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Aquaculture Collaborative Research and Development Program (ACRDP) Fact Sheet

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Potential Benthic Impacts of Pacific Geoduck (*Panopea generosa*) Aquaculture in British Columbia

Summary

The Pacific Geoduck (*Panopea generosa*) fishery is the most valuable dive fishery in British Columbia (BC). Significant interest from both wild harvesters and aquaculturists in the enhancement (of the wild stock) and culture of the species has been demonstrated, however, the expansion of the BC culture industry in intertidal and subtidal environments has been hindered in part by concerns over the potential benthic impacts of culture and harvest practices. Two projects on Pacific Geoduck aquaculture funded by the Aquaculture Collaborative Research and Development Program (ACRDP) have been conducted to examine the potential impacts of intertidal and subtidal geoduck culture and harvesting on the benthic environment. Results from both projects have demonstrated that the benthic impacts of small-scale geoduck out-planting and small- to large-scale harvesting in the experimental plots were relatively minor and limited in duration and/or spatial extent.

The Aquaculture Collaborative Research and Development Program (ACRDP) is a Fisheries and Oceans Canada (DFO) initiative to increase the level of collaborative research and development activity between the aquaculture industry and DFO. Research and development projects under ACRDP seek to improve aquaculture environmental performance and support optimal fish health.

Introduction

The Pacific Geoduck (*Panopea generosa*) is the largest burrowing clam in the world and can be found at depths of up to one meter below the sediment surface in both intertidal and subtidal environments. Unlike most clam species, geoduck display very little lateral movement, meaning their grow out location remains very localized with respect to where they were seeded. There has been a commercial geoduck fishery in British Columbia (BC) since 1975. In 2010, the wholesale value of geoduck exceeded $50 million.

Since the 1990s, much interest has been shown in the enhancement and culture of geoduck in BC (Heath, 2005) but concerns over the potential impacts of geoduck aquaculture and harvest on the benthic environment have been one hinderance to the expansion of geoduck aquaculture in the province. In Canada, most geoduck aquaculture activities to date have been in the subtidal zone with seed being out-planted on identified aquaculture tenures. Under aquaculture conditions, animals are grown at a higher density than that typically found in the wild, and require some form of predator protection. Planted geoducks are protected from predation by PVC plastic tubes (Fig. 1) in the intertidal area or by various forms of netting in the subtidal or intertidal area (Fig. 2) for about two years, after which the predator protection is removed. Geoduck take up to eight years to reach market size. To harvest the deep-dwelling geoducks, both culturists and harvesters in the wild fishery utilize pressurized water to 'liquefy' the sediment surrounding the area where a clam siphon is seen protruding from the sediment surface (Fig. 3).

Figure 1.
Commercial-scale, intertidal culture of Pacific Geoducks (*Panopea generosa*) in Washington state, using PVC tubes for predator protection of young seed. (Photo: C. Pearce DFO)

The combination of predator protection measures and harvest methods utilized (*i.e.*, liquefying the sediment to a depth of a meter or more) may have negative impacts on the benthic environment.

Figure 2.
Commercial-scale, subtidal culture of Pacific Geoducks (*Panopea generosa*) in British Columbia using netting for predator protection of young seed. (Photo: Underwater Harvesters' Association)

However, until this study, no peer-reviewed research papers had been published on the potential effects of geoduck culture on the benthos.

In a review paper, Dumbauld *et al.* (2009) identified three geoduck culture activities which could potentially impact the marine environment including: sediment disturbance caused during out-planting and harvesting and the addition of physical structure and change in material processes (changes brought on by the feeding and production of waste by the geoduck). Given the lack of research in this area and the increasing interest in geoduck farming, two ACRDP-funded projects were conducted to assess the potential benthic impacts of geoduck culture; the first examining impacts of both culture and harvesting on a small-scale and the second examining impacts of harvesting only, but on a much larger scale.

Methods

Project 1: "Juvenile geoduck out-planting: optimizing methods for maximizing aquaculture production and minimizing environmental impacts"

Field work for the first ACRDP-funded project was undertaken at an experimental plot in Nanoose Bay, BC (49°16.0'N, 124°11.2'W) on a gradually-sloping sand flat at the western edge of the bay between June 2005 and January 2007.

In July 2005, seed (average shell length: 29.6 mm) were out-planted in plastic tubes in a 3 x 20 m plot, 0.5 m above the low tide mark, and allowed to grow for one year. In July 2006, the entire plot was harvested at low tide using a pressurized water jet, to a depth of approximately 1 m, mimicking industry harvest practices.

Sediment samples were collected prior to out-planting (32 days before), after out-planting (25, 118, 191, 311, 353 days after) and post-harvest (1, 123, 191 days after). On each date, samples were collected at 0, 5, 10, 25, and 50 m (from harvest plot) along transects running onshore, parallel to shore, and offshore from the plot. Sediment analyses were performed at each combination of date, transect and distance to examine organic matter content, grain size distribution of surface-layer sediment, carbon and nitrogen content, redox potential, and sulphide concentration. Infaunal species were collected at 0 and 10 m along the parallel transect 32 days before out-planting, 25 and 191 days after out-planting and 1 and 191 days after harvesting. Infauna were identified to the lowest possible taxon and abundance, species richness, and abundance of dominant phyla were calculated.

Figure 3.
Harvesting intertidal-cultured Pacific Geoducks (*Panopea generosa*) in Washington state using pressurized water jets. (Photo: C. Pearce DFO)

Project 2: "Assessing potential benthic impacts of intertidal and subtidal geoduck clam harvest"

The second study was carried out at two different sites, each comprising a harvest plot, a nearby non-harvest area and an adjacent eelgrass bed. The first site was on a subtidal sandy strip off Cortes Island (50°02'N, 124°58'W, approximate) while the second site was located in the intertidal zone in Nanoose Bay, near the location used in the first study (harvest plot areas: 60 x 100 m and 15 x 30 m, respectively). The research took place between October 2008 and October 2010.

The plot at Nanoose Bay did not have any Pacific Geoducks present, while the one at Cortes Island was a fisheries enhancement area, previously seeded and ready for harvest during the course of the study. As with the previous smaller-scale project, the plots were harvested using a pressurized water jet, to a depth of approximately 1 m, mimicking industry harvest practices. Benthic sediment samples were collected at various time points ranging from 12 months prior to harvest to 12 months post-harvest at Cortes Island and days before harvest to 24 months post-harvest at Nanoose Bay. On each sampling date, sediment samples were collected in the harvest area (0 m for Cortes Island and Nanoose Bay), non-harvest area (5, 10, 25, 50, 75 m for Cortes Island and 1, 5, 10, 25, 50, 75 m for Nanoose Bay) and adjacent eelgrass bed (5, 10, 25, 50 m for Cortes Island and 1, 5, 10 m for Nanoose Bay). The maximum sampling distances covered both potentially impacted and non-impacted areas and approximated eelgrass boundaries. Sediment analyses were performed at each date and distance in the non-harvest zone and at each date in the harvest zone to examine grain size, percent organics, total nitrogen, total carbon, redox potential, sulphide concentration and infaunal community structure (number of species, number of individuals, and diversity). As with the previous study, infauna were identified to the lowest possible taxon. In the eelgrass beds, measurements of grain size distribution, infaunal community structure (same attributes as in other areas), eelgrass biomass, eelgrass shoot length, and eelgrass shoot density were taken. Suspended sediment concentration was measured using sediment traps at Cortes Island at all sampling distances within harvest, non-harvest, and eelgrass areas before and during harvest and during a winter storm event.

Results

Project 1. Most of the measured variables were not significantly negatively impacted by either the culture (predator tubes and seed) or harvesting (sediment liquefaction) processes. There was a significant decrease in sulphide concentration (seen up to 25 m outside the culture plot) after out-planting the seed, and the values remained within the "oxic a" zone (i.e. <300 μM) as defined by Wildish *et al*. (1999), indicating little to no ecological impact of this change. There was a significant increase in the silt and clay content of the sediment observed one day after harvesting, but only within the culture plot (0 m) and the impact was relatively short-lived, returning to baseline values within 123 days after the harvest. At 123 days post-harvest there was a significant increase in total carbon and redox potential, but these variations were not great enough to have significant benthic implications. These increases occurred at all distances along all transects and were not seen 1 day after harvest, suggesting that they were likely due to an external event, not the harvest process *per se*.

At 0 m after harvesting there was a decrease in infaunal abundance and richness (an increase was evident at 10 m). The rate of potential recovery of the infaunal community (to its original state) after harvesting could not be assessed, unfortunately, due to the subsequent seasonal (autumn) decline in abundance and richness and lack of long-term sampling in the study.

Project 2. There were no significant negative impacts on any of the sediment or infaunal variables measured in the harvest zone, nearby area, or eelgrass bed at either Cortes Island or Nanoose Bay. Additionally, there were no significant effects on any of the measured eelgrass parameters at the two sites. The distribution of suspended sediments resulting from the harvest was generally limited to within the harvest plot and the levels were not greater than those during wind or storm events.

Conclusions

Based on the sediment characteristics, infaunal community variables, and eelgrass parameters measured in these two ACRDP-funded projects, it would appear that the impacts to the benthic environment from small-scale geoduck out-planting and small- and large-scale harvesting activities in intertidal and subtidal areas are relatively minor and limited in duration and scale. It should be noted, however, that changes in habitat, size of the culture plot, frequency of culture, and seasonal timing of out-planting and harvest may alter the degree of impact on, and rate of recovery of, the marine environment. The results of these projects can be used to inform fishery and habitat managers concerned with the potential benthic impacts of intertidal and subtidal geoduck aquaculture and subtidal geoduck enhancement and fishery.

References

Dumbauld, B.R., Ruesink, J.L., Rumrill, S.S. 2009. Aquaculture 290: 196-223.

Heath, B. 2005. British Columbia Ministry of Agriculture and Lands, 8 pp.

Wildish, D.J., Akagi, H.M., Hamilton, N., Hargrave, B.T. 1999. Canadian Technical Report of Fisheries and Aquatic Sciences 2286: iii + 31 pp.

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For further information on these and other ACRDP projects, visit: **http://www.dfo-mpo.gc.ca/science/aquaculture/acrdp-pcrda/main_e.htm**

Information on this geoduck research can also be found at: **http://www.dfo-mpo.gc.ca/science/publications/article/2011/08-31-11-eng.html**

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