was revised in 2002, geoduck aquaculture was brand new. Indeed, major concerns about this invasive method of cultivation quickly prompted the legislature to fund the Sea Grant Geoduck Aquaculture Research Program (GARP) in 2007, with the final report issued in 2013. The GARP report provided a great deal of useful information, but Taylor habitually misstates that report's conclusions and quotes results out-of-context. A full critique of the GARP study follows.

- Page 4 second paragraph states "The SHB (Shellfish Hearing Board) has recognized Washington Sea Grant as the authority on the environmental impacts of geoduck farms. Specifically, in finding that the aquaculture gear and harvesting activities of a newly permitted geoduck farm will not likely cause adverse environmental impacts, the SHB relied on Washington Sea Grant, acknowledging 'it is the most specific and relevant scientific information currently available on this subject.' SHB No. 14-024 (FF 17)".

  Let's accept that part of that statement that says the GARP report is the best currently available. When one actually reads the report, it **does not** state anywhere that aquaculture gear and harvesting activities are unlikely to cause adverse environmental impacts. In fact, **it states the opposite.** Because Taylor says that the report supports geoduck aquaculture, doesn't make it so. Also, keep in mind that the GARP report is now 10 years old. Again, a full critique of the GARP report follows.

- Page 4, 3rd paragraph cites the 2016 Programmatic Biologic Consultation from the Seattle US Army Corp of Engineers (COE), National Marine Fisheries Service (NMFS), and the Washington US Fish and Wildlife Service (USFWS). The results of these reports are also grossly misstated by Taylor, and the reader is encouraged to look at the documents for themselves. Essentially, the COE asked the NMFS and USFWS to consult on their plan to continue issuing blanket permits for aquaculture (NWP 48). From reading the documents, it appears that both the NMFS and USDFW had significant concerns about the plan.

  https://www.nws.usace.army.mil/Portals/27/docs/regulatory/160907/NMFS_2016_09-02_WA Shellfish Aquaculture_WCR-2014-1502.pdf

  This link includes the report by the NMFS and starts with a letter from William Stelle, Jr., Regional Administrator of National Oceanic and Atmospheric Administration (NOAA) NMFS to the COE describing the important aspects of the programmatic biological opinion (PBO). It states that the proposed action (general expansion of

aquaculture) is not likely to jeopardize continued existence of ... Canary Rockfish..., "NMFS also concludes that the proposed action is likely to **adversely affect** Puget Sound Chinook Salmon, Hood Canal summer-run chum salmon, North American green sturgeon and their critical habitat, but is not likely to jeopardize the continued existence of these species or to adversely affect their critical habitat." An adverse effect is a serious problem, especially when we are considering **Chinook salmon**, which have been increasingly recognized as critical for survival of the **Southern Resident Orcas**. Bad, but I guess not so bad that they would be pushed to the point of extinction. An adverse effect on Chinook salmon is truly an unacceptable outcome.

While NMFS does state that they did not predict an adverse effect on orcas, keep in mind that this is a 7-year-old report, and it is very likely that the loss of *any* Chinook salmon would be viewed differently in 2023, since it is now more widely recognized that the endangered Southern Resident Orcas rely solely on Chinook salmon.

Indeed, the report does *require* extensive conservation measures. Taylor again mischaracterizes this as "*identified* 30 conservation measures that shellfish farmers *could* take...". What the letter actually says regarding incidental take is "The Take sets forth *non-discretionary* terms and conditions, including reporting requirements, that the Federal action agency *must comply with* to carry out the reasonable and prudent measures."

This is a good time to mention that the Corp of Engineers and Taylor Shellfish, after spending millions on legal fees later lost a lawsuit in Federal Court over this same blanket issuance of aquaculture permits for failing to require local mitigation, exactly the type of requirements mandated by the NMFS in the report cited by Taylor. This 2019 ruling, including a **scathing rebuke of Taylor and the COE** by Judge Lasnik may be viewed here:

https://protecthendersoninlet.org/us-district-court-seattle-judge-lasnik/

**Judge Lasnik goes into extensive detail about how the COE and codefendant Taylor misconstrue the evidence.**

Under the heading DISCUSSION :
"Having reviewed the submissions of the parties and the administrative record, and having heard the arguments of counsel, the Court finds that there is insufficient evidence in the record to support the agency's conclusion that the reissuance of NWP 48 in 2017 would have minimal individual and cumulative adverse impacts on the aquatic environment for purposes of the CWA (Clean Water Act) and that the Corps' environmental assessment does not satisfy NEPA's (National Environmental Policy Act) requirements. Although the minimal impacts finding is repeated throughout the Corps' Decision Document (see NWP003038, NWP003045-46, NWP003049, NWP003051, NWP003091, NWP003107), it is based on little more than (1) selectively chosen

statements from the scientific literature, (2) the imposition of general conditions with which all activities under nationwide permits must comply, and (3) the hope that regional Corps districts will impose additional conditions and/or require applicants to obtain individual permits if necessary to ensure that the adverse impacts will be minimal."

**The comments from Taylor Shellfish in their 31 January, 2023 letter follow an identical pattern of misinformation.**

Moving on to the report from the Washington Department of Fish and Wildlife which assessed the expected results of expanding aquaculture between 2016 and 2036.

https://www.nws.usace.army.mil/Portals/27/docs/regulatory/160907/USFWS_Final BiOp_AQ 20160826.pdf

This is another huge report, 265 pages in length, which I believe Taylor hopes that nobody actually reads. Its conclusion focuses on the likelihood that shellfish aquaculture would have a significant impact on the Marbled Murrelet and Bull trout, both endangered species, covered by the Endangered Species Act (ESA). They thought there was no threat to those two animals, but their document expansively describes the threats to all species and raises major concerns about the health of Puget Sound's marine habitat. There are many examples in the documents, but here are some:

Page 99
**"All or nearly all of the shellfish activities covered under this programmatic Opinion result in measurable and potentially significant effects to water quality, substrate condition, physical habitat structure and function, benthic/epibenthic community structure and composition, and predator-prey dynamics."**

Page 137
"Greene et al. (2012) published a report evaluating the status of the Puget Sound's nearshore pelagic foodweb, a multi-trophic level assessment in six oceanographic basins. Greene et al. report (2012, pp. 4, 43):
"Hood Canal and **south [Puget] Sound were rated the lowest [or least 'healthy'] in our system** ... "
The work and findings reported by Greene et al. (2012) provide a useful context in which to consider available information regarding Puget Sound carrying capacity and the potential effects of intensive shellfish aquaculture. However, despite the growing interest in this topic, **to date there has been little work performed that evaluates a scenario of pervasive and extremely high shellfish culturing densities in Washington's inland marine waters."**

Regulated shellfish activities in Washington State, specifically those for which this Opinion provides programmatic coverage, are likely to directly or indirectly affect **more than 45,000 acres** of nearshore marine habitat (45,000 to 50,000 acres in total; Willapa Bay: approx. 30,000 acres; Grays Harbor: approx. 4,000 acres; north Puget Sound: approx. 5,000 acres; **south Puget Sound: approx. 5,000 acres**; and, Hood Canal: approx. 3,000 acres). Regulated shellfish activities in Washington State also include subtidal wild geoduck harvest (a maximum of 6,050 acres per year in Hood Canal and Puget Sound). There can be no question that the Shellfish raising activities described here represent high culturing densities in Washington's inland marine waters. South Puget Sound leads the nation in the number of acres of intertidal geoduck cultivation, and Washington is the only State in the US that allows the massive use of plastics for this type of aquaculture. Is this good stewardship?

In summary, the reports from NMFS and Washington DFWL both paint a vivid picture of a degraded Puget Sound and describe significant impacts upon the Sound from commercial aquaculture, admonishing the Corp of Engineers to be diligent in their requirements for oversight, which the COE failed to do. So, this is yet another example of Taylor twisting the words of government and scientific reports to support its desire to massively expand aquaculture. It should not be allowed.

Again, the reader is strongly urged not to take Taylor's assertions at face value, or mine for that matter. **Please read the documents.**

## Section B: Why no further geoduck aquaculture permits should be granted until further research is performed.

There are three main reasons:

1) **Lack of sufficient scientific research into geoduck harvest methods, obscured by misinterpretation and misapplication of the findings of the GARP report by Taylor Shellfish.**

2) **Massive use of plastics not proven safe for the environment with an especially high risk of loss to the environment at site 2022103702.**

3) **Near complete ignorance of the genetic effects of hatchery geoduck on wild stocks, in spite of warnings in the 2013 Sea Grant Geoduck Aquaculture Research Program report (GARP).**

## 1: The GARP Report

**What is GARP?**

The technique of geoduck aquaculture was developed by University of Washington scientists in the 1990s and subsequently given over to industry which implemented commercial applications. By 2007, there was significant concern about the potential impact of geoduck aquaculture, which is done by implanting plastic tubes containing hatchery juveniles and later liquifying the beach with hydraulic jets to excavate the adult clams. The legislature mandated investigation because of the invasive nature of the methodology, and it commissioned the University of Washington to review the scientific knowledge base and come up with recommendations. Based on UWs review, the legislature stipulated the evaluation of "key uncertainties" and 6 priorities were established. Results were to be published before the end of 2013. The reader is encouraged to **carefully read this report**, the major elements of which are **only 11 pages**.

https://wsg.washington.edu/wordpress/wp-content/uploads/publications/Geoduck-Final-Report-Dec-2013.pdf

**What did they do?**

UW Sea Grant authorized studies for only three of the six "required" priorities, which were to look at the questions of 1) the effects of structures used in geoduck aquaculture 2) the effects of commercial harvesting 3) naturally occurring diseases and parasites in the existing geoduck population. They did recruit additional science already in progress to look at genetic interactions between cultured and wild geoducks addressing a 4th priority. They did not reproduce that actual research in the report, but made significant recommendations based on thorough review of those studies. The other two questions pertained to the extent of alteration of waters overlying a geoduck site and the impact of sterile triploid geoduck hatchery stock were simply not addressed. **Why not?**

**What did it cost?**

Total cost was $1,550,357. For this, the taxpayers got three peer-reviewed scientific studies and analysis of a fourth.

**What did the studies show?**

The GARP funded scientific study with greatest impact on aquaculture was *Resilience of Soft-Sediment Communities after Geoduck Harvest in Samish Bay, Washington authors Horwick and Ruesink of UW.* They evaluated the response of native eelgrass to geoduck aquaculture using reference plots to compare before and after effects. The **findings were dramatic with 44% reduction of eelgrass after harvest and complete loss 1 year later.** Equally important but now completely ignored, is that the authors noted **post-harvest decrease in abundance, richness, and diversity of other species** which they could not explain solely on the basis of loss of eelgrass biomass. They suspected additional impacts were present beyond those on eelgrass, and suggested further research. Because of these findings, eelgrass surveys are required for all aquaculture permits, but no follow-up based on the authors' suspicion of more extensive effects of geoduck aquaculture has been done that I am aware of.

The study *Ecological Effect of the Harvest Phase of Geoduck Clam Aquaculture on Infaunal Communities in Southern Puget Sound, Washington was eventually published in the Journal of Shellfish Research in 2015.* The 2013 GARP report includes a pre-published version. It is important to read the actual published and peer-reviewed scientific paper, as there are many important details that are not evident from reading this GARP summary. The authors conclude that 1) the sites of the study were so diverse that it limited the ways they could look at their data. 2) They didn't see a statistically significant numbers reduction or decrease in biodiversity from geoduck aquaculture harvest 3) They didn't see a statistically significant spill-over effect on adjacent plots.

These findings are stated out of context in the Taylor letter and do not appear in the conclusions of the GARP report. A major problem with this study is that it appears to ignore some of the data, and it lacks statistical strength. **The study only looked at 10 of 50 species**, essentially ignoring the rest. Of those 10, 3 (30%) were significantly diminished in number, although those species did not "approach local extinction". They did not identify a "sentinel species", one that could be followed to assess the overall health of the ecosystem. These kinds of limitations are common in *early* research, and it is normal to expect that additional work will be needed. This is why the GARP report in its conclusions, called for cumulative studies. Unfortunately, the follow-up work was not done. You may see a more complete review of this article including a link to the full-text version in Appendix A, critique 2.

The next study considered is *Effect of Geoduck Aquaculture Gear on Resident and Transient Macrofauna Communities of Puget Sound, Washington published in the Journal of Shellfish Research in 2015.* It concludes that geoduck aquaculture significantly affects the abundance, but not the biodiversity of species at the site. This paper has very similar problems to the first one in that it **analyzed only 12 of 68 species identified.** The research did not even include an assessment of the harvest phase. The paper is appropriately self-critical, describing how it is limited because it did not assess cumulative effects, was not designed to include salmonids, and suffered effects from "seasonal biofouling by macroalgae" on geoduck hardware. In the abstract, **the published paper calls itself a "first look" and calls for further studies.** Again,

these limitations are expected in early research, but that doesn't allow science to skip the follow-up. Please see a more complete critique here with a link to the complete published paper in Appendix A critique 1.

The last GARP funded study about parasites *Characterizing Trends of Native Geoduck Endosymbionts in the Pacific Northwest eventually published in The Journal of Shellfish Research* is basic research that may someday prove helpful. They describe newly recognized parasites and say that it's good to know about them in case there ever is an outbreak, but doesn't make any predictions or offer recommendations about risks of parasites in cultured geoducks on wild stocks.

**How did the GARP report summarize its conclusions?**

When I review the two-page section 4 of the GARP report "Research Priorities & Monitoring Recommendations", **it makes me wonder if anyone actually *read* it.**

The very first defined **research priority** is "**Cumulative effects of geoduck aquaculture**". The highest priority recommendation was for further research to see if keeping a geoduck aquaculture site in one place or adding others nearby had a significant effect. They recommended developing predictive models "1) to evaluate direct and indirect ecosystem effects in scenarios involving future increases in the extent of geoduck aquaculture and 2) identify appropriate indicator species that reflect the broader status of ecosystem health in response to geoduck aquaculture expansion." Have either of these been done? 10 years later, **NO**. The report does NOT conclude that geoduck aquaculture is environmentally safe, although specific elements of the report that may seem to say so are often cited out of context.

Equally important, Section 4 goes on to raise major concerns about the effect that hatchery geoduck plantings may have on wild geoduck stocks. By planting millions of hatchery juveniles, the potential to adversely affect the genetic pool of wild stocks was thought possible. These are two studies published in this timeframe, presumably the source for the report, but not specifically stated:
Maturation, Spawning, and Fecundity of the Farmed Pacific Geoduck *Panopea generosa* in Puget Sound, Washington, Journal of Shellfish research, Vol 34, 2015

https://www.semanticscholar.org/paper/Maturation,-Spawning,-and-Fecundity-of-the-Farmed-Vadopalas-Davis/80b295ed4791c9c4f34d9c947cd29c639932992c

Reduced Genetic Variation and Decreased Effective Number of Breeders in Five Year-Classes of Cultured Geoducks (Panopea generosa), Journal of shellfish research, Vol 34, 2015

https://bioone.org/journals/journal-of-shellfish-research/volume-34/issue-1/035.034.0120/Reduced-Genetic-Variation-and-Decreased-Effective-Number-of-Breeders-in/10.2983/035.034.0120.short

The first study found that cultivated geoducks are capable of spawning within 2-3 years of planting and could certainly mix with natives. The second study recommended procedures to increase genetic diversity in hatchery stock and suggested that the use of triploids should be considered to protect wild geoduck populations from genetic impact. Neither study suggests that the wild geoduck population is free from the risk of genetic alteration from hatchery stock. This is the same scenario that led to reduced survival of wild salmon because of the rearing of hatchery fish.

Back to the GARP report – referring to reproductive contribution from geoduck farms, it states "almost nothing is known about settlement of juveniles". They further go on to say "investigating triploid geoducks is critical for understanding the extent to which triploidy could help prevent genetic change to wild stocks". For those unfamiliar with the term, triploidy refers to a genetic modification which renders the clam sterile.

The GARP report outlines great concern for a genetic impact on wild geoduck from hatchery stock, yet 10 years later this question is unresolved. We do see rapid expansion of commercial geoduck farming with seemingly little concern for its potential harm.

**GARP Critique Summary**

Although industry claims that the GARP report supports their methods of geoduck aquaculture, it actually does nothing of the kind. It raises more questions than it answers.

The GARP report gave strong evidence of the detrimental effects of geoduck aquaculture on seagrass and raised suspicion that effects on the environment were greater than on just eelgrass. Researchers recommended that these other possible effects should be investigated.

Although genetic studies about the potential impact of hatchery geoduck on wild stocks were not obtained within the program, the compiling scientists of the GARP report assessed outside scientific studies and recommended both caution and further investigation.

The studies about planting and harvest techniques included in the GARP report are described by industry as definitive for establishing geoduck aquaculture as safe for the environment. On detailed review, these studies are significantly limited and do not have the scientific weight necessary to substantiate the marked expansion of geoduck aquaculture that has taken place since 2013. We simply do not know many of the answers. In particular, the strong recommendation to obtain cumulative, long-term studies has not been met. At best, the studies suggest that the beach is pretty resilient and *might* recover from insults *if allowed*. There are currently no requirements for requiring a permitted beach to remain fallow for recovery.

A reasonable question to ask Is why UW scientists aren't speaking up about the shortcomings of the GARP report. I don't know, but I speculate that it's because the State legislators spent significant taxpayer money and expected to get a definitive answer; UW scientists did what they

could in the 6 years given, but it wasn't enough time to answer all the questions. Politics being what it is, nobody wanted to say that the job would take more time and more money. UW certainly doesn't want to say they didn't get the job done (btw, they didn't get the job done). UW has the prestige of housing the "Sea Grant" people, their research programs benefit from that and I'm sure they wouldn't want their status to be impacted. Moreover, the industry has convinced government that aquaculture is vital to our future (**useful, not vital**). Repetitively making untrue assertions about the GARP study, Taylor tries to make them into fact. It is unfortunate that the same UW scientists whom we should be relying on to correctly explain the science to citizens and government, and to stand-up for the environment, are silent.

Finally, it should be noted that one of the major concerns of environmental activists, plastics in the environment, was not a priority at that time and was not even mentioned in GARP. The following section was written in response to false and misleading information conveyed to the Thurston County Planning Commission.

## 2: Plastics in the Environment

The shellfish industry argues that "Plastic Aquaculture gear is not a threat to Puget Sound" in a paper submitted to the Thurston County Planning Commission during the commission's review of the Shoreline Master Plan in 2021. A copy of that document is available for review.

https://s3.us-west-2.amazonaws.com/thurstoncountywa.gov.if-us-west-2/s3fs-public/2023-02/cped-board-pc-written-comments-received-for-12.02.2020-final.pdf

This paper makes many false and misleading statements and is reviewed in detail here. Each of the "Items" listed below is a false statement made in that paper written by Ramboll Environ US Corporation of Seattle Washington, who is a paid consultant for Taylor Shellfish.

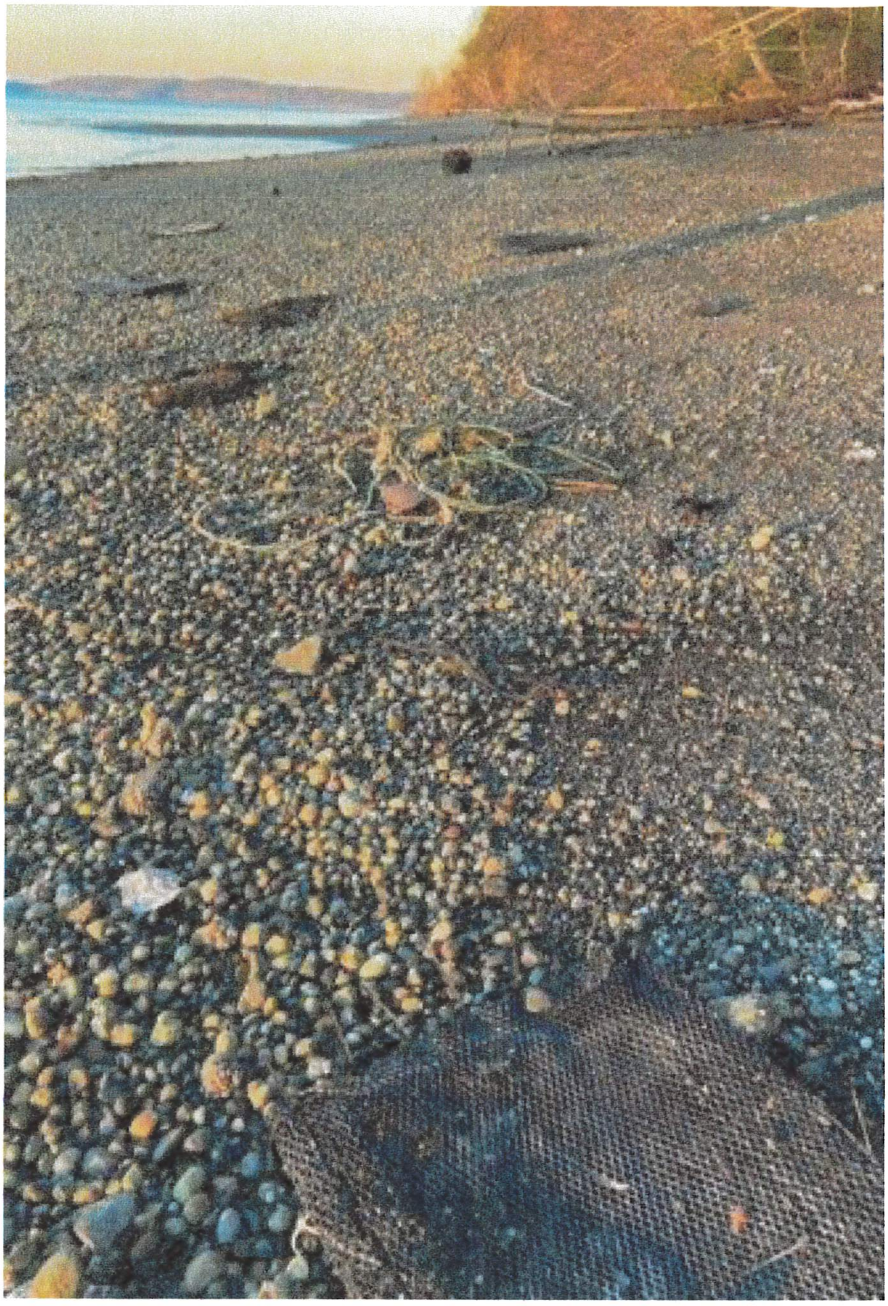
***Item 1.2*** *– "Aquaculture operations are not a significant source of marine debris."*
Aquaculture is a huge source of marine plastic in the environment and the use of the term "debris" is misleading. This plastic is intentionally placed, and present in the environment for many years while being used by the industry. Some of it certainly becomes debris when it is lost. Plastic impacts the environment no matter how you label it.

How much plastic are we talking about? One foot of 6 inch PVC pipe weighs 3.53 pounds. Taylor shellfish would plant 146,000 of these tubes in the Mazanti-Taylor beach, each about 1 foot in length, a total of **73 tons** of plastic. The claim that they will recover much of it is misleading. The industry typically reuses this plastic for as many 2-year cycles as possible, and by its own admission plans to use it for decades. The County should consider that by granting this permit, they are in-fact allowing the permanent placement of many tons of plastic in the environment. All of the plastic is subject to degradation and some will certainly become debris.

Bill Dewey sidesteps the question of plastics by claiming that they now use HDPE mesh tubes. While they are at times using those tubes, (which, while more resistant, do also degrade in spite of his claims), they have a great store of used PVC, which they continue to reuse and stockpile on their properties. Their Lockhart Property on Henderson Inlet was replanted in 2023 with PVC pipe. Please see below photograph.

The industry admits that plastics in the environment is a major problem, and cites literature about sources of plastic pollution. They are correct that terrestrial sources are the major contributor of microplastics in the environment. No argument. However, it is completely ingenuous to suggest that because indirect terrestrial sources are a major source of plastic pollution, that the county should permit the **direct** placement of tons of plastic in the environment. The industries' argument here has absolutely no merit.

The industry states: *"loss of aquaculture gear is already minimized."* What does this mean? They never claim to recover all the plastic, but give no data as to how much is lost. And they do lose it. Anyone who lives near an aquaculture site is used to having plastic aquaculture gear wash onto their beaches. On Otis Beach, where I live, it happens all the time.



In a separate letter, I've already characterized the dynamic nature of the proposed geoduck site with potential for 4 foot storm waves from two directions. The industry should define "minimal". What percent of lost tubes do they expect? In the unlikely event that they recover 99% of their tubes, that leaves approximately 1500 tubes (5,295 pounds) in the environment, which is highly significant. To the best of our knowledge, Thurston County has no plans to enforce a standard of tube recovery, nor do they have capacity for compliance assessment. It is irresponsible for the County to permit this process. Furthermore, the authors of Taylor's pro-plastics paper intentionally misstate the science when they say: "studies have shown that removal of marine debris is effective at mitigating the potential to create microplastics. (Andrady 2011)". This is the **actual abstract** of this citation with highlights:

"2011 Aug;62(8):1596-605.
doi: 10.1016/j.marpolbul.2011.05.030. Epub 2011 Jul 13.

# Microplastics in the marine environment

Anthony L Andrady [1]
Affiliations

- PMID: **21742351**
- DOI: 10.1016/j.marpolbul.2011.05.030

## Abstract

*This review discusses the mechanisms of generation and potential impacts of microplastics in the ocean environment. **Weathering degradation of plastics on the beaches results in their surface embrittlement and microcracking, yielding microparticles that are carried into water by wind or wave action.** Unlike inorganic fines present in sea water, microplastics concentrate persistent organic pollutants (POPs) by partition. The relevant distribution coefficients for common POPs are several orders of magnitude in favour of the plastic medium. Consequently, the microparticles laden with high levels of POPs can be ingested by marine biota. Bioavailability and the efficiency of transfer of the ingested POPs across trophic levels are not known and the potential damage posed by these to the marine ecosystem has yet to be quantified and modelled. Given the increasing levels of plastic pollution of the oceans it is important to better understand the impact of microplastics in the ocean food web. "*

As you can see, the paper does not say that it is environmentally sound to permit the placement of 73 tons of plastic into the marine environment, no matter what percent of that is actually lost and subsequently recovered.

This is a typical misuse of science by the industry. Their article really is an indictment of the process of geoduck farming.

**Item 1.3** – *"Aquaculture gear does not break down easily to form microplastics."*
The industry does not assert that aquaculture gear does not break down - they admit that it does. "Easily" is a qualitative term. Mechanisms for breakdown are well documented, indeed clearly stated in their own references (see above). "Weathering degradation of plastics on the beaches results in their surface embrittlement and microcracking, yielding microparticles that are carried into water by wind and wave action." These mechanisms include degradation by UV light, heat, mechanical abrasion by contact with beach substrate and breakdown by microbial agents. The argument that aquaculture plastics are not exposed to UV light is patently false.

While they are somewhat protected due to being submerged part of the time, these tubes are stored in direct sunlight when not in use, either on floating barges or in piles on Taylor Shellfish properties where they are extensively exposed to light and heat.

*Barge with used PVC tubes stored in Henderson Inlet for months, replanted on the Taylor Lockhard geoduck site*

Furthermore, any lost tubes washed onto shore away from the monitored site may be exposed for years. Residents in the area of shellfish farms often have a collection of such gear that has washed up.

*Plastic debris washed up on the beach at Ron Smith's residence*

There is no consideration given for the effect of mechanical abrasion on the plastic. If you have any doubt about the harshness of the beach environment, all you have to do is try to walk

barefoot on the beach in question. The substrate shifts constantly. On my nearby beach, I have seen the volume of gravel change by as much as 1 foot in depth in as little as a week.

The authors of this plastics paper make the argument that the presence of plastic debris in the environment from sources other than aquaculture makes the placement of the shellfish industry's plastic irrelevant. It is their argument that is irrelevant.

**Item 1.4** – *"Microplastics have not been shown to affect Puget Sound biota".*
Seriously? Do a quick web search for science articles about the effect of microplastics on marine life and you will be overwhelmed by the number of articles. There are now studies showing it to be a global problem, and all of our estuaries are impacted.
https://www.ncei.noaa.gov/news/tracking-global-marine-microplastics
I do agree with the authors that polystyrene spheres are not the most common polluting form. However, while discounting spheres because they are not the breakdown product of their plastic, they ignore the capacity for their plastic to degrade into microfibers, which is the most common form of plastic pollutant. While arguing that our Puget Sound waters are still relatively clean compared to some other places in the world, they seemed to think that adding to the problem is all right. It is not.

**Item 1.5** – *"Use of rigid PVC tubes do not pose a toxic hazard."* In this section, the authors state that the PVC pipe used by the shellfish industry contains no phthalates, but offer no reference to the actual pipe used or the chemical constituents of that pipe. There are numerous additives in all PVC pipe. Should they not submit documentation of what they intend to use? Should we accept this statement at face value as if from an uninterested party? Wikipedia states that it (PVC) "always requires conversion into a compound by the incorporation of additives such as heat stabilizers, UV stabilizers, plasticizers, processing aids, impact modifiers, thermal modifiers, fillers, flame retardants, biocides, blowing agents, smoke suppressors and (optionally) pigments." How many of these additives are used in their pipe? Are we supposed to believe that they commission a special pipe low in some additives because of their marine use? They do not say so, but in some documents (DEIS Burly Lagoon 2023) they claim to use "marine grade" plastic. I have tried doing a web search for "what is marine grade PVC". See for yourself. You will find no coherent description of this as a special product, and it seems to be simply ordinary Schedule 40 PVC.

**Item 1.6** – *"HDPE gear also does not pose a toxic hazard."* They state "few studies" as being available, but go on to state 1.6% loss of HDPE by weight in 12 months. Let's just do the math based on the weight of plastic for the proposed Johnson Point project. So, it's OK to put plastic in the beach that leaches 13,245 pounds of chemicals and/or microplastics in a year? How can this be a serious argument? Their final line is "Lack of degradation of HDPE gear is supported by the decades of use of aquaculture cages reported by Puget Sound growers." No science there, but a clear admission of intent to keep using the product forever in spite of evidence that it degrades.

**Item 1.7** – *"Microplastics are not a major source of exposure to persistent organic pollutants (POPs)."* The authors restate the known pathway of migration of microparticles which have an affinity for POPs, and then assert that because POPs are absorbed into sediments that it somehow doesn't matter. And, they say that there really isn't any good data anyway. What is important here is that marine organisms ingest microplastics, which have an affinity for POPs, thereby incorporating them into their tissues. As this moves up the foodchain, it eventually reaches the top of the chain which includes humans and orcas. If POPs are also absorbed into sediments, it doesn't make the foodchain problem any better. Their argument is irrelevant and only distracts from the main issue.

The conclusion of the paper continues to systematically misstate the facts. I would rewrite the conclusion thus:
Aquaculture operations **are** a significant source of marine plastic pollution and, although the products used are fairly robust, they do degrade. Based on the massive bulk of plastic embedded in the beach and the extended lifespan of its use, degradation is inevitable, and the amount of microplastics added to the environment is **highly** significant. The argument that, because the larger portion of marine plastic pollution is secondary from terrestrial sources, makes the intentional addition of many tons of plastic to our waters (even intermittently) absurd.

And, as to the effect on Puget Sound biota as being negligible, there is growing alarm in the scientific community about the dangers of microplastics. The advocates for plastic use in the marine environment would rather wait until the impacts are obvious to everyone. When the impact on marine biota is widespread, it will be too late. The opinion of the European Union in a recently published 300-page study suggested a "precautionary" approach.
https://op.europa.eu/en/publication-detail/-/publication/e9e7684a-906b-11ec-b4e4-01aa75ed71a1
It would seem the logical thing to do to wait for more data and restrict marine use of plastics until they can be shown to be safe.

If you wish to read more about the threat of plastic in our environment, please visit
https://protecthendersoninlet.org/the-threat-of-plastics-in-our-environment/
where there is a more general discussion.

Now that the real risk of plastics in the environment is outlined, what about the specific risk of putting huge quantities of plastic tubes at the Johnson Point site?

The choice of this site for geoduck aquaculture should be closely scrutinized as it represents a **potential disaster** from loss of plastic to the environment. This should be considered in the Environmental Assessment and a **full Environmental Impact Statement should be obtained**.

Please consider these details carefully:

This site is unusual compared to other projects where geoducks are farmed because of its extreme exposure. Please refer to the attached marine maps.

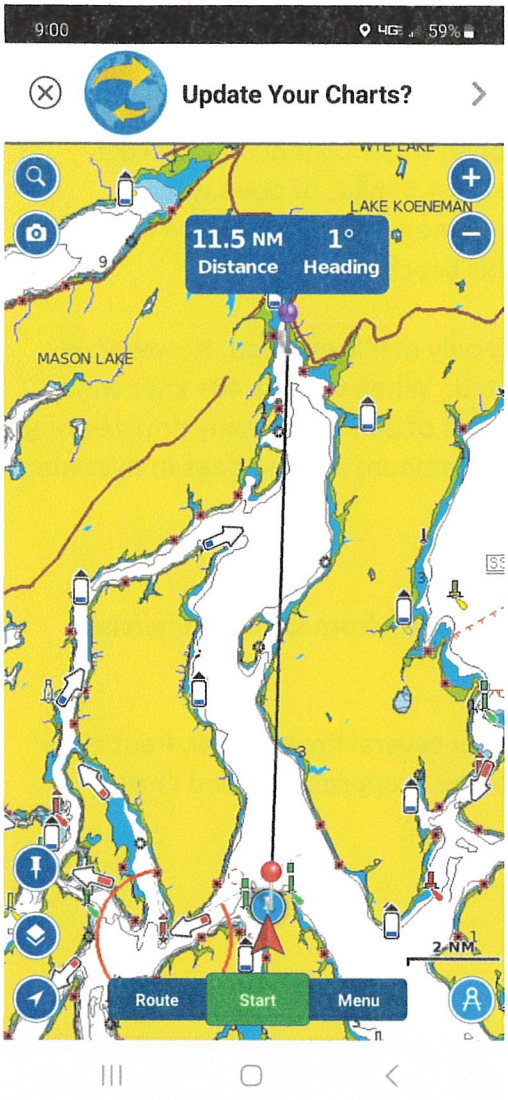
To the north lies Case Inlet, where there are 11+ miles of open water continuous with the proposed site. To the west lies Dana Passage where there are 4.5 miles of open water. Local sailors are well aware of the funneling effect of the marine bluffs on wind, and residents know that storms do create pronounced wave action on this beach.

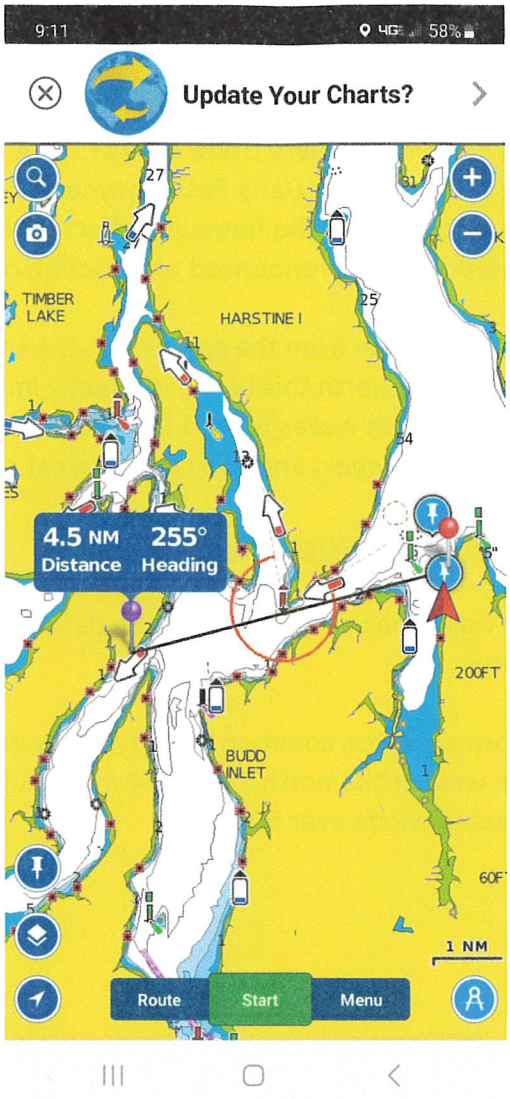
In our most common storm from the southwest, the site is only mildly exposed. However, in storms from the west or north this beach is directly impacted. When there is 40+ knot wind, the beach is thrashed with waves up to 4 feet. We have winds of 20+ knots many times through the year, probably every week, and you can see what a small amount of wind does in this video.

http://www.youtube.com/watch?v=XIWvjI9i9-w

Note also in the video the various aquaculture debris on the beach from local commercial shellfish operations.

While severe storms are less common, they typically do occur several times a year, frequently coming from the west or the north. I live 1/4 mile south of the proposed site, and I have personally witnessed winds over 60 mph.




David Hall is a resident whose property adjoins the Mazanti-Taylor site. You will find his letter opposing the site in your comments file. David has a lot of experience growing oysters on this beach, having sponsored 3-4 thousand student visitors during the last couple of decades. This has been in collaboration with South Sound Green, an educational program that has taught students about beach ecology, including a program on oyster growing. (By the way, this beach that has been used for decades for this program will no longer be accessible if this permit is allowed).

David has learned that oysters can only be grown in bags because loose oysters are rapidly dispersed by waves and currents. We on Johnson Point and Otis Beach are used to finding stray oyster bags from commercial shellfish operations across the inlet washing up on our beaches (see photos). We realize that Taylor likely can use robust methods to secure oyster bags (they will have to do so). However, it is highly unlikely that individual geoduck tubes can be adequately secured in the beach against a pounding 4-foot surf. Given the plan of planting 150,000 unsecured tubes in the beach (10 tubes/$m^2$ x 4047 $m^2$/acre x 3.6 acres = 145,692),

there is the potential for a disastrous result, with plastic tubes scattered for miles. Please also be aware that currents along this region of South Puget Sound are strong in nearby Dana Passage which is listed in the top 7 channels of Puget Sound for current speed (Encyclopedia of Puget Sound).

Taylor has previously submitted letters to the County Planning Commission (during the revision of the Shoreline Master Plan in November 2020) indicating that they have a plan for collecting lost tubes from their geoduck planting sites. It seems reasonable that they could collect errant tubes that wash up on the beach after a storm if they were prompt in their actions, but it seems unlikely that they could recover a significant number of tubes lost in deep water, which would require extended time with SCUBA gear traveling well beyond the borders of the site. It is my understanding from talking to a prominent South Sound grower that geoduck operators typically dive their sites only about once per year.

Let's think about this: If Taylor lost only 1% of its tubes in a severe storm, that would be 1,500 tubes, roughly 7,500 pounds of plastic! Even loss of 0.1% (150 tubes) might be beyond the capability of a dive crew to recover. In reality, we really don't know how many tubes are lost because there is no compliance monitoring by Thurston County, and the shellfish companies don't report it. Certainly, the county would not issue me a permit to dispose of this volume of plastic waste in the marine environment.

**The bottom line: Permitting for this site should be denied based on risk to the environment from lost plastic which is now being globally recognized as a major threat.**

Please see discussion on www.Protect Henderson Inlet.org for the real risk this plastic poses.

## 3: Genetic Risk to Wild Geoduck Stocks

This topic has been discussed thoroughly in the critique of the GARP report. Let me add that I have discussed the subject of genetic risk from current hatchery geoduck practices with Dr. Hank Carson of the Washington Department of Fish and Wildlife. Dr Carson is in charge of monitoring wild geoduck contact harvesting in deep waters, and has no direct involvement in managing intertidal geoduck cultivation. He shares my great concern that there may be harmful impact on the genetic diversity of wild geoduck stocks. We just don't know the answer to this question, and it is **imperative** that we stop permitting geoduck farms until we can understand the real impact. This was a strong recommendation of the GARP report.

## Conclusion

This letter conclusively refutes Taylor Shellfish's claims that science supports their invasive practice of geoduck aquaculture. Please focus on the factual information included in this letter.

Respectfully submitted for the members of Protect Henderson Inlet a 501(c)(3) organization.

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# Appendix

### Full Scientific Reviews

The following three critical reviews of scientific papers that are routinely cited by Taylor Shellfish as supporting the environmental safety of geoduck aquaculture, and are specifically listed on page 2 of their 31 January letter to Thurston County. These reviews are also available at https://protecthendersoninlet.org/ under the heading of SCIENCE.

# Critique 1

# Effects of Geoduck (Panopea generosa Gould, 1850) Aquaculture Gear on Resident and Transient Macrofauna Communities of Puget Sound, Washington

*Journal of Shellfish Research, Vol. 34, No. 1, 189–202, 2015*

*Author(s): P. Sean McDonald, Aaron W. E. Galloway, Kathleen C. McPeek and Glenn R. Vanblaricom*
*Source: Journal of Shellfish Research, 34(1):189-202.*

*Published By: National Shellfisheries Association*
*DOI: http://dx.doi.org/10.2983/035.034.0122*
*URL: http://www.bioone.org/doi/full/10.2983/035.034.0122*

*ABSTRACT In Washington state, commercial culture of geoducks (Panopea generosa) involves large-scale out-planting of juveniles to intertidal habitats, and installation of PVC tubes and netting to exclude predators and increase early survival. Structures associated with this* ***nascent*** *(bold added by RS) aquaculture method are examined to determine whether they affect patterns of use by resident and transient macrofauna. Results are summarized from regular surveys of aquaculture operations and reference beaches in 2009 to 2011 at three sites during three phases of culture: (1) pregear (–geoducks, –structure), (2) gear present (+geoducks, +structures), and (3) postgear (+geoducks, –structures). Resident macroinvertebrates (infauna and epifauna) were sampled monthly (in most cases) using coring methods at low tide during all three phases. Differences in community composition between culture plots and reference areas were examined with permutational analysis of variance and homogeneity of multivariate dispersion tests. Scuba and shoreline transect surveys were used to examine habitat use by transient fish and macroinvertebrates. Analysis of similarity and complementary nonmetric multidimensional scaling were used to compare differences between species functional groups and habitat type during different aquaculture phases. Results suggest that resident and transient macrofauna respond differently to structures associated with geoduck aquaculture. No consistent differences in the community of resident macrofauna were observed at culture plots or reference areas at the three sites during any year. Conversely, total abundance of transient fish and macroinvertebrates were more than two times greater at culture plots than reference areas when aquaculture structures were in place. Community composition differed (analysis of similarity) between culture and reference plots during the gear-present phase, but did not persist to the next farming stage (postgear). Habitat complexity associated with shellfish aquaculture may attract some structure-associated transient species observed infrequently on reference beaches, and may displace other species that typically occur in areas lacking epibenthic structure. This study provides a* ***first look*** *(bold added by RS) at the effects of multiple phases of geoduck farming on macrofauna, and has important implications for the management of a rapidly expanding sector of the aquaculture industry.*
*KEY WORDS: aquaculture effects, benthic community, geoduck, habitat provision, macrofauna, press disturbance, structural complexity, geoduck, Panopea generosa*

## Introduction

First of all, as with all scientific articles, they must be read in their entirety, not just the abstract which is only an overview and may not fully express the basis for conclusions or the limitations of the study. You may access the full text here.

https://wsg.washington.edu/wordpress/wp-content/uploads/publications/shellfish-research-april-2015/effects-of-geoduck-aquaculture-gear.pdf

One of the reasons that I chose this article is that it is one of three articles specifically cited by Taylor Shellfish in their arguments to the Thurston County Planning Commission in 2020 against restrictions being considered on geoduck aquaculture. In the letter from lawyer Dianni

Taylor E, she states "These studies demonstrate that, similar to other forms of shellfish aquaculture, geoduck farming does not have significant environmental impacts when properly managed."

https://s3.us-west-2.amazonaws.com/thurstoncountywa.gov.if-us-west-2/s3fs-public/2023-02/cped-board-pc-written-comments-received-for-12.02.2020-final.pdf

Simply stated, this scientific study proves nothing of the sort, and to characterize it as a key study supporting aquaculture is an extreme distortion. This is why.

## Analysis

First, this study was published in 2015 and is based on data collected in 2009-2011, so it's far from current. What is also important about that is that the authors describe it as a "first look." To date, there seems to have been no attempt at further looks to corroborate their findings, yet this is considered a key study worthy of being cited in a legal argument? It's a small study, honestly performed for the most part, but with very limited importance overall. If this were in the field of medicine, these results would never be actionable.

This study gathered data from three different sites, and, although the authors admit that there were significant differences in the sites, they had to be combined to provide enough data to be statistically analyzed.

The study looked at the effect of geoduck aquaculture in three phases, before planting, during planting, and after removal of geoduck tubes, which was roughly 2 years into the cycle. This pointedly ignores the most invasive phase which is the harvest, when hydraulic excavators are used to liquefy the beach as deep as three feet to extract the mature geoduck at age 5-7 years. Ideally, a study would last through a couple of complete cycles, but that would take a lot more time. Funding tends to be limited, and there is usually pressure at universities to publish, so there might not have been much of an incentive to extend the study.

It's not much of a surprise that most of the mobile species (not all) increased around the structure of the tubes. I think any 3rd grader with a fishing pole knows that fish are attracted to structure, but in science, we do have to prove things. That said, they may have proved something, but an increase in some species does not allow the conclusion that there is no significant impact (a conclusion of the lawyer, not the scientist), and the lack of carrying the study through the harvest phase relegates this paper to a role of minor importance in my opinion.

The following is important: in their analysis, they identified 68 different taxa (species). However, their analysis only included 12 species, which they called the most important ones, but didn't really say why they were the most important ones. It seems that they were the only ones for which they had enough data to analyze. Let's think about that for a minute. 12 species of 68 is less than 18%. They made their conclusions based on a fraction of the species present, excluding in their design anything mobile less than 6 cm long, without an explanation of why these 12 were important. By analogy, consider the Serengeti with its wildness and large population of mammals. If you chose importance by abundance, what would that say about the value of lions

in the ecosystem when there might be 1000 times the number of wildebeests? In all ecosytems the interdependence of species is of paramount importance and this study seems to ignore that basic question in order to draw a conclusion from the limited data that they had available. Admittedly, observing a hooved mammal might be a great deal easier than identifying small creatures in the tidelands while scuba diving through murky water, but such is the task they outlined for themselves.

There were no significant sightings of salmonids, so they appropriately excluded them from analysis. What? No conclusions about salmon in a landmark study?

This brings up a somewhat tangential subject, but the absence of salmon smolts reminds me that the control sites (a *control* is a separate area of study supposedly unaffected by whatever parameters are being looked at in the main study area, used for comparison) that were used as a standard in these research studies are far from what was present historically at these sites. The Olympia oyster once covered 70% of Salish Sea tidelands, reduced to only a tiny fraction of that now. If there was a true standard to compare, and the impact being measured was on a beach covered with native oysters, the impact of the implanted geoduck tubes and the subsequent observations would likely be far greater. Sadly, we now only have degraded ecosystems. Among many other species, out-migrating salmon including the endangered Chinook, would use native Olympia oyster beds as forage ground if those beds had survived. It is important to remind ourselves that the control areas used in these and all similar studies are already degraded. Best to refer to them as *reference areas*, as no true controls are available anymore. The truth of it is that, sadly, the scientists don't have much of a choice here.

Finally, I have a real problem with this statement in the authors introduction – "Projection of future aquaculture production to meet human food demands imply an expanding ecological footprint for these activities in nearshore environments." Whether good or bad, this is a true statement regarding shellfish aquaculture in general, but this is a study about *panopea generosa*, the geoduck. We don't eat them. We sell them abroad where they are consumed as an expensive delicacy. They are unnecessary, generally unavailable to the local consumer, and unimportant as a food source in the impacted area where they are grown. The authors inflate the importance of this study with such a statement. I also have a problem with the use of the word "nascent" in the abstract, which appropriately means beginning to be formed, but also has implications of a promising enterprise. The promise happens to be purely financial.

I would be interested in knowing what the authors think about the importance of this study relative to the big questions facing us about expanding aquaculture, especially about whether they endorse the use of their papers by Taylor Shellfish and others to support this expansion.

# Critique 2

ECOLOGICAL EFFECTS OF THE HARVEST PHASE OF GEODUCK (PANOPEA GENEROSA
GOULD, 1850) AQUACULTURE ON INFAUNAL COMMUNITIES IN SOUTHERN PUGET SOUND, WASHINGTON

*Journal of Shellfish Research, Vol. 34, No. 1, 171–187, 2015*

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*ABSTRACT Intertidal aquaculture for geoducks (Panopea generosa Gould, 1850) is expanding in southern Puget Sound, Washington, where gently sloping sandy beaches are used for field culture. Geoduck aquaculture contributes significantly to the regional economy, but has become controversial because of a range of unresolved questions involving potential biological impacts on marine ecosystems. From 2008 through 2012, the authors used a ''before–after-control-impact'' experimental design, emphasizing spatial scales comparable with those used by geoduck culturists to evaluate the effects of harvesting market-ready geoducks on associated benthic infaunal communities. Infauna were sampled at three different study locations in southern Puget Sound at monthly intervals before, during, and after harvests of clams, and along extralimital transects extending away from the edges of cultured plots to assess the effects of harvest activities in adjacent uncultured habitat. Using multivariate statistical approaches, strong seasonal and spatial signals in patterns of abundance were found, but there was scant evidence of effects on the community structure associated with geoduck harvest disturbances within cultured plots. Likewise, no indications of significant ''spillover'' effects of harvest on uncultured habitat adjacent to cultured plots were noted. Complementary univariate approaches revealed little evidence of harvest effects on infaunal biodiversity and indications of modest effects on populations of individual infaunal taxa. Of 10 common taxa analyzed, only three showed evidence of reduced densities, although minor, after harvests whereas the remaining seven taxa indicated either neutral responses to harvest disturbances or increased abundance either during or in the months after harvest events. It is suggested that a relatively active natural disturbance regime, including both small-scale and large-scale events that occur with comparable intensity but more frequently than geoduck harvest events in cultured plots, has facilitated assemblage-level infaunal resistance and resilience to harvest disturbances.*
*KEY WORDS: aquaculture, benthic, disturbance, extralimital, geoduck, infauna, intertidal, Panopea generosa, Puget Sound, spillover*

**Critique**

As in all scientific papers, the reader is encouraged to evaluate the entire article, which can be found here.

This study was published in 2015, based on data collected between 2008 and 2012. It seeks to determine whether there is a significant effect of a commercial geoduck operation on benthic (in the beach) organisms by comparing samples before, during, and after the harvest phase. Samples were obtained from three sites which were so different that the data from each of these sites had to be evaluated separately. "Such an approach had the unavoidable effect of reducing statistical power for detection of significant differences." Nevertheless, the data was analyzed using

multivariate and univariate methods, the latter described this way: "Some components of our data failed to meet underlying assumptions on which ANOVA (ed. a method of statistical analysis using one variable) methods are based."

So, what about that data? In this study 50 taxa (species) were identified in samples. They chose to evaluate the 10 most abundant ones, citing reasons for inclusion based on behavior in the ecosystem for only one of those species. So, only 20% of the identified species were evaluated other than a gross measurement by weight. Please see my discussion about the problem of this approach in critique 1. There is no discussion of the importance or lack thereof for the other 40 species. Their final conclusion was that there was no significant effect of the geoduck aquaculture project, but along the way they state "Of the 10 most frequently sampled infaunal taxa, only 3 indicated evidence of reduction in abundance persisting as long as four months after conclusion of harvest activities." The math is pretty easy here. 30% of the most common species show reduction in numbers, in their view, not significant? But rest assured, the three did not "approach local extinction."

So, the conclusion is that there wasn't much effect, but there are also many disclaimers. They point out that, it was hard to find good sites to study, that the sites were relatively isolated and being used for geoduck for the first time, and that patchy harvest could significantly affect the data. Also, the long-term effects were unknown. "The data may not provide sufficient basis for unequivocal extrapolation when a given plot is exposed to a long series of successive geoduck aquaculture cycles. Likewise, it may not be appropriate to extend the findings of the current study to cases when a number of separate plots are adjacent to one another, and encompass significantly larger surface area than any single plot." In other words, they can't really say what might happen in practice.

The authors conclude with "resolution of the questions of larger special spatial and temporal scales will be a major challenge for geoduck farmers as they continue production on existing plots and expand into new areas, and will be an important research goal in the interest of informed management policies by natural resource agencies."

There has been no attempt that I am aware of to reproduce or further evaluate these findings with follow-up studies as of July 2023, particularly with regard to the potential cumulative effects of geoduck aquaculture.

This, like the scientific paper in critique 1, is **not a landmark study**, and I think that it does not have the power to guide major policy decisions. It honestly attempts to draw conclusions based on limited data, and appropriately disclaims the results. It is a **gross mischaracterization** by the shellfish industry to say: *"These studies demonstrate that, similar to other forms of shellfish aquaculture, geoduck farming does not have significant environmental impacts when properly managed."* (Quote Diani Taylor E in a letter to the Thurston County Planning Commission 25 November 2020).

# Critique 3

## Aquaculture disturbance impacts the diet but not ecological linkages of a ubiquitous predatory fish

Estuaries and Coasts

By: Kathleen C. McPeek, P. Sean McDonald, and Glenn VanBlaricom

https://doi.org/10.1007/s12237-014-9909-z

*Abstract*

*Aquaculture operations are a frequent and prominent cause of anthropogenic disturbance to marine and estuarine communities and may alter species composition and abundance. However, little is known about how such disturbances affect trophic linkages or ecosystem functions. In Puget Sound, Washington, aquaculture of the Pacific geoduck clam (*Panopea generosa*) is increasing and involves placing nets and polyvinyl chloride (PVC) tubes in intertidal areas to protect juvenile geoducks from predators. Initial studies of the structured phase of the farming cycle have documented limited impacts on the abundance of some species. To examine the effect of geoduck aquaculture on ecological linkages, the trophic relationships of a local ubiquitous consumer, Pacific staghorn sculpin (*Leptocottus armatus*), to its invertebrate prey were compared between geoduck aquaculture sites and nearby reference areas with no aquaculture. Mark-recapture data indicated that sculpin exhibit local site fidelity to cultured and reference areas. The stomach contents of sculpin and stable isotope signatures of sculpin and their prey were examined to study the trophic ecology of cultured and reference areas. Results showed that the structured phase of geoduck aquaculture initiated some changes to staghorn sculpin ecology, as reflected in sculpin diet through stomach content analysis. However, carbon and nitrogen stable isotopes revealed that the general food web function of sculpin remained unchanged. The source of carbon at the base of the food web and the trophic position of sculpin were not impacted by geoduck aquaculture. The study has important implications for geoduck aquaculture management and will inform regulatory decisions related to shellfish aquaculture policy.*

**Critique 3**

This critique needs to be taken in context, that it is, the study's use by the shellfish industry to state that "geoduck farming does not have a significant environmental impact when properly managed."

As for the science, this is a well-performed study studying the effect of a commercial geoduck operation on only a single species, the Pacific Staghorn Sculpin. They didn't find any major impact on the fish, other than that its diet was a bit different. Why did they choose this fish? Because it is common and easy to study. What is its importance relative to other species in the ecosystem? Not stated other than that it is a "generalist." They did not present any arguments that the Sculpin represents a sentinel species (one whose well-being might forecast that of the whole ecosystem). It is not always the most common species that has the most important effect in an ecosystem.

What they do say is this: "It is important to note that the present study is based on data from one prevalent member of the fish community with a generalized diet. Nearshore fishes may experience more dramatic impacts compared to staghorn sculpin, depending on how primary prey respond to changes in habitat complexity." In other words, we don't know anything about any of the other fishes from this study. As far as I know, there has been no attempt to study any of the other fish.

The paper goes on to say, similar to others reviewed here: "the results cannot be extrapolated to forecast the impacts of geoduck aquaculture operations in close proximity or repeated farming activities in the same location." In other words, these are limited results in space and time. We don't know what will happen if you keep running the farm in this spot, or if you put another one nearby.

I do take issue with the authors over their concluding statement: "Despite the aforementioned limitations, the present study and concurrent work by McDonald et al. and VanBlaricom et al. provide data to better balance economic interests with those of maintaining natural ecosystems and are critical for geoduck aquaculture management." They don't bother to explain their logic in coming to such a bold conclusion. Those mentioned studies were reviewed in critiques 1 and 2; these three limited papers taken together do provide a few interesting data points concerning commercial geoduck aquaculture. They do not even approach a serious attempt to establish commercial geoduck farming as having no significant environmental impact.

In my opinion, the authors' statement is absurd, untrue, and self-serving. In simple terms, it encourages the shellfish industry to misuse this science to further their own business and financial interests.