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21 March 2023

TO: Kraig Chalem
Community Development Center
Thurston Co Washington

RE: Development project 2022103702
Subject: Critique of Science about geoduck aquaculture

Mr. Chalem:

Please enter these comments in the record for the permit application for the aquaculture project on Johnson Point Loop.

Taylor shellfish has previously stated that aquaculture has been shown by science to pose no risk to the environment, and it is assumed that they will try to make the same arguments in support of their position for the Johnson Point Loop site.

As a scientist, I am qualified to review these studies, and I take strong issue with Taylor's statements. I offer these critiques of the scientific literature habitually cited by the industry, including Taylor. It is important that non-scientists understand what the limitations of the science is – what we know, what we don't know, and what is speculative vs fact.

These critiques appear under the heading of "Science" on the website of Protect Henderson Inlet, a non-profit organization interested in preserving the health of all Salish Sea waters.
https://protecthendersoninlet.org/

Please see this letter with attachments written to the Thurston County Planning Committee in January 2021 for the full details of their argument that geoduck aquaculture does not impact the environment.
https://www.thurstoncountywa.gov/planning/planningpcagenda/written comments received for 12.02.2020 final.pdf
In her letter to the county, Counsel Diani Taylor states "These studies demonstrate that, similar to other forms of shellfish aquaculture, geoduck farming does not have significant environmental impacts when properly managed." The following three critiques specifically address the three scientific studies that Taylor contends support their claims. The stated studies

do not support these claims, nor can I find others that do. I am first including my "Opinion" section from the PHI website that makes clear for non-scientists a bit of how science actually works.

For those without the time to read these details, I will summarize: These studies are generally honestly done, but very limited in their extent of investigation, addressing less than 20% of species in and near the geoduck farms, and are full of disclaimers from the scientist authors about the short-term nature of their work including admonishments for follow-up cumulative, long-term studies. Those studies have not been done since the 2015 publish dates, and I am unable to find any that are in-progress. The claims of the industry seem to have been accepted without question.

Opinion

It may seem odd to start a science section with an opinion page, but it's important to understand that while there is generally only one scientific truth, how we arrive at that truth is often a circuitous path. Often, in ongoing study of a subject with science, we ferret out the mistakes and the misconceptions that inevitably occur in the early phases as hypotheses are explored, theories expanded, and new possibilities discovered. This is the nature of science. It works very well, but certainly requires time for accurate analysis. Most importantly, it often requires persistence and follow-up to find the real truth.

I am a scientist, a retired medical doctor with 35 years of practice experience in science, and have read an untold number of scientific studies over the years, mostly about the human condition. I also have an undergraduate degree (Bachelor of Science in Biology) which included some studies in Marine Invertebrate Zoology at the Gulf Coast Research Lab in Ocean Springs, Mississippi. While I don't consider myself a true expert in the science of Puget Sound beaches, it does give me a solid basis for the analysis of existing science. As I begin to read and dissect papers that are purported to reach certain conclusions, I am disturbed by the misuse of some of these studies by industry. It will be my goal to share my critiques as I try to gain broader understanding about just what the science *does* and *does not* say about commercial aquaculture techniques.

If my critique piques your interest, I would encourage you to obtain and read the entire scientific study, as abstracts are by their very nature limited.

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
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Published By: National Shellfisheries Association
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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 Commision 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 wands 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 like 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 imo.

This 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 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 lion in the ecosystem when there might be 1000 times the number of wildebeest? 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 scubaing 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, may be 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 have been far different. Out-migrating salmon used to use native Olympia oyster beds as forage ground. It is important to remind ourselves that the controls areas used in these and all similar studies are already degraded. 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, that 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 February 2023, particularly with the 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.

IMO, 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.

Sincerely,

Ron Smith, president Protect Henderson Inlet