EFFECTS OF GEODUCK BIOLOGICAL SAMPLE HANDLING AND TRANSPORT TIME ON MEAN WEIGHT ESTIMATION

Context

The commercial fishery for the Pacific Geoduck Clam (*Panopea generosa*) began in British Columbia (BC) in 1976 and has since grown to be one of the highest valued fisheries in BC at CAD $46.6 million in 2012 (BC Agriculture 2012).

The Geoduck fishery in BC is managed at the level of the individual Geoduck bed. Geoduck biomass is estimated for each bed as the product of bed area, Geoduck density on the bed, and mean Geoduck weight for the bed. Harvest options are based on regional annual exploitation rates of 1.2 – 1.8 % applied to the estimated current biomass for each bed (Bureau et al. 2012). Since 2001, mean Geoduck weight has been estimated from fishery-dependent data derived from numbers and weights of landed Geoducks recorded in commercial harvest logbooks (Hand and Bureau 2012; Bureau et al. 2012). Fishery-independent dive surveys are conducted to estimate Geoduck density on the beds, which historically included the collection of biological samples for age determination. Geoduck biological samples thus provide an additional source of mean weight information for some surveyed beds.

A number of reasons make commercial harvest data preferable over biological sample data for Geoduck mean weight estimation (Bureau et al. 2012). Commercial harvest data offer better spatial representation within a bed (i.e., harvest from more locations) and a larger number of Geoducks within a bed than biological samples. The larger sample size in commercial catch is expected to produce more precise estimates of mean weight. Commercial harvest data also provide bed-specific mean weight estimates for a greater number of beds than do biological samples. Mean weight estimates from commercial harvest data are updated yearly while few biological samples are collected in a given year. Timing between commercial harvest, recruitment events and biological sampling dates can lead to differences in mean weight estimates. The increased temporal resolution of commercial harvest data is also better able to capture variations in recruitment events that can lead to higher (or lower) estimates of mean weight.

Calculations of Geoduck harvestable biomass and fishery harvest options must rely on estimates of mean weight that are representative of Geoducks counted during density dive surveys. Concerns over the representativeness of commercial catch data to estimate Geoduck mean weight were raised because juvenile Geoducks are sometimes too small to be seen by harvesters and because of concerns over size selectivity in the fishery (Hand and Bureau 2012). However, some juveniles that are too small to be seen by harvesters may also be too small for survey divers to see. Bureau et al. (2012) showed that mean weights estimated from biological samples were lower than mean weights derived from commercial catch data for the Haida Gwaii and Prince Rupert regions while no differences were observed for the Central Coast and South Coast. Therefore, based on observed differences between biological sample and commercial catch mean weights, correction factors of -10% and -8% were recommended to be applied to the fishery-dependent mean weights for Haida Gwaii and Prince Rupert, respectively, until further work was conducted. It was recognized that Geoduck biological samples are subject to more handling and longer transport times than the commercial catch, and therefore biological samples could be subject to greater water loss (i.e., weight loss) prior to being weighed. However, due to lack of data, analyses presented in Bureau et al. (2012) did not take into

account the possible effects of increased handling and transport time on biological sample mean weight estimates.

Fisheries and Oceans Canada's Pacific Region Fisheries Management Branch requested Pacific Region Science Branch to provide science information and advice to answer the following questions:

1. Does handling and transport time of Geoduck biological samples account for differences in mean weight estimates observed between biological samples and commercial catch data for the Haida Gwaii and Prince Rupert regions?
2. When handling and transport time of Geoduck biological samples are accounted for, are there still differences between mean weight estimates from biological samples and the commercial catch for the Haida Gwaii and Prince Rupert regions?
3. Are correction factors still required for mean weight estimates derived from commercial catch data from Haida Gwaii and Prince Rupert regions?

An experiment was conducted to determine if handling practices and transport time of Geoduck biological samples can affect mean weight estimates (Bureau and Curtis 2014). Results indicated that increased handling and longer duration between collection and weighing at a landing dock result in greater weight loss in biological samples compared to commercial catch. Correction factors, based on empirical transit time data and results of the experiment, were applied to biological sample data from 1994 to 2010 for Haida Gwaii and Prince Rupert regions. There were no statistically significant differences between corrected mean weights from biological samples and mean weights from commercial catch data for Geoducks from the Haida Gwaii and Prince Rupert regions. Therefore, correction factors are no longer recommended for fishery-dependent mean weight estimates for the Prince Rupert and Haida Gwaii Regions. Mean weight for the purpose of Geoduck biomass calculation can be estimated directly from commercial logbook data.

This Science Response Report results from the Science Response Process of June 2013 on the effects of Geoduck biological sample handling and transport time on mean weight estimation. This Science Response replaces previous science advice on this issue provided in Bureau et al. (2012). At this time, there is no expectation of further advice on this issue.

Background

Geoduck harvest methods are the same for the commercial fishery and biological samples, i.e., Geoducks are individually harvested by divers using a stinger (pressurized water jet), placed in bags, and brought onto the boat; however, handling practices differ. Commercial Geoducks are rubber banded, counted, packed into plastic crates ("cages"), and kept cool until offload at the dock or transshipment to a packer vessel at the end of the day; Geoducks are kept cool in the holds of the packer vessel during transit. When commercial Geoducks are offloaded at a dock, weight of landed Geoducks for each fishing vessel is recorded by third-party dock-side validators. Biological samples are rubber banded and individually double-tagged before being packed into cages, with tagging consisting of drying a portion of each valve of the shell with compressed air before applying a plastic tag on each valve with glue. Cages of biological samples are typically kept on the deck of the survey vessel, and samples are transported by the survey vessel to a landing port where they are weighed and validated in the same manner as the commercial catch. Biological samples are then shipped to a processing facility where individual Geoduck weight and shell measurements are recorded; mean weight estimates from biological samples are based on these individual Geoduck weights.

Bureau et al. (2012) showed that for biological samples, the transit time between the offloading dock and the processing plant, where individual Geoducks are weighed, resulted in increased weight loss, compared to commercial samples which are weighed at the offload dock. Bureau et al. (2012) developed correction factors for mean weights derived from biological samples to account for weight loss between the dock and processing facilities; however, mean weights from biological samples were still significantly lower than mean weights from commercial catch for the Haida Gwaii and Prince Rupert regions. Bureau et al. (2012) suggested that the difference in mean weights may be due to some amount of size selectivity in the Geoduck fishery in the Haida Gwaii and Prince Rupert regions, and therefore recommended correction factors be applied to the mean weights derived from commercial catch data for those regions.

Additional factors which may influence differences in mean weight between biological samples and commercial catch, which were not considered by Bureau et al. (2012) due to lack of data, include the possible effects of handling (tagging) of biological samples prior to transport, and differences in storage temperature and transit time to the offloading docks between biological samples and commercial catch.

Analysis and Response

Weight Loss Experiment

Weight loss in harvested Geoducks likely occurs as a result of water loss due to Geoducks retracting their necks when disturbed or handled, and from a slow loss of water over time. Bureau and Curtis (2014) conducted an experiment to investigate rates of weight loss over time in harvested Geoducks subject to two treatments, representing the different protocols for the handling and transport of biological samples and commercial catch. The experiment investigated whether handling of biological samples (tagging prior to transport), and differences in storage temperature and transit time to the offloading docks, between biological samples and commercial catch, resulted in differences in weight loss. Correction factors were derived to account for the greater weight loss in biological samples and corrected biological sample mean weight estimates were compared to commercial catch mean weight estimates. Detailed methodology and results are presented in Bureau and Curtis (2014).

A sample of 611 Geoducks (32 cages) was collected off Gabriola Island on April 19, 2012 and landed at the Pacific Biological Station. All cages were individually weighed when landed and separated into two treatment groups (time = 0). Geoducks in sixteen cages (half) were tagged and kept at room temperature to represent handling and transport conditions of biological samples (biological treatment) while Geoducks in the other sixteen cages were not tagged and were refrigerated between 4 and 6 °C to represent handling and transport conditions of commercial catches (commercial treatment). All cages in both treatments were again weighed individually after 4 h (after tagging of biological treatment) and every 4 h thereafter over a 64 h period.

Transport time of biological samples and commercial catches were calculated for each of the three North Coast rotational areas (Haida Gwaii, Prince Rupert and Central Coast) and for the whole North Coast combined, and used to estimate the percent weight loss resulting from tagging and differences in transit time between biological samples and commercial catches. Correction factors to account for differences in weight loss associated with tagging and transit of biological samples were developed and applied to biological sample data. Corrected biological sample mean weight estimates were then compared to mean weight estimates from commercial catches.

Bureau and Curtis (2014) found that tagging Geoducks resulted in significantly greater weight loss when compared to Geoducks that were not tagged, implying that biological samples would initially lose more weight than commercially harvested Geoducks (Figure 1).

Bureau and Curtis (2014) compared the transport times between collection and landing for biological samples from Prince Rupert, Haida Gwaii and Central Coast to transport times for commercially harvested Geoducks from the same regions. Biological samples experienced longer transit times than commercial catches for all three regions (34.9 h, 31.2 h and 5.7 h longer, respectively). Transport time of biological samples, for the whole North Coast combined, took on average 20.7h longer than transport time of commercial catches (Figure 1).

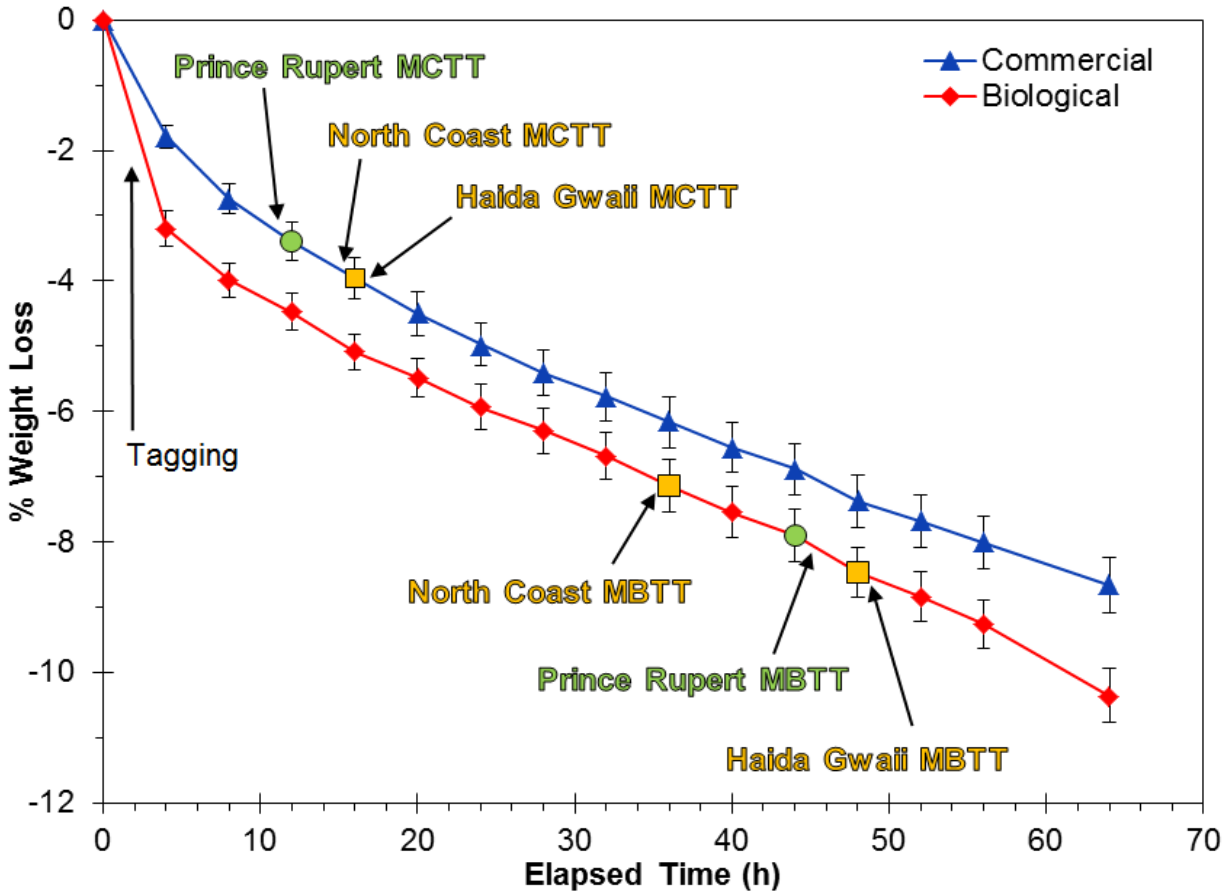

Figure 1: Mean percent weight loss ± SE in Geoducks over time in the Biological (tagged and non-refrigerated) and Commercial (untagged and refrigerated) treatments. MCTT = Mean Commercial Transit Time and MBTT = Mean Biological Transit Time, based on transit time data. n=16 cages for each treatment and time interval. Green circles are points that were compared for the Prince Rupert region. Orange squares from Biological treatment were each compared to the orange square in the Commercial treatment.

In the weight loss experiment, Bureau and Curtis (2014) showed that weight loss increased over time, implying that the longer transport times for biological samples (compared to commercial catches) from Prince Rupert and Haida Gwaii regions would result in greater weight loss in biological samples than that observed in commercially harvested Geoducks from the same regions (Figure 1). The combined effects of tagging and longer transport time for biological samples was estimated to cause a 5.0% and 4.6% greater weight loss (relative to initial weight) in biological samples than in the commercial catch, for Prince Rupert and Haida Gwaii

respectively. Bureau and Curtis (2014) found no evidence that storage temperature had an effect on the rate of weight loss of Geoducks.

Comparison of Geoduck mean weights estimated from commercial catch data to Geoduck biological sample data corrected for increased weight loss due to tagging and transit time

To make biological sample data and commercial catch data comparable, Bureau and Curtis (2014) developed correction factors for biological sample data to account for: 1- weight loss due to tagging and longer transit time to the dock, and 2- to account for weight loss between the landing docks and processing plants. Mean Geoduck weights from corrected biological sample data were then compared to mean weights from commercial catches for Haida Gwaii and Prince Rupert regions. When the correction factors were used, no statistically significant differences were observed between mean geoduck weights estimated from biological samples and commercial catches.

Conclusions

Bureau and Curtis (2014) demonstrated that tagging and longer transport time of Geoduck biological samples accounted for significantly greater weight loss compared to commercial catches for the Haida Gwaii and Prince Rupert regions. When weight loss associated with tagging and increased transit time of biological samples are accounted for, no statistically significant differences were detected between mean weights estimated from biological samples and from the commercial catch for the Prince Rupert and Haida Gwaii regions. Therefore, the correction factors previously recommended in Bureau et al. (2012), to be applied to Geoduck mean weights derived from commercial catch data, are no longer recommended for the Haida Gwaii and Prince Rupert regions.

Recommendations

1. Continue to estimate Geoduck mean weights, for the purposes of biomass calculations, from fishery-dependent data (i.e., numbers and validated weights of landed Geoducks recorded in commercial harvest logbooks).
2. Geoduck mean weight correction factors proposed by Bureau et al. (2012) are no longer recommended for the Prince Rupert and Haida Gwaii regions.

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