ENVIRONMENTAL ASSESSMENT OF PROPOSED GEODUCK HARVEST ON THE ALDEN BANK NE GEODUCK TRACT (#02800)

Commercial geoduck harvest is jointly managed by the Washington Departments of Fish and Wildlife (WDFW) and Natural Resources (DNR) and is coordinated with treaty tribes through annual harvest management plans. Harvest is conducted by divers from subtidal beds between the -18 foot and -70 foot water depth contours (corrected to mean lower low water, hereafter MLLW). Harvest is rotated throughout Puget Sound in seven geoduck management regions. The fishery, its management, and its environmental impacts are presented in the Puget Sound Commercial Geoduck Fishery Management Plan and Final Supplemental Environmental Impact Statement (WDFW & DNR, May 2001). The proposed harvest at Alden Bank is described below.

Proposed Harvest Dates: 2024 - 2025

Tract name: Alden Bank NE tract (Tract #02800)

Description: (Figure 1, Tract vicinity map)

The Alden Bank NE geoduck tract is a subtidal area of approximately 317 acres (Table 1) between Cherry Point on the mainland and Sucia Island in the San Juan Islands/Strait of Georgia Geoduck Management Region (Figure 1). The commercial tract area is between the -40 ft. and the -70 ft. (MLLW) water depth contours.

The tract harvest area is bounded by a line projected southeasterly from a control point (CP) on the -70 foot (MLLW) water depth contour in the most northerly portion of the tract at 48°49.945’ N latitude, 122°50.500’ W longitude (CP 1) along the -70 foot (MLLW) water depth contour to a point at 48°49.443’ N latitude, 122°49.640’ W longitude (CP 2); then southwesterly to a point at 48°49.269’ N latitude, 122°49.947’ W longitude (CP 3); then westerly to a point at 48°49.173’ N latitude, 122°50.621’ W longitude (CP 4); then northwesterly to a point at 48°49.674’ N latitude, 122°51.035’ W longitude (CP 5); then northeasterly to the point of origin (Figure 2).

This estimate of the tract boundary is made using Geographic Information System (GIS) data layers that were generated from NOAA soundings. All contours are corrected to mean lower low water (MLLW). The shoreline data is from DNR, digitized at 1:24,000 scale in 1999. The -70 ft. (MLLW) water depth contour is used for the deep water boundary. The biological survey indicates that Alden Bank is deeper than -40 ft. (MLLW) throughout the entire tract area. The latitude and longitude positions are reported in decimal minutes to the closest thousandth of a minute. Corner latitude and longitude positions are generated using GIS, and have not been field verified to determine consistency with area estimates, landmark alignments, or water depth contours. The delineation of the tract boundary will be field verified by DNR prior to any geoduck harvest. Any variance to the stated boundary will be coordinated between WDFW and DNR prior to geoduck harvest.

Substrate:

Geoducks are found in a wide variety of sediments ranging from soft mud to gravel. The most common sediments where geoducks are harvested are sand with varying amounts of mud and/or gravel. The specific sediment type of a bed is primarily determined by water current velocity. Coarse sediments are generally found in areas of fast currents and finer (muddier) sediments in areas of weak currents. The major impact of harvest will be the creation of small holes where the geoducks are removed. The holes fill in within a few days to several weeks and have no long-term effects. The substrate holes refill in areas with strong water currents much faster than in areas with weak water currents. Water currents tend to be strong in the vicinity of the Alden Bank NE tract. Currents reach an estimated maximum flood velocity of 3.1 knots and maximum ebb velocity of 2.6 knots (Tides and Currents software; station #2086; 0.8 miles W. of Matia Island).

Substrate types are consistent across this tract (subsurface substrates from dig samples are found in Table 2) with sand being the predominant surface substrate type on all transects (Table 3, Figure 3). Mud was the dominant substrate on 7 transects in the southern portion of the tract. Other substrate types observed includes mud, shell, pea gravel, gravel, boulders and cobble.

Water Quality:

Water conditions vary greatly at the Alden Bank NE tract. The following data on water quality has been provided by the Washington Department of Ecology (DOE) for the Georgia Strait - N. of Patos Is. station (GRG002) at 48.8083° North latitude; 122.9533° West longitude. For the year 2015 (the most recent data year available), for water depths between 40 and 70 feet, the mean reported dissolved oxygen (D.O.) concentration is 7.3 mg/l with a range from 5.9 to 8.2 mg/l. The mean salinity at this station was 28.9 ppt with a range from 27.4 to 29.8 ppt. The mean water temperature at this station was 50.7°F with a range from 47.6 to 56.5°F.

This area is classified as "Approved" by the Washington Department of Health (DOH) for commercial shellfish harvest. This area is regulary tested for inorganic arsenic prior to harvest, but the 2024- 2025 status is unknown at this time. This tract is not currently on the list of approved tracts to export geoducks to China (https://doh.wa.gov/community-and-environment/shellfish/commercial-shellfish/export/export-china). Officials from China recently advised NOAA that they lifted the ban on imports of live shellfish from Washington and Alaska. The Department of Health continues to coordinate the collection of geoduck samples for arsenic analysis throughout Puget Sound (8/25/2015). More detailed information regarding arsenic can be found at the DOH web site, including a fact sheet found at https://doh.wa.gov/community-and-environment/contaminants/arsenic.

DNR will verify the health status of the Alden Bank NE tract prior to any state sanctioned geoduck harvest.

Biota:

Geoduck:

The Alden Bank NE geoduck tract is approximately 317 acres and currently contains an estimated 1,829,128 pounds of geoducks (Table 1). The geoduck biomass estimate at this tract is based on a 2013 Lummi Tribe survey estimate of 2,212,497 pounds and a subtraction of reported commercial harvest of 383,369 pounds (through April 12, 2024). On all 10 dig stations (n=99 geoducks), geoducks were considered commercial quality (Table 2). Geoduck dig station difficulty ratings ranged from “very easy” to “difficult” to dig. Factors contributing to digging difficulty on station #3 were moderate to low abundance and a shell layer. In 2015, WDFW placed additional transects on this tract (22 transects). In a paired t-test (95% confidence interval) there was no significant difference between the transect densities observed by WDFW and the Lummi Tribe.

The geoduck density on this tract is moderate to low, currently averaging 0.07 geoducks/sq.ft. compared to a Puget Sound average density of about 0.16 geoducks/sq.ft. The geoducks at the Alden Bank NE tract have an average weight of 1.95 pounds compared to the Puget Sound average geoduck weight of 2.42 pounds. The weights of geoducks do not vary much among the dig stations sampled. The lowest average whole weight is 1.74 pounds per geoduck at station #9 and the highest average whole weight is 2.07 pounds per geoduck at station #8 (Table 4).

Geoducks are managed for long term sustainable harvest. No more than 2.7% of the fishable stocks are harvested (total fishing mortality) each year in each management region throughout Puget Sound. The fishable portion of the total Puget Sound population includes geoducks that are found in water deeper than -18 feet and shallower than -70 feet (corrected to mean lower low water - MLLW). Other geoducks which are not harvestable are found inshore and offshore of the harvest areas. Observations in south Puget Sound show that major geoduck populations continue to depths of 360 feet. Additional geoducks exist in polluted areas and are also unavailable for harvest, but continue to spawn and contribute to the total population.

The low rate of harvest is due to geoduck's low rate of natural recruitment. WDFW has studied the regeneration rate of geoducks on certain tracts throughout the Salish Sea. The estimated average time to regenerate a tract to its original density, after removal of 65 percent of the geoducks, is 55 years. The recovery time for the Alden Bank tract is unknown. The research to empirically analyze tract recovery rates is continuing.

Fish:

Geoduck beds are generally devoid of rocky outcroppings and other relief features that attract and support many fish species, such as rockfish and lingcod. The bottoms are relatively flat and composed of soft sediments, providing few attachments for macroalgae, which also is associated with rockfish and lingcod. The fish observed during the surveys at the Alden Bank NE tract were various species of flatfish (sanddabs, starry flounder, and a skate), sculpins, and dogfish sharks (Table 6).

WDFW marine fish managers were asked of their concerns regarding any possible impacts on groundfish and baitfish due to geoduck fishing. Greg Bargmann of WDFW stated that geoduck fishing would have no long-term detrimental impacts and may have some short-term benefits to flatfish populations by increasing the availability of food. Dan Penttila of the WDFW Fish Management Program recommended that eelgrass beds within the harvest tract should be preserved for any spawning herring. No eelgrass has been observed on this tract. The entire tract is below a depth of -40 feet (MLLW) and eelgrass has never been observed on geoducks tracts at this depth.

There are no Pacific herring spawning grounds documented on Alden Bank (Figure 4). However, a herring pre-spawner holding area has been identified off the northern shoreline of Alden Bank. With a horizontal separation from known herring fish spawning sites, a nearshore geoduck harvest restriction of -18 ft. or deeper, and lack of eelgrass beds or any significant spawning substrate within the tract, geoduck harvest on the Alden Bank NE tract should have no detrimental impacts on herring spawning.

Sand lance spawning has not been documented on Alden Bank (Figure 4). Sand lance populations are widespread within Puget Sound, the Strait of Juan de Fuca and the coastal estuaries of Washington. They are most commonly noted in areas such as the eastern Strait and Admiralty Inlet. However, WDFW plankton surveys and ongoing exploratory spawning habitat surveys suggest that there are very few if any bays and inlets in the Puget Sound basin that will not be found to support sand lance spawning activity. Sand lance spawning occurs at tidal elevations ranging from +5 feet to about the mean higher high water line. After deposition, sand lance eggs may be scattered over a wider range of the intertidal zone by wave action. The incubation period is approximately four weeks. Sand lances are an important part of the trophic link between zooplanktons and larger predators in the local marine food webs. Like all forage fish, sand lances are a significant component in the diet of many economically important resources in Washington. On average, 35 percent of juvenile salmon diets are comprised of sand lance. Sand lances are particularly important to juvenile Chinook salmon, and comprise approximately 60 percent of their diet. Other economically important species, such as Pacific cod (*Gadus macrocephalus*), Pacific hake (*Merluccius productus*) and dogfish (*Squalus acanthias*) feed heavily on juvenile and adult sand lance. There is substantial vertical separation between sand lance spawning (+5 feet to mean higher high water) and geoduck harvest activity at Alden Bank (-40 ft. to -70 ft., MLLW). Geoduck harvest on the Alden Bank NE tract should have no detrimental impacts on sand lance spawning.

There is no surf smelt spawning habitat identified on the Alden Bank NE tract (Figure 4). The nearest documented surf smelt spawning habitat is in the vicinity of Cherry Point on the mainland. Surf smelt deposit adhesive, semitransparent eggs on beaches that have a specific mixture of coarse sand and pea gravel. Inside Puget Sound, surf smelt spawning is thought to be associated with freshwater seepage, where the water keeps the spawning gravel moist. Eggs are deposited near the water's edge in water a few inches deep, around the time of the high water slack. There is substantial vertical separation between surf smelt spawning (slack high tide) and geoduck harvest activity at Alden Bank (-40 ft. to -70 ft., MLLW). Geoduck harvest on the Alden Bank NE tract should have no detrimental impacts on surf smelt spawning.

NOAA Fisheries Service announced on April 27, 2010 that it was listing canary and yelloweye rockfish as “threatened” and bocaccio as “endangered” under ESA (federal Endangered Species Act). The listings became effective on July 27, 2010. Historic high levels of fishing and water quality are cited as reasons that these rockfish populations are in peril and have been slow to recover. On January 23, 2017; canary rockfish were delisted based on newly obtained samples and genetic analysis (Federal Register 82 FR 7711). Geoduck fishery managers are tracking this process and will take actions necessary to reduce the risk of “take” of any listed rockfish species that could potentially result from geoduck harvest activity.

Two salmon populations, Puget Sound Chinook salmon and Hood Canal summer run chum salmon, were listed by the National Marine Fisheries Service on March 16, 1999, as threatened species under the federal Endangered Species Act. Critical habitat for summer run chum salmon populations includes all marine, estuarine, and river reaches accessible to the listed chum salmon between Dungeness Bay and Hood Canal, as well as within Hood Canal. The timing for summer run chum spawning is early September to mid-October. Out-migration of juveniles has been observed in Hood Canal during February and March, though may occur as late as mid-April. The Alden Bank NE tract is outside of the critical habitat range for Hood Canal summer run chum salmon.

Critical habitat for Puget Sound Chinook salmon includes all marine, estuarine and river reaches accessible to listed Chinook salmon in Puget Sound. WDFW recognizes 27 distinct stocks of Chinook salmon: 8 spring-run, 4 summer-run, and 15 summer/fall and fall-run stocks. The existence of an additional five spring-run stocks is in dispute. The majority of Puget Sound Chinook salmon emigrate to the ocean as sub-yearlings. There are no major streams or tributaries near the Alden Bank NE geoduck tract that support Chinook salmon runs.

The geographic separation (horizontal) of this tract from known spawning tributaries and vertical separation of geoduck harvest (deeper and seaward of the -18 ft. MLLW contour) from juvenile salmon rearing areas and migration corridors (upper few meters of the water column) reduces or eliminates potential impacts to salmon populations. Charles Simenstad of the University of Washington School of Fisheries stated that the exclusionary principle of not allowing leasing/harvesting in water shallower than -18 ft. MLLW, the 2 foot vertically from elevation of the lower eelgrass margin, and within any regions of documented herring or forage fish spawning should under most conditions remove the influences of harvest- induced sediment plumes from migrating salmon. Geoduck harvest should have no impact on salmon populations.

On May 7, 2007, NOAA Fisheries Service announced listing of Puget Sound steelhead as “threatened” under ESA. This listing includes more than 50 stocks of summer- and winter-run steelhead. Steelhead share many of the same waters as Puget Sound Chinook salmon, which are already protected by ESA, and will benefit from shared conservation strategies. The nearest identified river in the vicinity of the Alden Bank NE tract that support steelhead stocks is the main stem of the Lummi River (approximately 7.4 miles). The Lummi River has a winter steelhead run. The horizontal separation between tributaries that support steelhead runs and the Alden Bank NE tract will assure that geoduck harvest will likely have no impact on steelhead populations.

Green sturgeon have undergone ESA review in recent years, due to depressed populations. NOAA Fisheries Service produced an updated status review on February 22, 2005, and reaffirmed that the northern green sturgeon Distinct Population Segment (DPS) warranted listing as a species of concern, however proposed that the Southern DPS should be listed as threatened under the ESA. NMFS published a final rule on April 7, 2006, listing the Southern DPS as threatened [pdf] (71 FR 17757), which took effect June 6, 2006. The green sturgeon critical habitat proposed for designation includes the outer coast of Washington within 110 meters (m) depth (including Willapa Bay and Grays Harbor) to Cape Flattery and the Strait of Juan de Fuca to its United States boundary. Puget Sound proper has been excluded from this critical habitat designation. The Alden Bank NE geoduck tract is outside or at the fringe of the critical habitat range of green sturgeon; therefore geoduck harvest will likely have no adverse effects on ESA recovery efforts for green sturgeon populations.

Invertebrates:

Many different kinds of invertebrates which are frequently found on geoduck beds were observed on this tract, including anemones, tunicates, bivalves, cnidarians, crabs, cucumbers, gastropods, barnacles, nudibranchs, sea stars and annelid worms (Table 6).

Geoduck harvest has not been shown to have long-term adverse effects on these invertebrates. Geoduck harvest can depress local populations of some benthic invertebrates, however most of these animals recover within one year.

There is on-going interest from recreational and commercial crab fishers about interactions between geoduck harvest activity and Dungeness crab populations. Dr. Dave Armstrong at the University of Washington has determined that Dungeness crab utilize Puget Sound bottoms from the +1 foot level out to the -330 foot level. The California Department of Fish and Wildlife suggest that coastal Dungeness crab can be found in waters as deep as 750 feet (https://wildlife.ca.gov/Conservation/Marine/Life-History-Inv-And-Plants). Jensen (2014) and WDFW information (personal comm. WDFW Biologist Don Velasquez, personal comm. 7/23/15) confirm a similar vertical distribution in Puget Sound, though the highest densities are found between the 0 to 360 foot water depth contours.

To determine the potential impacts to Dungeness crab, the percentage of substrate disturbed during fishing was calculated and compared to the entire crab habitat within the tract and shoreward of the tract to the +1 foot level and seaward out to -360 foot (MLLW) water depth contour (Figure 5, Potential crab habitat map). The entire crab habitat along this tract is approximately 3707 acres. There are about 1,133,226 harvestable geoducks on this tract, from the 2013 pre-fishing survey estimate. With a harvest of 65 percent, the total number harvested would be 736,597 geoducks. Approximately 1.18 square feet of substrate is disturbed for every geoduck harvested, so 736,597 x 1.18 = 869,184 square feet of substrate. This equals about 20 acres. This is about 0.5 percent of the total available crab habitat in the vicinity of this tract. Based on the moderate number of observations of Dungeness crab occupying this tract, the low amount of disturbance, and the lack of effects observed at the Thorndyke Bay study, we conclude that any effects on Dungeness crab populations will be very minor, if they occur at all.

Aquatic Algae:

Large attached aquatic algae are not generally found in geoduck beds in large quantities. Light restriction often limits algal growth to areas shallower than where most geoduck harvest occurs. Aquatic algae observed (Table 7) during geoduck surveys include:

> Small and large foliose red algae; Laminaria algae; small and large unidentified brown algae; Desmarestian algae; Agarum sp.; and diatoms.

John Boettner and Tim Flint, from the WDFW Habitat Division, have stated that if geoduck fishing is restricted to seaward of the eelgrass beds, they have no concerns about the fishing and that the existing conditions in the fishery SEIS are sufficient to protect fish and wildlife habitat and natural resources. No eelgrass beds are known to exist in the vicinity of the tract, likely due to the deep depth of Alden bank at this location (>40 ft. MLLW).

Marine Mammals:

Several species of marine mammals, including seals, sea lions, and river otters may be observed in the vicinity of this geoduck tract. Killer whales (*Orcinus orca*) may also be observed in the vicinity of this tract. The Southern Resident stock of killer whales resides mainly in the San Juan Islands throughout spring and summer, but incursions south into Puget Sound occur more frequently during winter months (Brent Norberg, NOAA, pers. comm. 5/15/06). The Southern Resident stock of killer whales was listed as "endangered" under the federal Endangered Species Act (ESA) by the National Marine Fisheries Service on November 15, 2005. This is in addition to the designation of this stock in May 2003 as "depleted" under the Marine Mammal Protection Act. More information and a recovery plan for this stock can be found at the NOAA website: https://www.fisheries.noaa.gov/action/listing-southern-resident-killer-whale-under-esa.

Hand pick shellfish fisheries, like geoduck harvesting, are considered Category III under the Marine Mammal Authorization Program for Commercial Fisheries. This means that there is a "rare or remote" likelihood of marine mammal "take," (Brent Norberg, NOAA, pers. comm. 5/15/06). Precautions should be taken by commercial divers, when marine mammals are in the area, to be aware of marine mammal movements and behavior to eliminate the remote risk of entanglement with diver hoses and lines.

Birds:

A variety of marine birds are common in Puget Sound and in the general vicinity of this tract. The most significant of these are guillemots, murres, murrelets, grebes, loons, scoters, dabbing ducks, black brant, mergansers, buffleheads, cormorants, gulls, and terns. Blue heron, bald eagles, and osprey are regularly observed. Geoduck harvest does not appear to have any significant effect on these birds or their use of the waters where harvest occurs. A study by DNR and the WDFW was conducted at northern Hood Canal to learn the effects of geoduck fishing on bald eagles (Watson *et al*., 1995). A significant conclusion of this study is that geoduck clam harvest is unlikely to have any adverse impacts on bald eagle productivity.

Other uses:

Adjacent Upland Use:

Unlike most geoduck tracts, the Alden Bank NE tract is not located along a shoreline.

Harvest is only allowed during daylight hours, and no harvest is allowed on Saturdays, Sundays, or state holidays. The only visual effect of harvest is the presence of the harvest vessels on the tract. These 35-40 foot boats are anchored during harvest and all harvest is conducted out of sight by divers. Noise from the boats, compressors and pumps may not exceed 50 dBA measured 200 yards from the noise source, 5 dBA below the state noise standard.

Fishing:

This area is a prime sport fishing area for Dungeness crab. The recreational crab fishery is generally open from mid-August through the end of September and it then re-opens the first or second week of October through December 31. Some recreational salmon and halibut fishing could occur seasonally in proximity to the geoduck bed. The WDFW Sport Fishing Rules pamphlet describes additional seasons, size limits, daily limits, specific closed areas, and additional rules for salmon and other marine fish species. A few small-scale commercial fisheries may take place in the area. Treaty commercial crab harvest occurs sporadically between August 1 and October 1. State commercial crab harvest opens on October 1 and lasts through March. The fishing which does occur, can be intensive and it may present gear conflicts with the geoduck harvesting effort in the area. This area is generally free from any crab activity from April 15 through July 31.

Geoduck fishing on this tract is managed in coordination with the northern Puget Sound Treaty Tribes through annual state/tribal harvest management plans.

Navigation:

Alden Bank experiences a moderate amount of recreational vessel traffic, with seasonal fluctuations. The Alden Bank NE tract is not within a major traffic lane. Geoduck harvesting at this site should not result in any significant navigational conflicts. The Department of Natural Resources will notify the local boating community prior to harvests.

Summary:

Commercial geoduck harvest is proposed for the Alden Bank NE geoduck tract located between Cherry Point and Sucia Island. The tract was most recently surveyed in 2013 by the Lummi Tribe and in 2015 by WDFW. The tract biomass estimate is based on the 2013 survey and recent harvests. The tract is far removed from any upland residences. There is potential for gear conflicts with the commercial crab fishery. To reduce the potential for gear conflicts, the geoduck harvest should occur between April 15 and August 1. The anticipated environmental impacts of this harvest are within the range of conditions discussed in the Final Supplemental Environmental Impact Statement (2001) for the commercial geoduck clam fishery.

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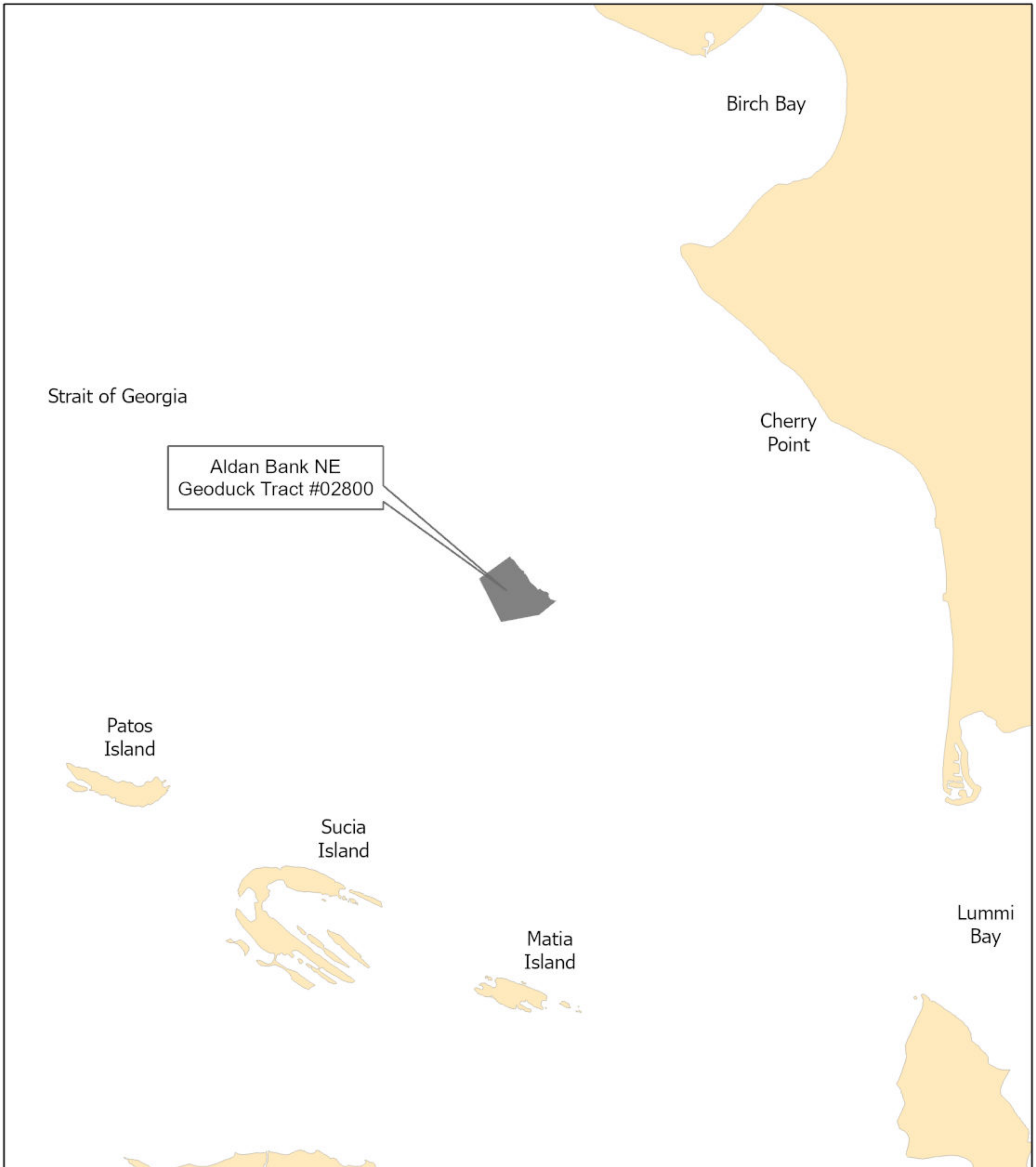
Figure 1. Vicinity Map, Alden Bank NE Commercial Geoduck Tract #02800



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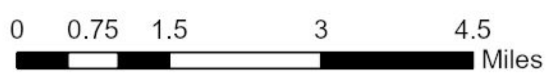
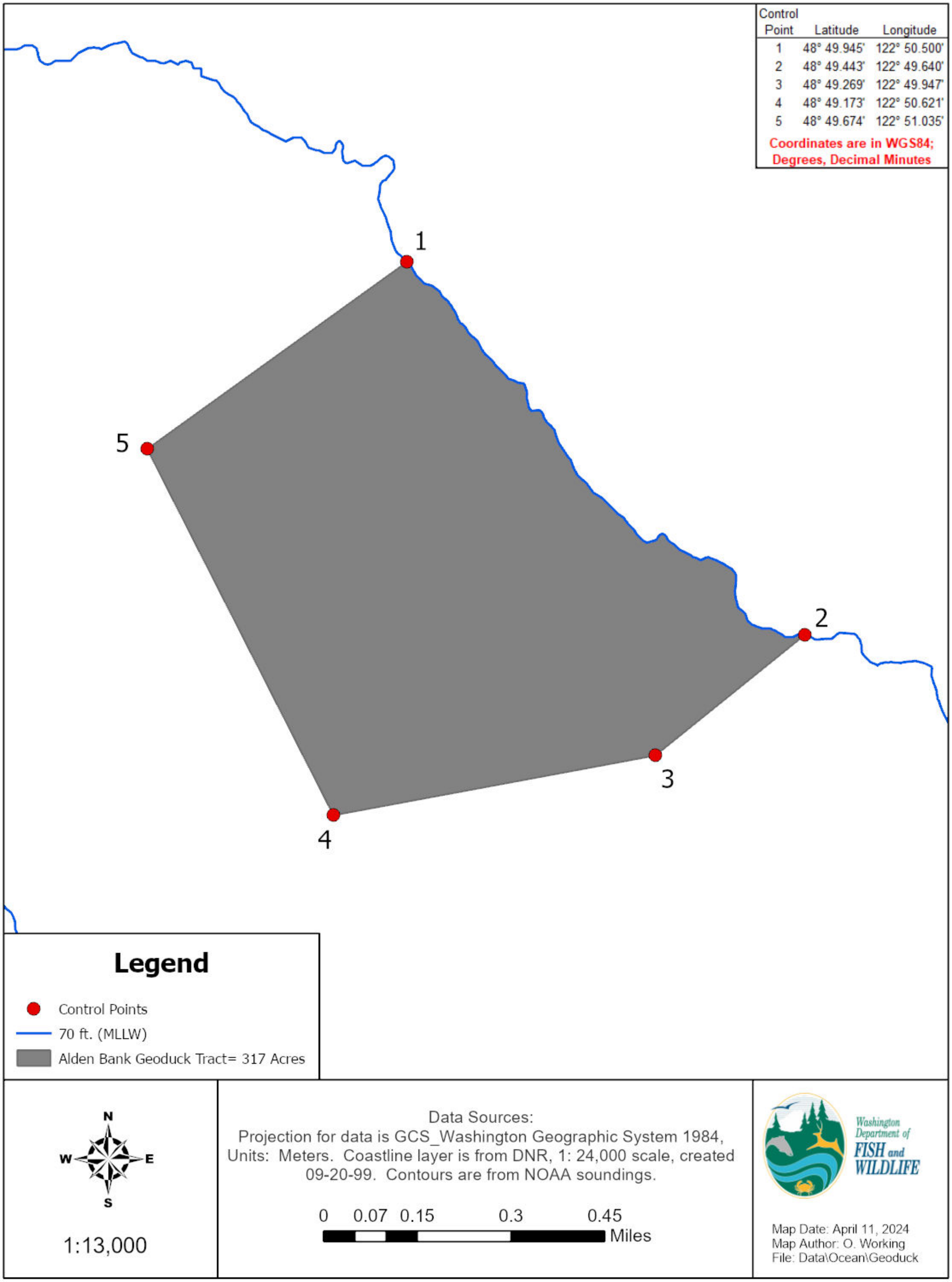
Data Sources:
Projection for data is GCS_Washington Geographic System 1984, Units: Meters. Coastline layer is from DNR, 1: 24,000 scale, created 09-20-99. Contours are from NOAA soundings.



Washington Department of FISH and WILDLIFE

Map Date: April 11, 2024
Map Author: O. Working
File: Data\Ocean\Geoduck

Figure 2. Control Points Map, Alden Bank NE Commercial Geoduck Tract #02800



Control Point	Latitude	Longitude
1	48° 49.945'	122° 50.500'
2	48° 49.443'	122° 49.640'
3	48° 49.269'	122° 49.947'
4	48° 49.173'	122° 50.621'
5	48° 49.674'	122° 51.035'

Coordinates are in WGS84; Degrees, Decimal Minutes

Data Sources:
Projection for data is GCS_Washington Geographic System 1984, Units: Meters. Coastline layer is from DNR, 1: 24,000 scale, created 09-20-99. Contours are from NOAA soundings.

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File: Data\Ocean\Geoduck

Figure 3. Transect and Dig Station Map, Alden Bank NE Commercial Geoduck Tract #02800

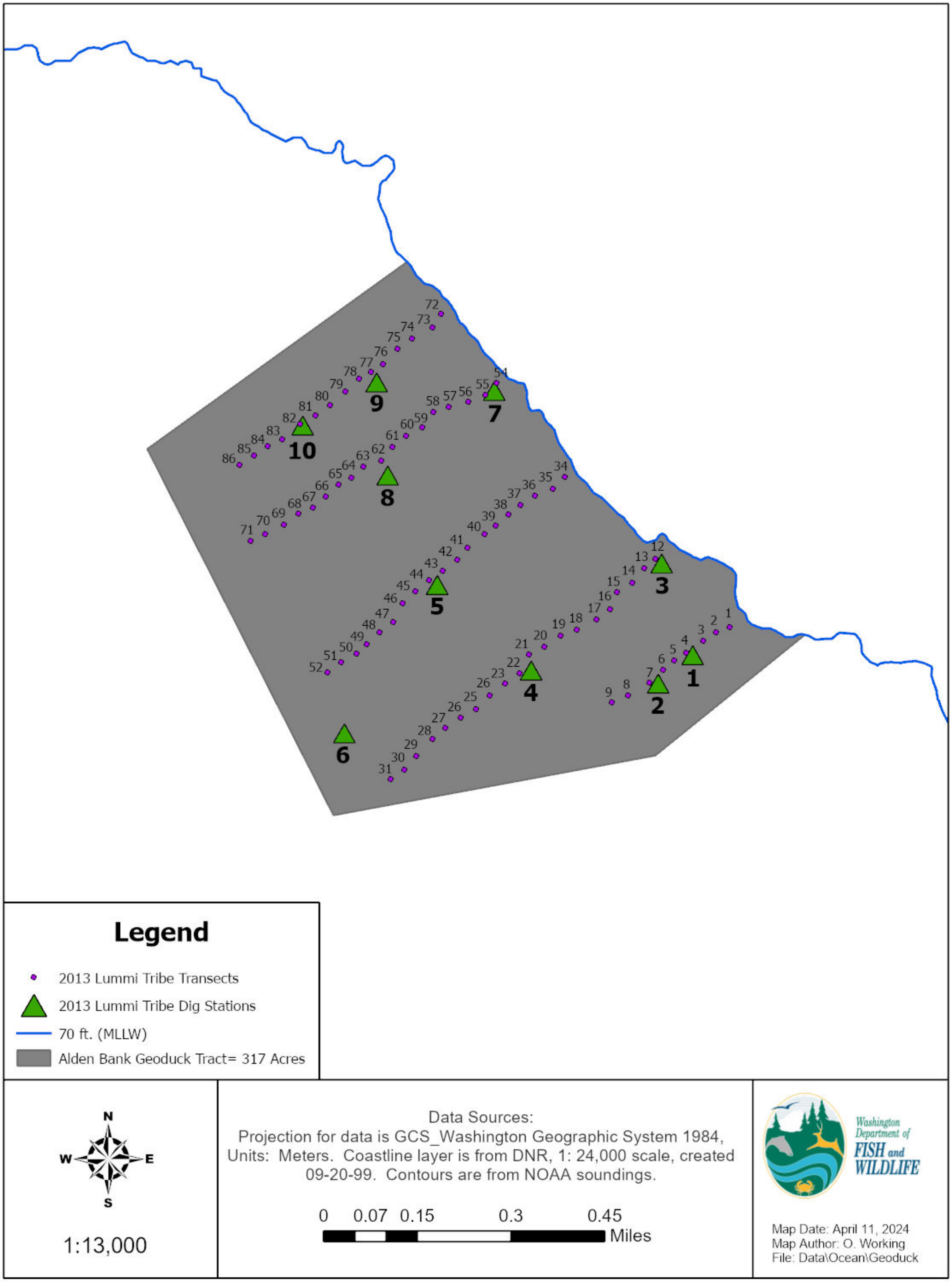


Figure 4. Fish Spawning Areas Near the Alden Bank NE Commercial Geoduck Tract #02800

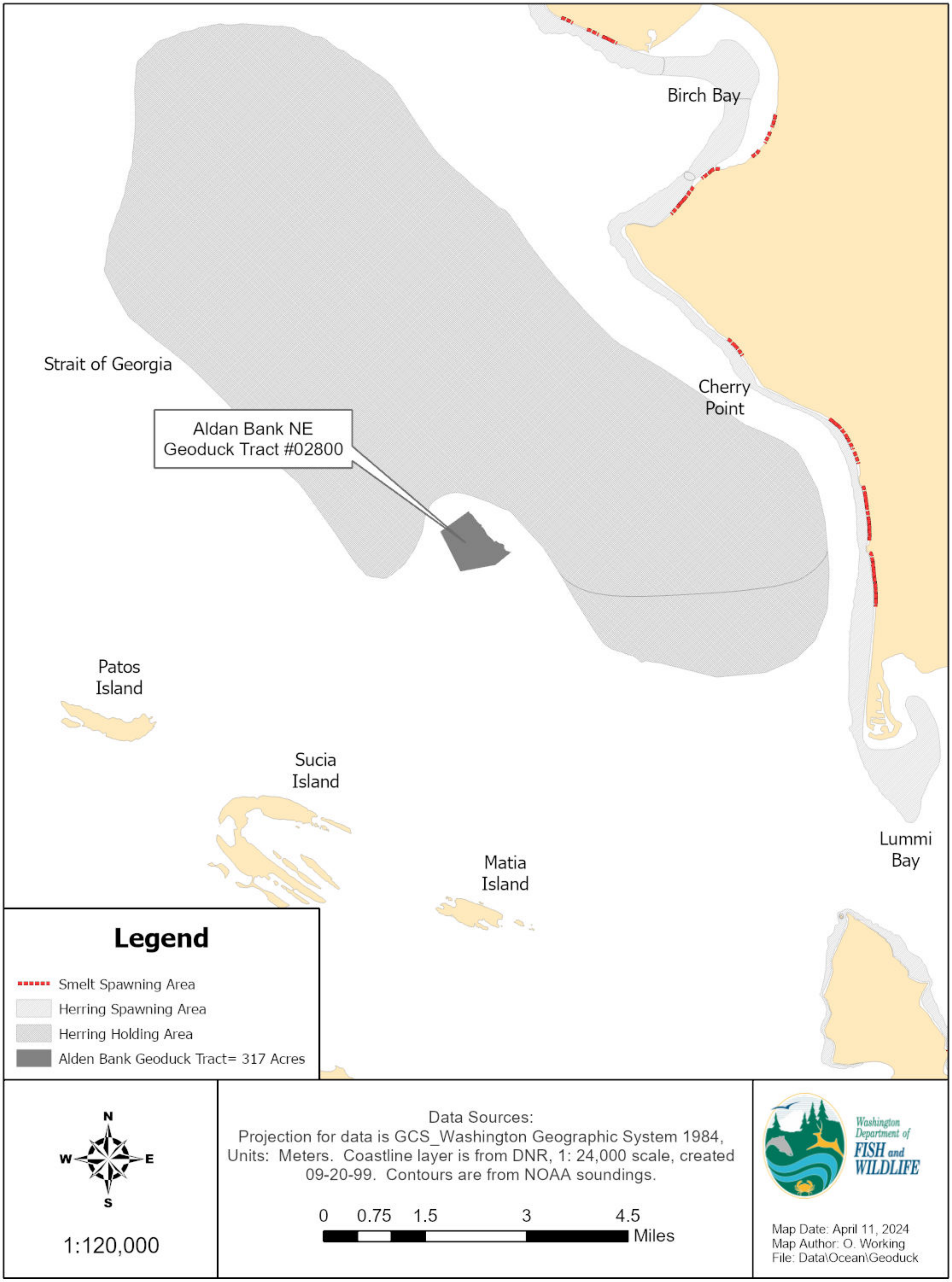
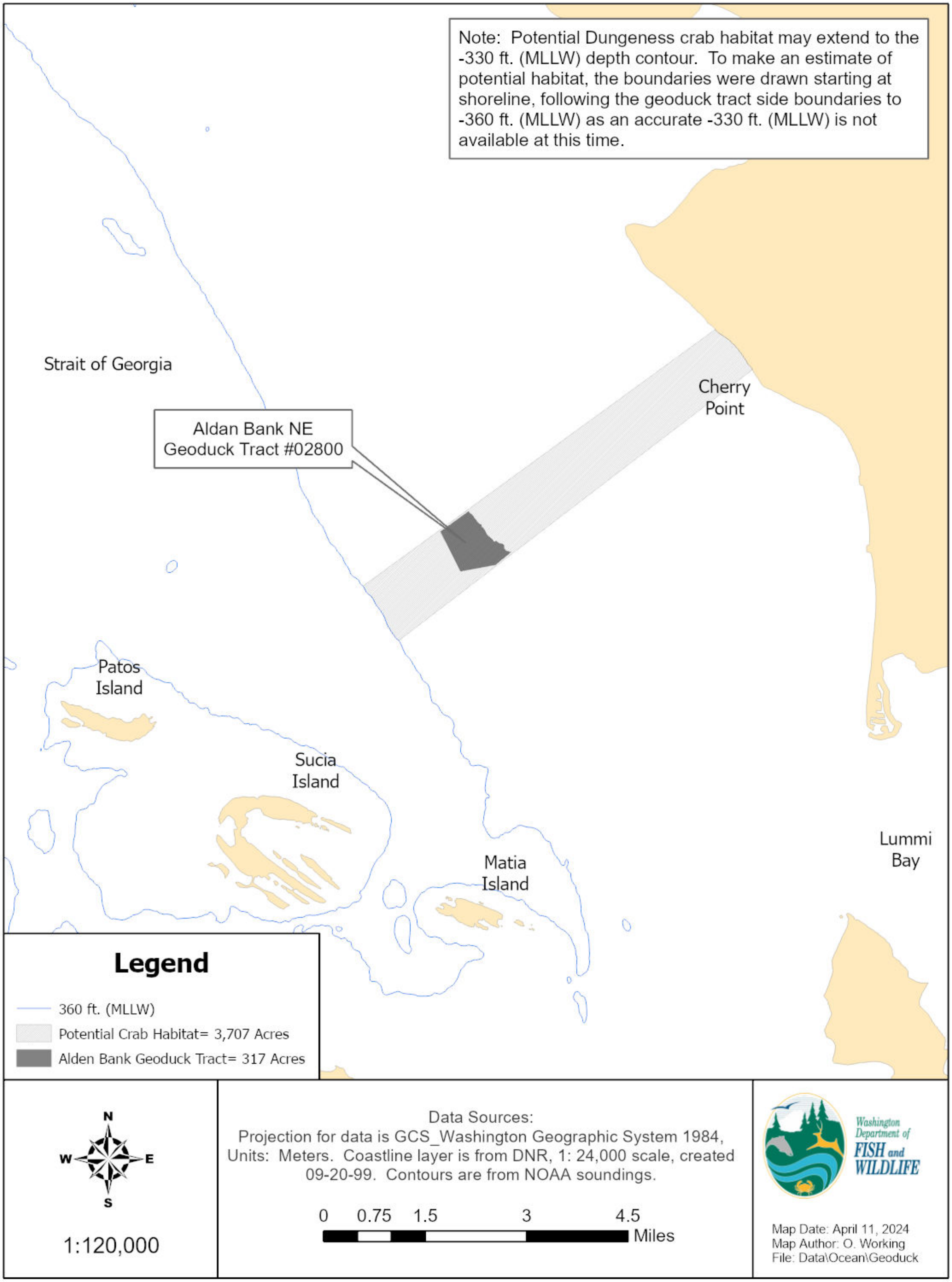


Figure 5. Potential Dungeness Crab Habitat Map, Alden Bank NE Commercial Geoduck Tract #02800



EXPLANATION OF SURVEY DATA TABLES

The geoduck survey data for each tract is reported in seven computer-generated tables. These tables contain specific information gathered from transect and dig samples and diver observations. The following is an explanation of the headings and codes used in these tables.

Tract Summary

This table is a general summary of survey information for the geoduck tract including estimates of *Tract Size* in acres, average geoduck *Density* in animals per sq.ft., *Total Tract Biomass* in pounds with statistical confidence, and *Total Number of Geoducks*. Mass estimators are reported in average values for *Whole Weight* and *Siphon Weight* in pounds. Geoduck siphon weights are also reported in *Siphon Weight as a percentage of Whole Weight.* Biomass estimates are adjusted for any harvest that may occur subsequent to the pre-fishing survey.

Digging Difficulty

This table presents a station-by-station evaluation of the factors contributing to the difficulty of digging geoduck samples with a 5/8” inside nozzle diameter water jet. Codes for the overall subjective summary of the digging difficulty are given in the *Difficulty* column. An explanation of the codes for the dig difficulty follows:

Code	Degree of Difficulty	Description
0	Very Easy	Sediment conducive to quick harvest.
1	Easy	Significant barrier in substrate to inhibit digging.
2	Some difficulty	Substrate may be compact or contain gravel, shell or clay; most geoducks still easy to dig.
3	Difficult	Most geoducks were difficult to dig, but most attempts were successful.
4	Very Difficult	It was laborious to dig each geoduck. Unable to dig some geoducks.
5	Impossible	Divers could not remove geoducks from the substrate.

Abundance refers to the relative geoduck abundance; a zero (0) indicates that geoducks were very sparse, a one (1) indicates that they were moderately abundant and a two (2) indicates that they were very abundant. *Depth* refers to the depth that the geoducks were found in the substrate. A zero (0) indicates that they were shallow, a one (1) indicates that they were moderately deep and a two (2) indicates that they were very deep. The columns labeled *Compact*, *Gravel*, *Shell*, *Turbidity* and *Algae* refer to factors that contribute to digging difficulty by interfering with the digging process. A zero (0) in one of these columns indicates that the factor was not a problem, a one (1) indicates that the factor caused moderate difficulty and a two (2) indicates that the factor caused a significant amount of difficulty when digging. *Compact* refers to the compact or sticky nature of a muddy substrate. *Gravel* and *Shell* refer to the difficulty caused by these substrate types. *Turbidity* refers to the turbidity within the water near the dig hole caused by the digging activity. High turbidity makes it difficult to find the geoduck siphon shows. The difficulty of digging associated with turbidity varies with the amount of tidal current present. Therefore, the turbidity rating refers only to the conditions occurring when the sample was collected. *Algae* refers to algal cover, which also makes it difficult for the diver to find geoduck siphon shows. Because algal cover varies seasonally, this value only applies to the conditions when the sample was collected. The *Commercial* column gives a subjective assessment of whether or not it would be feasible to harvest geoducks on a commercial basis at the given station.

Transect Water Depths, Geoduck Densities and Substrate Observations

This table reports findings for each transect. *Start Depth* and *End Depth* (corrected to MLLW) are given for each transect. *Geoduck Density* is reported as the average number of geoducks per square foot for each 900 square foot transect. *Substrate Type* and *Substrate Rating* refer to evaluations of the substrate surface. A two (2) rating indicates that the substrate type is predominant. A one (1) rating indicates the substrate type was present.

Geoduck Weights and Proportion Over 2 Pounds

This table summarizes the size and quality of the geoducks at each of the stations where dig samples were collected. Weight values for any geoduck dig samples that were damaged during sampling to the extent that water loss occurred, are excluded from calculations. The *Number Dug* column lists the number of geoducks collected. The *Avg. Whole Weight (lbs.)* column gives the average sample weight of whole geoduck clams for each dig station. The *Avg. Siphon Weight (lbs.)* column gives the average weight of the siphons of the geoducks for each dig station. The percentage of geoducks greater than two pounds is given in the *% Greater than 2 lbs.* column.

Transect - Corrected Geoduck Count and Position Table

This table reports the diver *Corrected Count*, the geoduck siphon *Show Factor* used to correct the count, and the *Latitude/Longitude* position of the start point of each survey transect. Raw (observed) siphon counts are “corrected” by dividing diver observed counts for each transect with a siphon “show” factor (See WDFW Tech. Report FPT00-01 for explanation of show factor) to estimate the sample population density. Transect positions are reported in degrees and decimal minutes to the thousandth of a minute, datum WGS84.

Most Common and Obvious Animals Observed

This table summarizes the animals, other than geoducks, that were observed during the geoduck survey, and reports the total number of transects on which they were present (*# of Transects Where Observed)*. This is qualitative presence/absence data only, and only animals that can be readily seen by divers at or near the surface of the substrate are noted. The *Group* designation allows for the organization of similar species together in the table. Whenever possible, the scientific name of the animal is listed in *Taxonomer*, and a generally accepted *Common Name* is also listed. Many variables may make it difficult for divers to notice other animals on the tract, including but not limited to poor visibility, diver skill, animals fleeing the divers, animal size, or cryptic appearance or behavior (in crevasses or under rocks).

Most Common and Obvious Algae Observed

This table summarizes marine algae observed during the geoduck survey, and reports the total number of transects on which they were seen (*# of Transects Where Observed)*. This is qualitative presence/absence data only, and only for macro algae, with the exception of diatoms. At high densities diatoms form a "layer" on or above the substrate surface that is readily visible and obvious to divers. Other types of phytoplankton are not sampled and are rarely noted. Whenever possible, the scientific name or a general taxonomic grouping of each plant is listed in *Taxonomer*.

Last Updated: April 14, 2020
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Table 1. GEODUCK TRACT SUMMARY

Alden Bank NE geoduck tract #02800

Tract Name	Alden Bank NE
Tract Number	02800
Tract Size (acres)[a]	317
Density of geoducks/sq.ft.[b]	0.068
Total Tract Biomass (lbs.)[b]	1,829,128
Total Number of Geoducks on Tract[b]	936,867
Confidence Interval (%)	11.0%
Mean Geoduck Whole Weight (lbs.)	1.95
Mean Geoduck Siphon Weight (lbs.)	N/A
Siphon Weight as a % of Whole Weight	N/A
Number of Transect Stations	81
Number of Geoducks Weighed	99

[a.] Tract area is between the -70 ft. (MLLW) water depth contours

[b.] Biomass is based on the 2013 Lummi Tribe Pre-fishing geoduck survey biomass of 2,212,497 lbs. minus total reported harvest of 383,369 lbs through April 12, 2024

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Table 2: DIGGING DIFFICULTY TABLE

Alden Bank NE geoduck tract #02850, 2013 Lummi Tribe pre-fishing geoduck survey

Dig Station	Difficulty (0-5)	Abundance (0-2)	Depth (0-2)	Compact (0-2)	Gravel (0-2)	Shell (0-2)	Turbidity (0-2)	Algae (0-2)	Commercial (Y/N)
1	2	1	0	1	1	0	0	0	Y
2	1	2	0	0	0	0	0	0	Y
3	3	1	0	0	0	1	0	0	Y
4	2	2	0	0	1	1	0	0	Y
5	1	2	1	0	0	1	0	0	Y
6	0	0	0	0	0	1	0	0	Y
7	2	2	0	0	0	0	0	0	Y
8	0	1	0	0	0	0	0	0	Y
9	1	2	0	0	1	1	0	0	Y
10	2	1	1	0	0	1	0	0	Y

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Table 3: TRANSECT WATER DEPTHS, GEODUCK DENSITIES, AND SUBSTRATE OBSERVATIONS

Alden Bank NE geoduck tract #02850, 2013 Lummi Tribe pre-fishing geoduck survey

	Start Depth	End Depth	Geoduck Density	Substrate [c]						
Transect	(ft) [a]	(ft) [a]	(no. / sq ft) [b]	mud	sand	peagravel	gravel	shell	cobble	boulder
1	53	45	0.0681		2	1		1		
2	45	42	0.0622		2	1		1		
3	42	41	0.0459		2	1		1		
4	41	41	0.0874		2			1		
5	41	41	0.0607	1	2					
6	41	41	0.0785	1	2					
7	41	42	0.0830	1	2					
8	42	42	0.0889	1	2					
9	42	41	0.0430	1	2					
12	55	49	0.0726	1	2			1		
13	49	47	0.0756	1	2			1		
14	47	47	0.0785	1	2			1		
15	44	44	0.1407		2			1		
16	44	44	0.1081		2			1		
17	44	44	0.0948		2		1			
18	44	43	0.1081		2			1		
19	43	42	0.1156	1	2		1			
20	42	41	0.0933	1	2			1		
21	41	40	0.0978	1	2			1		
22	40	40	0.1126	1	2			1		
23	40	40	0.1126	1	2		1	1	1	1
24	40	40	0.0844	1	2			1		
25	40	40	0.1496	1	2			1		
26	40	41	0.1363	1	2			1		
27	41	41	0.1393	1	2			1		
28	41	43	0.1096	1	2			1		1
29	43	46	0.0859	1	2			1		
30	46	47	0.0919	1	2			1		1
31	47	47	0.0933	1	2			1		
34	51	47	0.0770	1	2	1		1		
35	47	46	0.1037	1	2					
36	46	45	0.1067	1	2	1				
37	45	45	0.0770	1	2					
38	45	45	0.0681	1	2					
39	45	45	0.0385	1	2					
40	45	44	0.0904	1	2					
41	44	42	0.0815	1	2					
42	42	42	0.0207	1	2					
43	42	41	0.0548	1	2					
44	42	43	0.0622	1	2					
45	43	43	0.0726	1	2					
46	43	44	0.0415	1	2					

Table 3. Continued

Transect	Start Depth (ft) [a]	End Depth (ft) [a]	Geoduck Density (no. / sq ft) [b]	Substrate [c]						
				mud	sand	peagravel	gravel	shell	cobble	boulder
47	44	45	0.0593	1	2					
48	45	48	0.0652	1	2					
49	47	50	0.0400	1	2					
50	50	50	0.0504	1	2					
51	50	52	0.0385	1	2					
52	52	52	0.0281	1	2					
54	54	49	0.0267	1	2	1		1		
55	49	49	0.0296	1	2	1		1		
56	49	48	0.0844	1	2			1		
57	48	47	0.1037	1	2					
58	47	46	0.1481	1	2			1		
59	46	44	0.1407	1	2			1		
60	44	45	0.1141	1	2			1		
61	46	46	0.1407	1	2					
62	46	45	0.1867	1	2					
63	46	46	0.1659	1	2					
64	46	47	0.0933	1	2			1		
65	47	47	0.0800	1	2			1		1
66	47	48	0.0770	1	2			1		
67	48	51	0.0326	1	2					
68	51	53	0.0089	1	2					
69	53	54	0.0356	1	2					
70	54	55	0.0563	1	2					
71	55	54	0.0356	1	2					
72	58	51	0.0578	1	2	1		1		
73	51	50	0.0993	1	2	1		1		1
74	50	49	0.1126	1	2	1		1		
75	49	48	0.1407	1	2	1		1		
76	48	47	0.1304	1	2			1		
77	48	48	0.1185	1	2	1		1		
78	46	46	0.1007	1	2			1		
79	46	46	0.0963	1	2			1		
80	46	46	0.0904	1	2			1		
81	46	48	0.0593	1	2			1		1
82	48	50	0.0607	1	2					
83	50	52	0.0267	1	2					
84	52	52	0.0296	1	2					
85	52	54	0.0341	1	2					
86	54	55	0.0296	1	2					

Table 3. Continued

[a.] All depths are corrected to mean lower low water (MLLW)
[b.] Densities were calculated using the default 0.75 show factor
[c.] Substrate codes: 1 = present ; 2 = dominant

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Table 4: GEODUCK WEIGHTS AND PROPORTION OVER 2 POUNDS

Alden Bank NE geoduck tract #02850, 2013 Lummi Tribe pre-fishing geoduck survey

Dig Station	Number Dug	Avg. Whole Weight (lbs.)	Avg. Siphon Weight (lbs.)	% of geoducks on station greater than 2 lbs.
1	10	1.95	N/A	60%
2	10	1.95	N/A	50%
3	10	1.75	N/A	20%
4	10	2.01	N/A	70%
5	10	2.06	N/A	50%
6	10	2.01	N/A	50%
7	11	2.05	N/A	64%
8	10	2.07	N/A	50%
9	10	1.74	N/A	20%
10	12	1.89	N/A	33%

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Table 5: TRANSECT CORRECTED GEODUCK COUNT AND POSITION TABLE

Alden Bank NE geoduck tract #02850, 2013 Lummi Tribe pre-fishing geoduck survey

Transect	Corrected Geoduck Count per 900 sq. ft. Transect	Geoduck Siphon Show Factor [a]	Latitude [b]	Longitude [b]
1	61	0.750	48° 49.451	122° 49.799
2	56	0.750	48° 49.443	122° 49.828
3	41	0.750	48° 49.430	122° 49.853
4	79	0.750	48° 49.413	122° 49.889
5	55	0.750	48° 49.402	122° 49.913
6	71	0.750	48° 49.388	122° 49.937
7	75	0.750	48° 49.370	122° 49.964
8	80	0.750	48° 49.351	122° 50.009
9	39	0.750	48° 49.341	122° 50.042
12	65	0.750	48° 49.543	122° 49.959
13	68	0.750	48° 49.529	122° 49.982
14	71	0.750	48° 49.508	122° 50.006
15	127	0.750	48° 49.495	122° 50.039
16	97	0.750	48° 49.470	122° 50.052
17	85	0.750	48° 49.456	122° 50.080
18	97	0.750	48° 49.441	122° 50.120
19	104	0.750	48° 49.432	122° 50.155
20	84	0.750	48° 49.416	122° 50.188
21	88	0.750	48° 49.404	122° 50.219
22	101	0.750	48° 49.378	122° 50.238
23	101	0.750	48° 49.363	122° 50.268
24	76	0.750	48° 49.346	122° 50.300
25	135	0.750	48° 49.326	122° 50.327
26	123	0.750	48° 49.314	122° 50.359
27	125	0.750	48° 49.299	122° 50.391
28	99	0.750	48° 49.283	122° 50.418
29	77	0.750	48° 49.258	122° 50.450
30	83	0.750	48° 49.239	122° 50.475
31	84	0.750	48° 49.225	122° 50.502
34	69	0.750	48° 49.652	122° 50.155
35	93	0.750	48° 49.635	122° 50.180
36	96	0.750	48° 49.625	122° 50.216
37	69	0.750	48° 49.612	122° 50.246
38	61	0.750	48° 49.598	122° 50.272
39	35	0.750	48° 49.582	122° 50.297
40	81	0.750	48° 49.570	122° 50.320
41	73	0.750	48° 49.550	122° 50.355
42	19	0.750	48° 49.533	122° 50.377
43	49	0.750	48° 49.517	122° 50.407
44	56	0.750	48° 49.504	122° 50.435
45	65	0.750	48° 49.488	122° 50.463
46	37	0.750	48° 49.470	122° 50.489
47	53	0.750	48° 49.444	122° 50.508
48	59	0.750	48° 49.429	122° 50.535
49	36	0.750	48° 49.412	122° 50.561
50	45	0.750	48° 49.398	122° 50.582

Table 5. Continued

Transect	Corrected Geoduck Count per 900 sq. ft. Transect	Geoduck Siphon Show Factor [a]	Latitude [b]	Longitude [b]
51	35	0.750	48° 49.386	122° 50.615
52	25	0.750	48° 49.371	122° 50.642
54	24	0.750	48° 49.780	122° 50.304
55	27	0.750	48° 49.763	122° 50.328
56	76	0.750	48° 49.753	122° 50.363
57	93	0.750	48° 49.745	122° 50.403
58	133	0.750	48° 49.737	122° 50.436
59	127	0.750	48° 49.715	122° 50.459
60	103	0.750	48° 49.703	122° 50.491
61	127	0.750	48° 49.687	122° 50.520
62	168	0.750	48° 49.668	122° 50.542
63	149	0.750	48° 49.658	122° 50.580
64	84	0.750	48° 49.643	122° 50.605
65	72	0.750	48° 49.633	122° 50.631
66	69	0.750	48° 49.616	122° 50.657
67	29	0.750	48° 49.600	122° 50.683
68	8	0.750	48° 49.591	122° 50.713
69	32	0.750	48° 49.575	122° 50.744
70	51	0.750	48° 49.561	122° 50.782
71	32	0.750	48° 49.551	122° 50.813
72	52	0.750	48° 49.874	122° 50.426
73	89	0.750	48° 49.855	122° 50.443
74	101	0.750	48° 49.839	122° 50.486
75	127	0.750	48° 49.824	122° 50.516
76	117	0.750	48° 49.802	122° 50.544
77	107	0.750	48° 49.790	122° 50.570
78	91	0.750	48° 49.780	122° 50.595
79	87	0.750	48° 49.762	122° 50.622
80	81	0.750	48° 49.743	122° 50.653
81	53	0.750	48° 49.728	122° 50.684
82	55	0.750	48° 49.715	122° 50.715
83	24	0.750	48° 49.693	122° 50.753
84	27	0.750	48° 49.683	122° 50.783
85	31	0.750	48° 49.669	122° 50.811
86	27	0.750	48° 49.656	122° 50.841

[a.] The default 0.75 show factor was used to correct combined geoduck counts

[b.] Latitude and longitude are in WGS84 datum, degrees and decimal minutes

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Table 6: MOST COMMON AND OBVIOUS ANIMALS OBSERVED

Alden Bank NE geoduck tract #02850, 2013 Lummi Tribe pre-fishing geoduck survey

# of Transects where Observed	Group	Common Name	Taxonomer
27	ANEMONE	BURROWING ANEMONE	*Pachycerianthus fimbriatus*
12	ANEMONE	ANEMONE	Unspecified anemone
8	ANEMONE	STRIPED ANEMONE	*Urticina sp.*
6	ANEMONE	PLUMED ANEMONE	*Metridium senile*
6	ASCIDIAN	SESSILE TUNICATE	Unspecified tunicate
20	BIVALVE	MOLLUSC	Unspecified mollusc
13	BIVALVE	HORSE CLAM	*Tresus sp.*
3	BIVALVE	FALSE GEODUCK	*Panomya beringiana*
1	BIVALVE	HEART COCKLE	*Clinocardium nuttalli*
23	CNIDARIA	HYDROIDS	Unspecified Hydroid
1	CNIDARIA	SEA PEN	*Ptilosarcus gurneyi*
28	CRAB	DECORATOR CRAB	*Oregonia gracilis*
16	CRAB	HERMIT CRAB	Unspecified hermit crab
14	CRAB	DUNGENESS CRAB	*Cancer magister*
12	CUCUMBER	SEA CUCUMBER	*Parastichopus californicus*
43	FISH	FLATFISH	Unspecified flatfish
6	FISH	DOGFISH SHARK	*Squalus acanthias*
4	FISH	SCULPIN	Unspecified cottid
1	FISH	SKATE	*Raja sp.*
32	FISH EGGS	SKATE EGG CASE	*Raja sp.*
18	GASTROPOD	NUDIBRANCH	Unspecified nudibranch
1	GASTROPOD	MOON SNAIL EGGS	*Polinices lewisii*
2	MISC	ARTHROPOD	Unspecified arthropod
1	MISC	GIANT BARNACLE	*Balanus nubilis*
5	NUDIBRANCH	ARMINA	*Armina californica*
3	NUDIBRANCH	HERMISSENDA	*Hermissenda crassicornis*
22	SEA STAR	SAND STAR	*Luidia foliolata*
17	SEA STAR	SUNFLOWER STAR	*Pycnopodia helianthoides*
3	SEA STAR	SHORT-SPINED STAR	*Pisaster brevispinus*
1	SEA STAR	FALSE OCHRE STAR	*Evasterias troschelli*
1	SEA STAR	SEA STAR	Unspecified sea star
65	WORM	ROOTS	Chaetopterid polychaete tubes

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Table 7: MOST COMMON AND OBVIOUS ALGAE OBSERVED

Alden Bank NE geoduck tract #02850, 2013 Lummi Tribe pre-fishing geoduck surve

# of Transects Where Observed	Taxonomer
3	*Agarum sp.*
4	*Desmarestia sp.*
1	Diatoms
5	*Laminaria sp.*
48	Small Red Algae
17	Large Red Algae
5	Small Brown Algae
2	Large Brown Algae

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