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Estimating Geoduck Harvest Rate and Show Factors in Southeast Alaska

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Abstract

In Southeast Alaska, guideline harvest levels for commercial harvest of geoduck clams are calculated as the product of estimated biomass and a fixed annual 2% harvest rate. Prior to applying the harvest rate, biomass estimates are inflated by 20% to account for geoducks that were not counted during dive surveys. Use of the inflation factor, termed "show factor", is intended to produce a more accurate estimate of biomass, by acknowledging that some geoduck siphons remain hidden beneath substrate at the time of survey. The current show factor was calculated with limited data. The current harvest rate was established as a compromise between those rates used for geoduck fisheries in British Columbia and Washington State. This report outlines the background, study plan and data collection methods for this age composition and show factor project. The analysis phase of the project, which has not been completed, will use these recently produced results to estimate parameters used to calculate harvest rate and show factors that are explicitly intended for Southeast Alaska geoduck populations. Additionally, show factors will be calculated for several sites, including geoduck beds with and without evidence of sea otter predation to determine if geoduck shows are influenced by sea otters.

Key words: age composition, dive survey, geoduck, harvest, show factor, Southeast Alaska

Introduction

Management and harvest rate history

The geoduck fishery management plan for Southeast Alaska was adopted by the Alaska Board of Fisheries in 2000 and was developed by the department in cooperation with the Southeast Alaska Regional Dive Fisheries Association (SARDFA) Geoduck Committee. The core elements of the plan include establishment of guideline harvest limits based on biomass estimates, survey frequency requirements, a limit reference point (i.e. threshold) of 30% of original estimated biomass, and an annual harvest rate of 2% in all fishery areas. The harvest rate was established as an intermediate level between those used in Washington State and British Columbia fisheries, where age-based equilibrium models were used to estimate harvest rate (Breen, 1992; Bradbury and Tagart, 2000; Bradbury et al., 2000; Hoffman et al., 2000). More recently, in British Columbia an age-structured projection model has been used to determine harvest rates (Zhang and Hand, 2007). The annual harvest rate in British Columbia varies from 0.75 – 2 % of the virgin biomass per year, and in Washington the annual harvest rate is 2.7 % of the total estimated biomass.

The geoduck management plan also requires a self-imposed tax on SARDFA members for all geoduck landings. The revenue is used in part to test for water quality and paralytic shellfish poisoning, both of which are mandatory prior to geoduck harvest and sales. The tax also helps fund geoduck stock assessment surveys and management and is the primary source of funding for this study.

Stock Assessment, biomass, and show factor

Stock assessment surveys for geoducks in Southeast Alaska began in 1994 and methods have evolved since that time. Prior to 2006, biomass was estimated based on the mean count of geoducks per meter of shoreline and the mean weight (called shoreline-based model). Starting in 2006, there was a shift from the shoreline-based model to an area-based model, which relies on estimates of geoduck density and measurements of bed area, along with mean weight, to produce estimates of biomass. One effect of switching to the area-based approach was reduced variability surrounding biomass estimates. Since the lower-bound biomass estimate of the 90% confidence interval is used to calculate guideline harvest levels (GHLs), the new model approach led to a corresponding increase in GHLs in most surveyed areas. Although this has been an improvement to the method of estimating biomass and setting GHLs, the show factor value has remained unchanged and studies in Southeast Alaska have been limited. Show factor is defined as the ratio of geoduck siphons visible during a single observation of any defined area to the true abundance of harvestable geoducks in that area (Bradbury et al., 2000). Since visibility of geoduck siphons may be influenced considerably by survey site conditions at the time of survey, the show factor may greatly impact estimates of biomass. For this reason, it is important to use show factor values that are as accurate as possible when estimating biomass and setting GHLs.

Extensive research has been conducted on geoduck show factors in British Columbia and Washington State over many years. British Columbia uses a show factor of 90% (Campbell et al., 2004) and Washington found mean show factors to be 73% (Bradbury et al., 2000). Study of show factors in Southeast Alaska has been limited to very few sites, and may not be fully representative of areas, habitat types, and conditions encountered during geoduck surveys. Results of these studies indicate that about 83% of geoducks are counted by divers (Pritchett et al., 1999). Currently, biomass estimates are adjusted upward by using a show factor of 80%. Although this value is within the range of values estimated in British Columbia and Washington, the appropriateness is unknown due to the sparse data upon which it is based. For an example of how show factors have been applied in Southeast Alaska, see Rumble and Siddon (2011).

Southeast commercial geoduck harvesters believe that the show factor of geoduck clams is affected by the presence of sea otters. Sea otter populations have exploded in Southeast Alaska since their reintroduction in 1965. Predation by sea otters has negatively affected the region's dive fisheries, including geoducks, by reducing standing stock biomass and in turn, GHLs. To determine if geoduck show factor is affected by the presence of sea otters, we conducted show plot studies in fishery areas known to have sea otter predation and areas that do not have sea otter predation.

Goals and objectives

The goals of the study were twofold: 1) produce an appropriate Southeast Alaska-specific harvest rate for geoducks, and 2) produce a show factor, or show factors, that are valid for use in a wide range of scenarios (areas, habitats, ocean conditions, sea otter presence or not) encountered during dive surveys of geoducks.

Objectives for estimating the harvest rate for Southeast Alaska were:

1) Determine the age structure of various populations by collecting and aging approximately 200 randomly chosen geoduck shells from at least four different geoduck fishery areas in Southeast Alaska (Figure 1).
2) Determine size distribution (weight and length) and estimate growth rates for each fishery area.
3) Calculate growth rate for each fishery area.
4) Calculate the natural mortality rate for each fishery area.

Objectives for estimating show factor(s) were:

1) Count geoduck siphons and then verify by digging all geoducks within ten 10m2 (10-meter by 1-meter) show plots from each of at least two different geoduck fishery areas in Southeast Alaska where sea otter predation is evident.
2) Count geoduck siphons and then verify by digging all geoducks within ten 10m2 (10-meter by 1-meter) show plots from each of at least two different geoduck fishery areas in Southeast Alaska where there is no sea otter presence.

Methods

Some of the goals and objectives were accomplished for the harvest rate and show factor studies in conjunction with each other. Combining these two projects reduced the amount of geoducks that were removed from each of the fishery areas. Within each fishery area, about 200 geoducks were sampled for the harvest rate study, and show factor studies were conducted in the following four fishery areas in summer 2012 (see Figure 1):

1) Cone Island North (District 3) - sea otter affected
2) East San Fernando (District 3) - sea otter affected
3) Vallenar Bay (District 1) - not sea otter affected
4) Nakat Inlet (District 1) - not sea otter affected

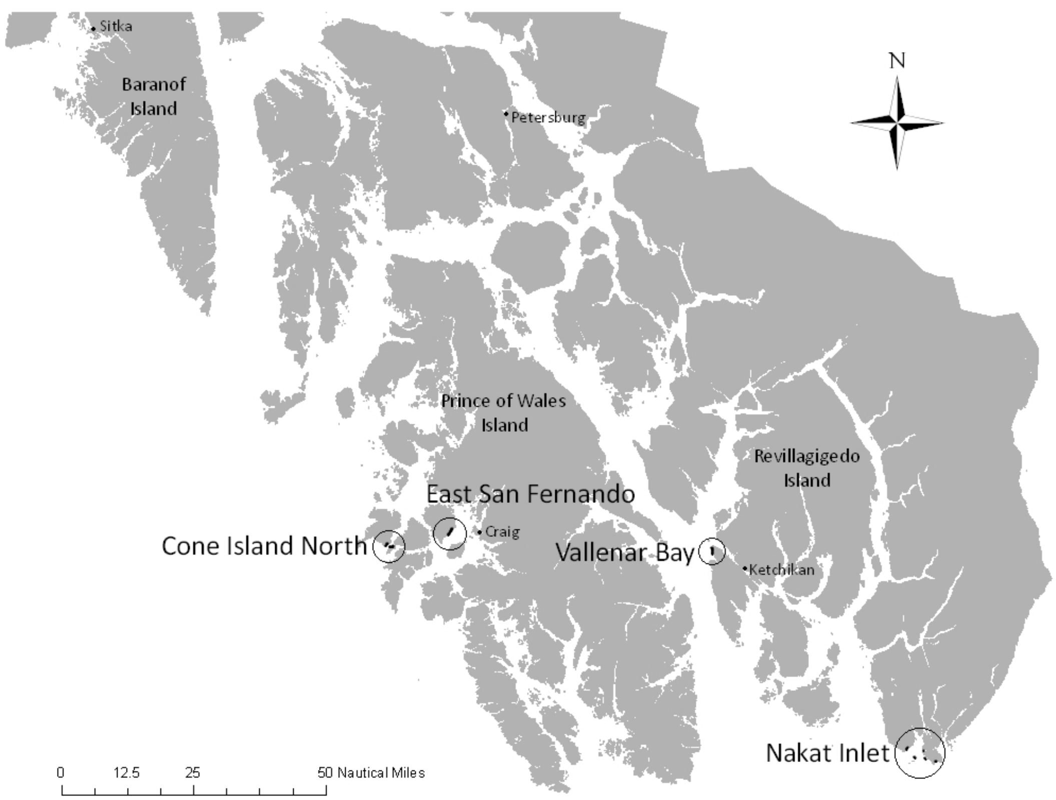

Figure 1. Four Southeast Alaska fishery areas (circled) that are age composition and show plot research sites.

Transects and geoduck counting, attempted dredging, and geoduck collection was completed for each of the four fishery areas. The laboratory sample processing, estimates of growth rate and mortality, and estimates of show factor for the four fishery areas will be completed in before the summer of 2013.

In each of the fishery areas, 10 transects were surveyed. These transects were pre-determined and spaced out evenly across the geoduck beds. Transect coordinates were loaded into the GPS units of each of the two skiffs that were used for diving.

In order to produce the most valid show factor (number of geoducks counted/total geoducks present), show plot transects in this study closely mimicked transects conducted during stock assessment surveys. Two divers swam as a team along each transect, each diver holding a 1-meter rod (a 2.1cm diameter white PVC tube) in a horizontal position perpendicular to the transect path. Diver 1 carried a 10m line with attached weight, and a compass mounted on the transect rod to maintain the predetermined compass bearing. Diver 2 carried a writing slate with a data form attached to the rod. As soon as geoduck clams were found, Diver 1 dropped the weight and both divers swam and counted geoduck clams under their respective rods until the line was taut. Diver 1 used hand signals to relay geoduck counts to Diver 2 for recording. Then Diver 1 pulled the line and weight to the next starting position and began next 10-meter segment.

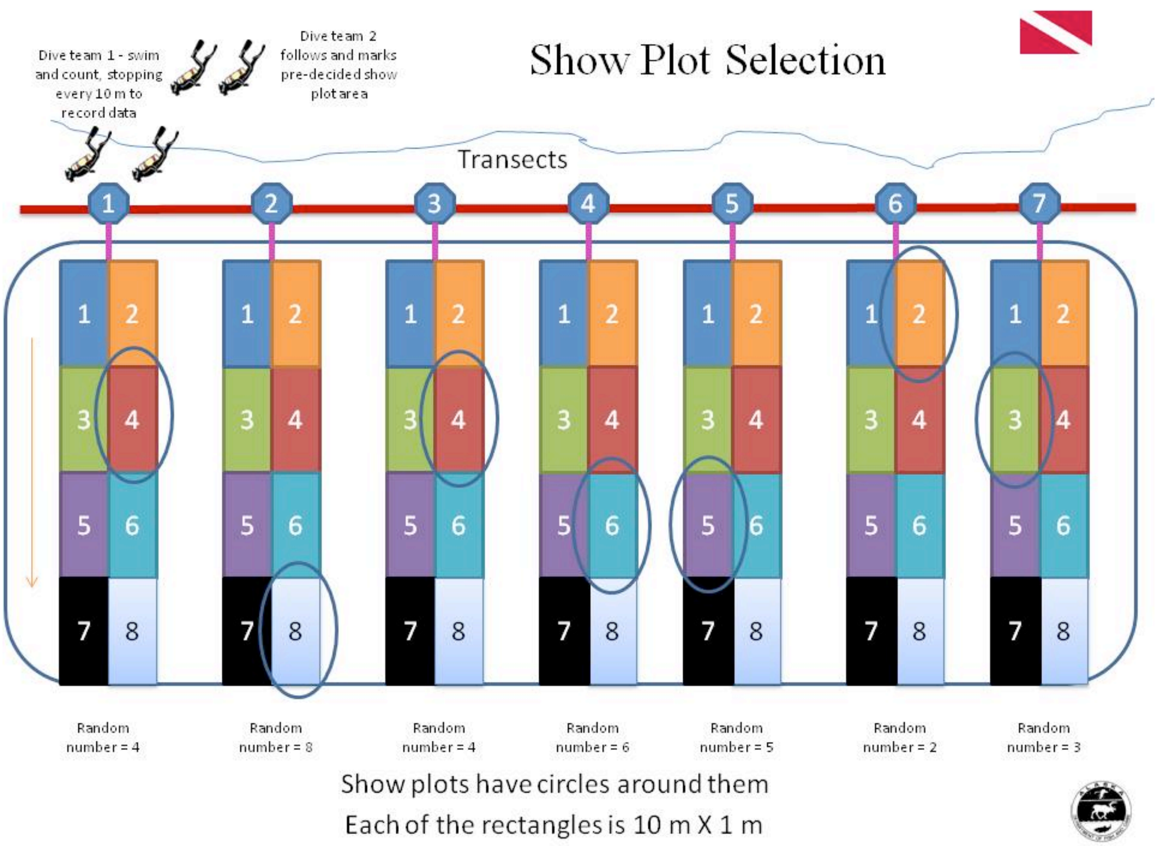

Figure 2. Show plot selection diagram.

As the divers surveyed the transect, one 10-meter segment had been randomly selected (pre-determined) as the show plot site by a second dive team swimming behind the first dive team (for example see Figure 2). To reduce chance of bias, Dive Team 1 was informed of the show plot selection only after estimates within the segment had been completed. Immediately after Dive Team 2 identified the show plot, the four corners were marked by Dive Team 2 with flagging, and then the entire perimeter was marked with line with the help of both dive teams.

Each show plot was marked with a buoy to the ocean surface so that it could be found for future geoduck marking and dredging. After the show plot boundaries were marked, divers placed flags in the substrate next to each geoduck siphon observed within the show plot area. Divers returned to the sample site after at least 18 hours to flag geoducks that they had not flagged before in the defined show plot. After all visible geoduck siphons were flagged, the total number of flags in the show plot were counted and recorded. The flags, show plot lines, and anchors were then removed.

Geoduck sample removal

Attempted geoduck removal from show plot areas by commercial geoduck harvest divers, contracted by SARDFA, was not successful. The contracted divers were responsible for operation of harvest/sampling equipment, removing substrate to expose geoducks, and freeing geoducks from the substrate. The equipment setup of the dredge did not work as originally planned. The removal of the substrate was slow and the sides of the show plot area caved in, producing inadequate results. ADF&G dive teams conducted dives separate from contract divers (separate dive partners, equipment, and surface support), but were in close proximity and observed and recorded the sampling process with video and still photos. The purpose of ADF&G divers diving near the show plots was to ensure that show plot line boundaries remain intact, to make sure that digging stayed within boundaries, and to help collect and transport the geoducks. Sampled geoducks were bagged and brought to the surface where they were counted, weighed, processed to remove the meat, and the shells were cleaned and tagged with an identification number.

Laboratory sample processing

Geoduck valves were processed at the Alaska Department of Fish and Game Age Determination Unit (ADU). The ADU processed the left valve (shell) for aging (with few exceptions). Processing included measurement of valve length (mm), height (mm), and weight (g). To determine ages, subsamples from each valve were obtained using a thin-section technique similar to that found in Hagen and Jaenicke 1997 (see Neves and Moyer 1988 for a comparison of techniques). For each specimen, a rough cut section centered around the umbo was cut out of the valve hinge using a tile saw. Three serial sections were cut using a thin-section saw. The first cut was positioned as close to the center of the umbo as possible and subsequent cuts were made into the hinge plate. The sections were mounted to a glass petrographic slide with clear mounting resin. Slides were placed in a slide holder and the sections were thinned using a mechanical grinding wheel and then polished. Aging of these specimens has not been completed. Ages will be estimated by counting annuli viewed using reflected light and a stereomicroscope, and the specimen age recorded.

Estimates of growth rate and natural mortality

Sampled geoducks will be used to assess growth and natural mortality for the region or by individual area where appropriate; currently, no data exist for these life history parameters in Southeast Alaska. Growth will be compared among areas using the Ludvig von Bertalanffy model:

$$W_{(t)} = W_{\infty}\left[1 - e^{-k(t-t_0)}\right]^{\beta}$$

where W(t) is the weight at age t, W∞ the maximum weight, and k and β are growth parameters (Quinn and Deriso, 1998). Growth parameters will be estimated and compared among areas using nonlinear least squares methods.

Estimates of natural mortality rate will be calculated using catch curve analyses (Seber, 1982; Quinn and Deriso, 1998) in a similar manner done with geoducks in British Columbia (Bradbury and Tagart 2000) by examining age frequency data. Generally, a regression of the frequency of geoducks (ln-transformed) as a function of age will be performed on a truncated dataset where both young and old ages will be removed. Although estimates of natural mortality rate for each area are desired, sampling constraints will likely require pooling age frequency data among areas.

Estimates of Show Factor
Show factor experiments have been conducted but not analyzed and estimated. To estimate the ability of divers to accurately count geoducks during normal survey procedures we will compare the percentage difference between total geoducks and the survey count (i.e., show factor) in the 10m2 show plots. Total geoducks will be estimated by either the total number of flags placed or the total number extracted by the commercial divers within the show plots. Variation in show factors will be compared among areas using a nested one-way ANOVA with areas nested within the otter treatment (presence/absence). However, due the low sample size (n=2) for the otter treatment and the confounding affect of spatial proximity, the analysis may be simplified into a one-way ANOVA with the main treatment being area (rather than otter presence). In addition, covariates of substrate type, water temperature, and a subjective estimate of how easy geoducks are to see (showing) will be examined. All data will be transformed appropriately to meet assumptions of ANOVA.

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