ENVIRONMENTAL ASSESSMENT OF PROPOSED GEODUCK HARVEST
ALONG THE SOUTHWESTERN SHORELINE OF ANDERSON ISLAND
AT THE ANDERSON ISLAND SOUTH GEODUCK TRACT (#13350)

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 six 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 along the southwestern shoreline of Anderson Island is described below.

Proposed Harvest Dates: 2020 - 2021

Tract name: Anderson Island South tract (Tract #13350)

Description: (Figure 1, Tract vicinity map)

The Anderson Island South geoduck tract is a subtidal area of approximately 72 acres (Table 1) along the southwestern shoreline of Anderson Island in the South Puget Sound Geoduck Management Region. The northern boundary of the tract begins approximately 270 yards southerly of the geographic landmark Treble Point and continues southerly approximately 3,970 yards to Thompson Cove. The commercial tract area lies between the minus 18 foot and minus 70 foot (MLLW) water depth contours.

The Anderson Island South tract is adjacent to and southerly of the Treble Point tract (#13300) and adjacent to and northerly of the Thompson Cove tract (#13400). The Anderson Island South geoduck tract is bounded by a line projected southerly from a Control Point (CP) on the -18 foot (MLLW) water depth contour at 47°09.023 N. Latitude, 122°44.538’ W. Longitude (CP1) along the -18 foot (MLLW) water depth contour to a point at 47°07.590’ N. Latitude, 122°42.576’ W. Longitude (CP2); then westerly to a point on the -70 foot (MLLW) water depth contour at 47°07.527’ N. Latitude, 122°42.692’ W. Longitude (CP 3); then northerly along the -70 foot (MLLW) water depth contour to a point at 47°08.971’ N. Latitude, 122°44.621’ W. Longitude (CP 4); then easterly to the point of origin (Figure 2). All positions are in WGS84 datum.

Commercial harvests on this tract must be within the designated tract boundary polygon described above. Vessels conducting geoduck harvest operations must remain seaward of a line two hundred yards seaward from and parallel to the line of ordinary high tide, to conform with state statute (RCW 77.60.070). Any variance to the stated boundary line will be coordinated between WDFW and DNR and will be implemented by DNR for commercial geoduck harvests.

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 can be strong in the vicinity of the Anderson Island South tract. Currents reach a maximum flood velocity of 1.6 knots per hour and maximum ebb velocity of 1.9 knots (Tides and Currents software; station #1821; Nisqually Reach; estimate from January 24, 2020 to January 30, 2021

Substrates types vary greatly across this tract (subsurface substrates from dig samples found in Tables 2-A, 2-B) with sand being the predominant surface substrate type observed in the northern portion of the tract (transects 1-16; Table 3A, Figure 3-A). In the southern portion of the tract (transects 18-29; Table 3A, Figure 3-A) the substrate types include sand, pea gravel, gravel, shall cobble and boulders. Cobble and shell present significant hindrances to digging in the most southern portion of the tract.

Water Quality:

Water quality is good at the Anderson Island South tract. Water at this tract is affected by strong water currents and turbulence of Nisqually Reach, which prevents stratification (water layering) and brings deeper nutrient-rich waters to the surface. At a WA Department of Ecology water quality station at Nisqually Reach (NSQ001), periodic water quality samples were taken between 1989 and 1996 (most recent data year available). The following information from this station is for samples taken between water depths of 0.5 to 10 meters. The dissolved oxygen concentrations ranged between 6.1 and 13.1 mg/l with an average of 9.2 mg/l. pH ranged between 7.6 to 8.7 with an average of 7.6. Salinities ranged between 16.2 to 30.3 psu with an average of 27.4 psu. Water temperatures ranged from 5.5 to 15.1 ºC with an average temperature of 10.8 ºC.

This area is classified as "Approved" by the Washington Department of Health (DOH) for commercial shellfish harvest. This area has been tested for inorganic arsenic levels (Jerry Borchert, DOH, pers. comm., 7/10/14) and this tract is not currently on the list of approved tracts to export geoducks to China. More detailed information regarding arsenic can be found at the DOH web site, at http://www.doh.wa.gov/CommunityandEnvironment/Shellfish/CommercialShellfish/Export/ExporttoChina. DNR will verify the health status of the Anderson Island South tract prior to any geoduck harvest.

Biota:

Geoduck:

The Anderson Island South geoduck tract received a survey (27 transects) by the Nisqually Tribe in 2002 and there has been on-going harvest since then. The tract received an "in-season" surveyed by WDFW in 2012 (Figure 3-B). The results of the 2002 survey are used for the tract biomass estimate, since the in-season survey may be biased by harvesting patterns on the tract. The 2012 survey transects and dig stations are used to supplement the 2002 survey data in the preparation of this environmental assessment.

The Anderson Island South geoduck tract is approximately 72 acres and currently contains an estimated 1,415,843 pounds of geoduck (Table 1). The geoduck biomass estimate at this tract is based on a 2002 Nisqually Tribe survey estimate of 2,476,544 pounds and a subtraction of reported commercial harvest of 1,060,701. On all 10 dig stations (2002 & 2012), geoducks were considered commercial quality (Tables 2-A, 2-B). No geoduck dig stations were rated "very easy" to dig. 5 dig stations were rated as "easy" to dig. 5 dig stations had ratings ranging between "some difficulty" to "very difficult". Factors contributing to digging difficulty were depth in substrate, compactness, gravel, shell, and turbidity. On WDFW dig station #s 2 and 18 (Table 2-B), cobble was noted as a hindrance to digging and this substrate type contributed to a "very difficult" rating on station #2.

The current geoduck density on this tract is high, averaging 0.24 geoducks/sq.ft., compared to a Puget Sound average density of about 0.16 geoducks/sq.ft. The pre-fishing geoduck density estimate from the 2002 Nisqually Tribe survey minus the number of geoducks taken through 2011 was 0.35 geoducks/sq.ft. In contrast, the WDFW "in-season" survey in 2012 estimates an average geoduck density of 0.27 geoducks/sq.ft. on this tract suggesting differences between the surveys or unexplained geoduck mortality, or both.

During the 2002 prefishing survey, the geoducks at the Anderson Island South tract were near average weight for Puget Sound at 1.86 pounds. The lowest average whole weight was 1.37 pounds per geoduck at station #18 and the highest average whole weight was

2.33 pounds per geoduck at station #1 (Table 4-A). Nisqually transect locations are listed in Table 5.

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 primarily to geoduck's low rate of natural recruitment. WDFW has studied the regeneration rate of geoducks on certain previously harvested tracts scattered throughout Puget Sound. The estimated average time to regenerate a new crop of geoducks after removal of 100 percent of the original geoducks is 39 years. In actual fishing 100 percent of the geoducks are never removed. The average percentage removal of the tracts mentioned above was 69 percent. Recent surveys in South Puget Sound indicate that the rate of tract recovery may have changed dramatically in the last decade, possibly due to lower recruitment, increased mortality, or a combination of both factors. The regeneration 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 which provide few attachments for macroalgae, which also is associated with rockfish and lingcod. The fish observed during the surveys at the Anderson Island South tract were various species of flatfish, sand dabs, starry flounders, sculpins, and unspecified fish (Table 6).

WDFW marine fish managers were asked of their concerns of any possible impacts on groundfish and baitfish that geoduck fishing would have. 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 along this tract below a depth of -16 feet (MLLW). The Anderson Island South nearshore tract boundary will be along the -18 foot (MLLW) water depth contour to provide year-round protection to Pacific herring spawning habitat and provide a vertical buffer between eelgrass beds and geoduck harvest.

There are no Pacific herring spawning grounds documented along the shoreline of Anderson Island or in the vicinity of the Anderson Island South tract (Figure 4). However, a herring prespawner holding area has been identified off the western shoreline of Anderson Island. 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 within the tract, geoduck harvest on the Anderson Island tract should have no detrimental impacts on herring spawning.

Sand lance spawning has been documented along the southern shoreline inshore of the Anderson Island South tract (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 about 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, where 60 percent of their diet is comprised of sand lance. 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 (-18 ft. to -70 ft., MLLW). Geoduck harvest on the Anderson Island South tract should have no detrimental impacts on sand lance spawning.

There are two areas of surf smelt spawning habitat that have been identified off-tract but in the general vicinity of the proposed harvest area of the Anderson Island South tract. One area is northerly of Treble Point and the other is in the southern portion of Thompson Cove (Figure 4). 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 (-18 ft. to -70 ft., MLLW). Geoduck harvest on the Anderson Island South 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 include all marine, estuarine, and river reaches accessible to the listed chum salmon between Dungeness Bay and Hood Canal and 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 out-migration may be as late as mid-April. The Anderson Island South 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 subyearlings.

Streams or tributaries near the Anderson Island South geoduck tract are McAllister Creek (approximately 2.1 miles from the tract), Nisqually River (approximately 2.5 miles from the tract), and Chambers Creek (7.2 miles). Two runs of Chinook salmon have been identified in the Nisqually River basin. The status of the Spring/Summer run of Chinook salmon in the Nisqually River basin is extinct (NMFS, Appendix E, TM-35, Chinook Status Review). The status of the natural Summer/Fall run of Chinook salmon in the Nisqually River basin is mixed native and non-native origin; a composite of wild, cultured, or unknown/unresolved production; and healthy with a 5-year geometric mean for total estimated escapement at 699 fish (NMFS, Appendix E, TM-35, Chinook Status Review).

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. Steelheads share many of the same waters as Puget Sound Chinook salmon, which are already protected by ESA, and will benefit from shared conservation strategies. There are no identified streams or rivers in the vicinity of Anderson Island that support steelhead stocks. The horizontal separation between tributaries that support steelhead runs and the Anderson Island South tract will assure that geoduck harvest will likely have no impact on steelhead populations.

Green sturgeons 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 Anderson Island South geoduck tract is outside of the critical habitat range of green sturgeon and geoduck harvest at this location will have no adverse effects on ESA recovery efforts for green sturgeon populations.

Invertebrates:

Many different kinds of invertebrates were observed which are frequently found on geoduck beds were observed on this tract, including anemones, bivalves, cnidarians, crab, cucumbers, gastropods, sponges, 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 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. Dungeness crab were observed on 9 out of 40 transects on the Anderson Island South tract during the 2012 survey. 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 minus 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 (www.dfg.ca.gov/marine/pdfs/response/**crab**.pdf). Jensen (2014) and WDFW information (personal comm. WDFW Biologist Don Velasquez, 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 1,677 acres. There were about 1,332,130 harvestable geoducks on this tract, from the 2002 pre-fishing survey estimate. With a minimum harvest level of 65 percent, the total number harvested would be 865,884 geoducks. Approximately 1.18 square feet of substrate is disturbed for every geoduck harvested, so 865,884 x 1.18 = 1,021,744 square feet of substrate. This equals about 23 acres. This is about 1.40 percent of the total available crab habitat in the vicinity of this tract.

WDFW and DNR have studied the effects of geoduck harvest on the population of Dungeness crab at Thorndyke Bay in Hood Canal. The results of 4.6 years of study have shown no adverse effects on crab populations due to geoduck fishing. Based on few observations of Dungeness crab occupying this tract, the low 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:

> Laminarian algae; Desmarestian algae; Ulva (sea lettuce); and small and large foliose red algae.

John Boettner and Tim Flint, from the WDFW Habitat Division, have stated that as long as geoduck fishing was restricted seaward of the eelgrass beds they have no concerns about the fishing. This was confirmed by WDFW Habitat Division who stated that the existing conditions in the fishery SEIS are sufficient to protect fish and wildlife habitat and natural resources. The shallow boundary of geoduck harvest is set at least two vertical feet seaward of the deepest eelgrass to protect all eelgrass from harvest activities. An eelgrass survey done on June 14, 2012 by WDFW divers swimming the entire shoreward boundary of the tract, and no eelgrass was documented below a depth of -16 feet (MLLW). The shoreward boundary of this tract will be no shallower than the -18 foot water depth contour (MLLW), which should provide sufficient buffer for any eelgrass beds in the vicinity of the tract.

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 draft conservation plan for this stock can be found at the NOAA website (http://www.nwr.noaa.gov/Marine-Mammals/Whales-Dolphins-Porpoise/Killer-Whales/ESA-Act-Status/Listing-Final.cfm). 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:

The upland property at Anderson Island, along the Anderson Island South tract, has Pierce County Shoreline Environmental Designations of Natural, Conservancy, and Shoreline Residential. To minimize possible disturbance to adjacent residents, harvest vessels are not allowed within 200 yards of the ordinary high tide line (OHT) or shallower than -18 feet (MLLW) whichever is farther seaward. 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 not a prime sportfishing area, however, some recreational salmon 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. The fishing, which does occur, should not create any problems for the geoduck harvesting effort in the area.

Geoduck fishing on this tract is managed in coordination with the southern Puget Sound treaty tribes through annual state/tribal harvest management plans. The non-Indian geoduck fishery should not be in conflict with any concurrent tribal fisheries.

Navigation:

Nisqually Reach experiences moderate recreational and commercial vessel traffic, with seasonal fluctuations. The Anderson Island South tract is not within a major traffic lane and areas close to shore are used primarily by small boats. 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 harvest.

Summary:

Commercial geoduck harvest is proposed for the Anderson Island South geoduck tract located along the southwestern shoreline of Anderson Island. The tract was most recently surveyed in the year 2002 with a supplemental "in-season" survey done in 2012. The tract biomass estimate is based on the 2002 survey and recent harvests. 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. To reduce possible impacts to baitfish and eelgrass, harvest will be deeper and seaward of the -18 foot (MLLW) water depth contour. No significant impacts are expected from this harvest.

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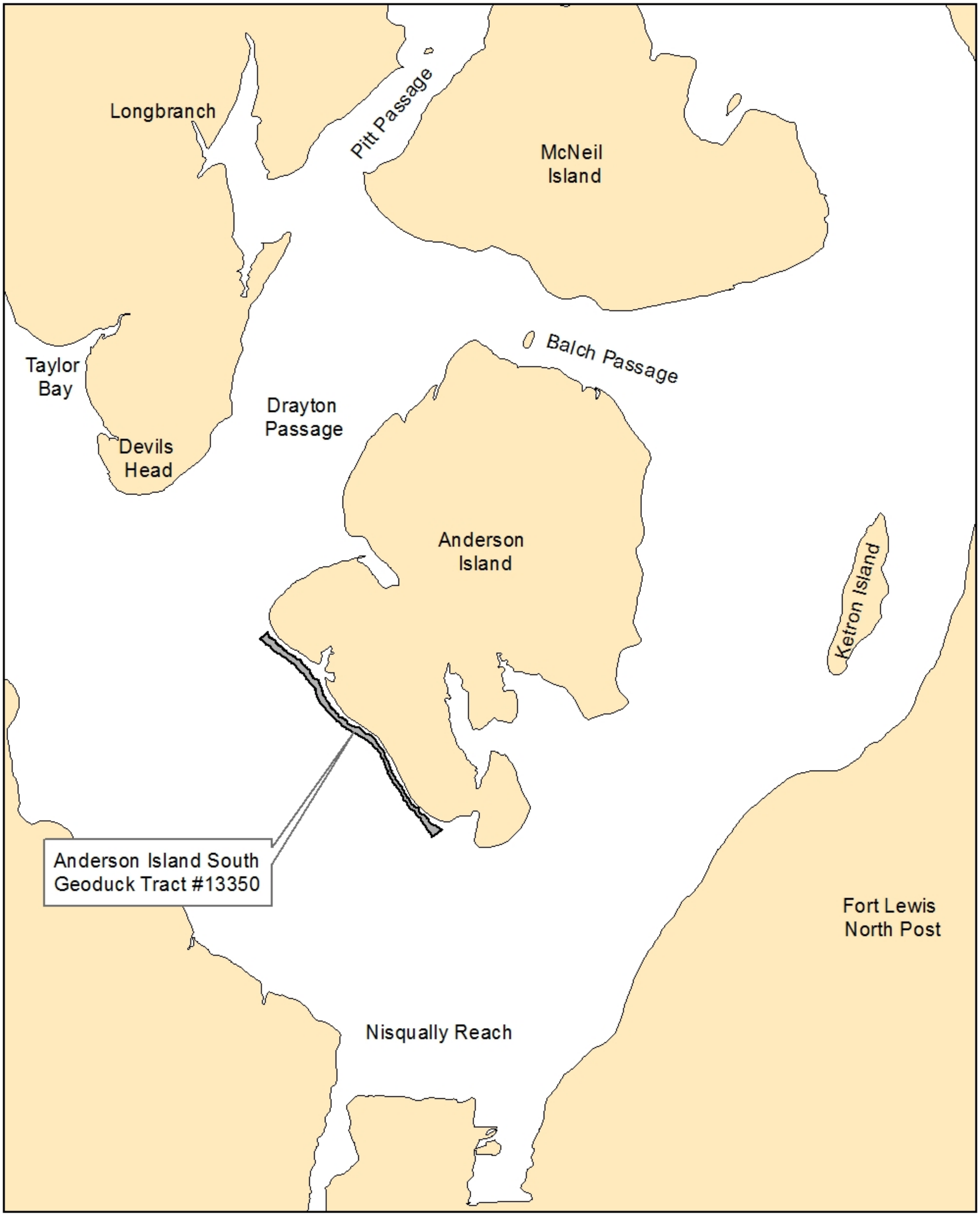
Figure 1. Vicinity Map,
Anderson Island South Commercial Geoduck Tract #13350



N
W E
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1:80,000
1 inch = 1.26 miles

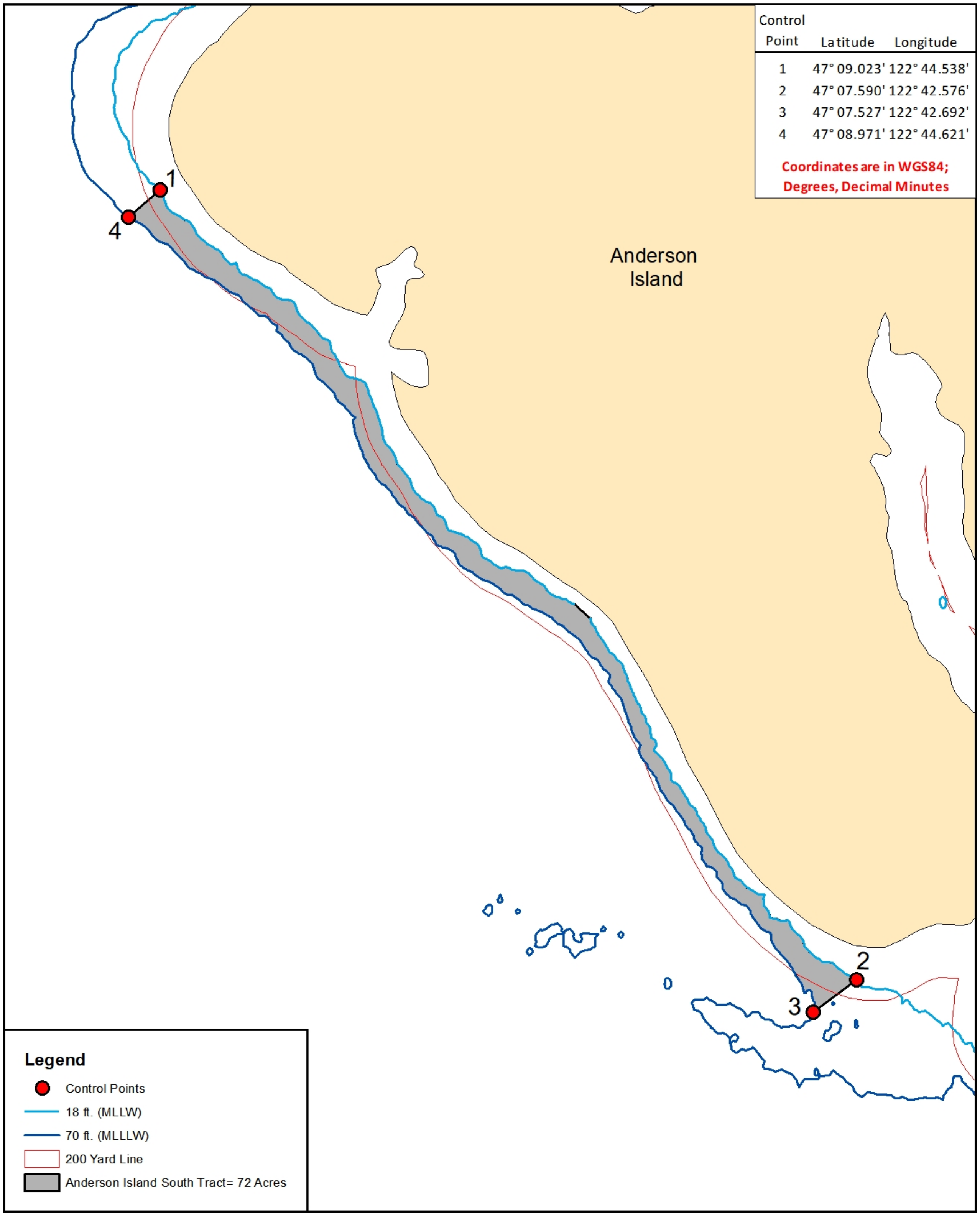
Data Sources:
Projection for data is GCS_Washington Geographic System 1984,
Units: Decimal Degrees. Coastline layer is from DNR, 1: 24,000 scale,
created 09-20-99. Contours are from NOAA soundings.

0 0.3 0.6 1.2 1.8 2.4 Miles

Washington Department of FISH and WILDLIFE

Map Date: June 22, 2017
Map Author: O. Working
File: Data\Geoduck\EAs\2017

Figure 2. Control Points Map, Anderson Island South Commercial Geoduck Tract #13350



Control Point	Latitude	Longitude
1	47° 09.023'	122° 44.538'
2	47° 07.590'	122° 42.576'
3	47° 07.527'	122° 42.692'
4	47° 08.971'	122° 44.621'

Coordinates are in WGS84; Degrees, Decimal Minutes

N W E S

1:20,000
1 inch = 0.32 miles

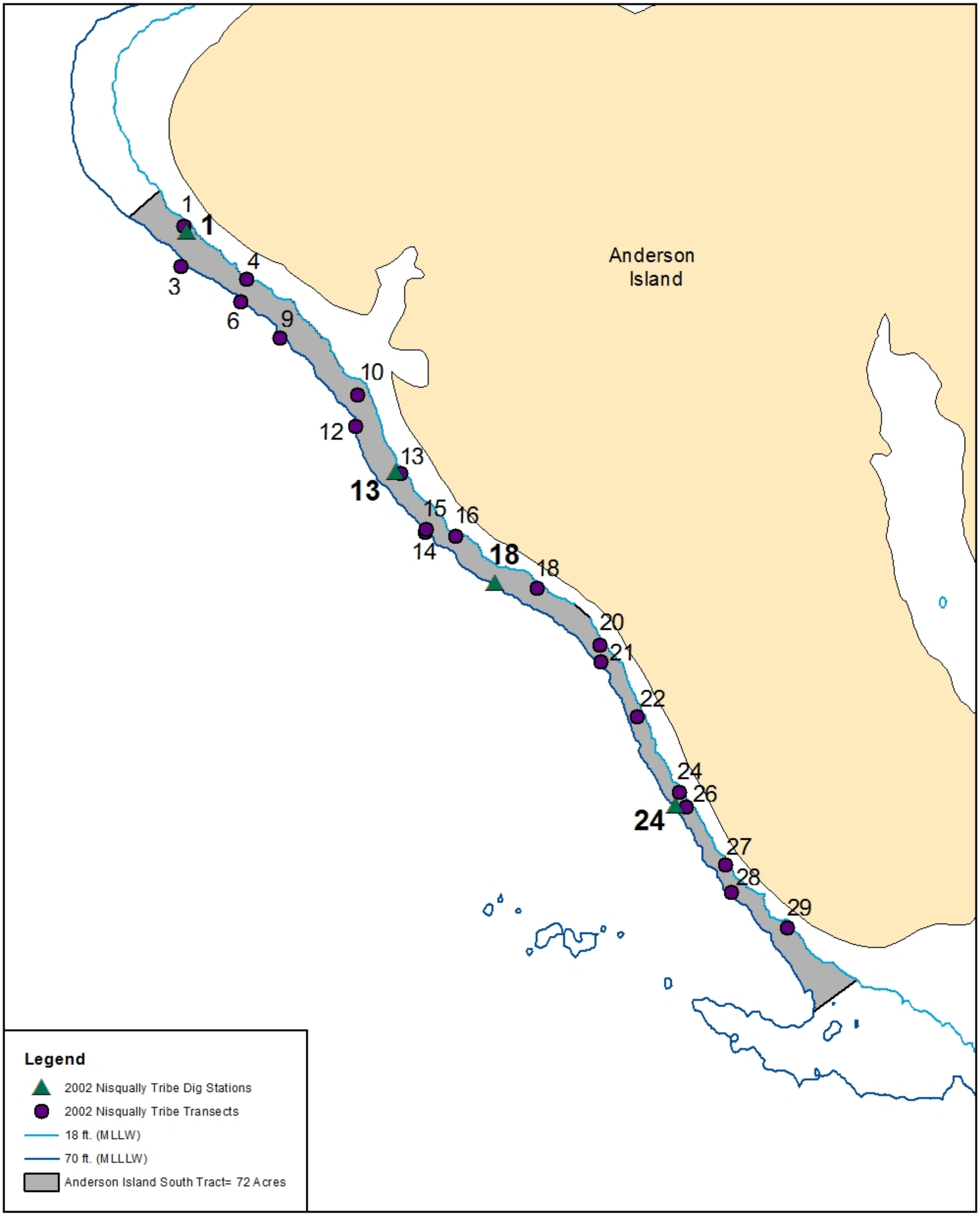
Data Sources:
Projection for data is GCS_Washington Geographic System 1984,
Units: Decimal Degrees. Coastline layer is from DNR, 1: 24,000 scale,
created 09-20-99. Contours are from NOAA soundings.

0 0.075 0.15 0.3 0.45 0.6 Miles

Washington Department of FISH and WILDLIFE

Map Date: January 31, 2020
Map Author: O. Working
File: Data\Geoduck\EAs\2020

Figure 3. Transect and Dig Station Map, Anderson Island South Commercial Geoduck Tract #13350



1:20,000
1 inch = 0.32 miles

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

0 0.075 0.15 0.3 0.45 0.6 Miles

Washington Department of FISH and WILDLIFE

Map Date: June 22, 2017
Map Author: O. Working
File: Data\Geoduck\EAs\2017

Figure 4. Fish Spawning Areas Near the Anderson Island South Commercial Geoduck Tract #13350

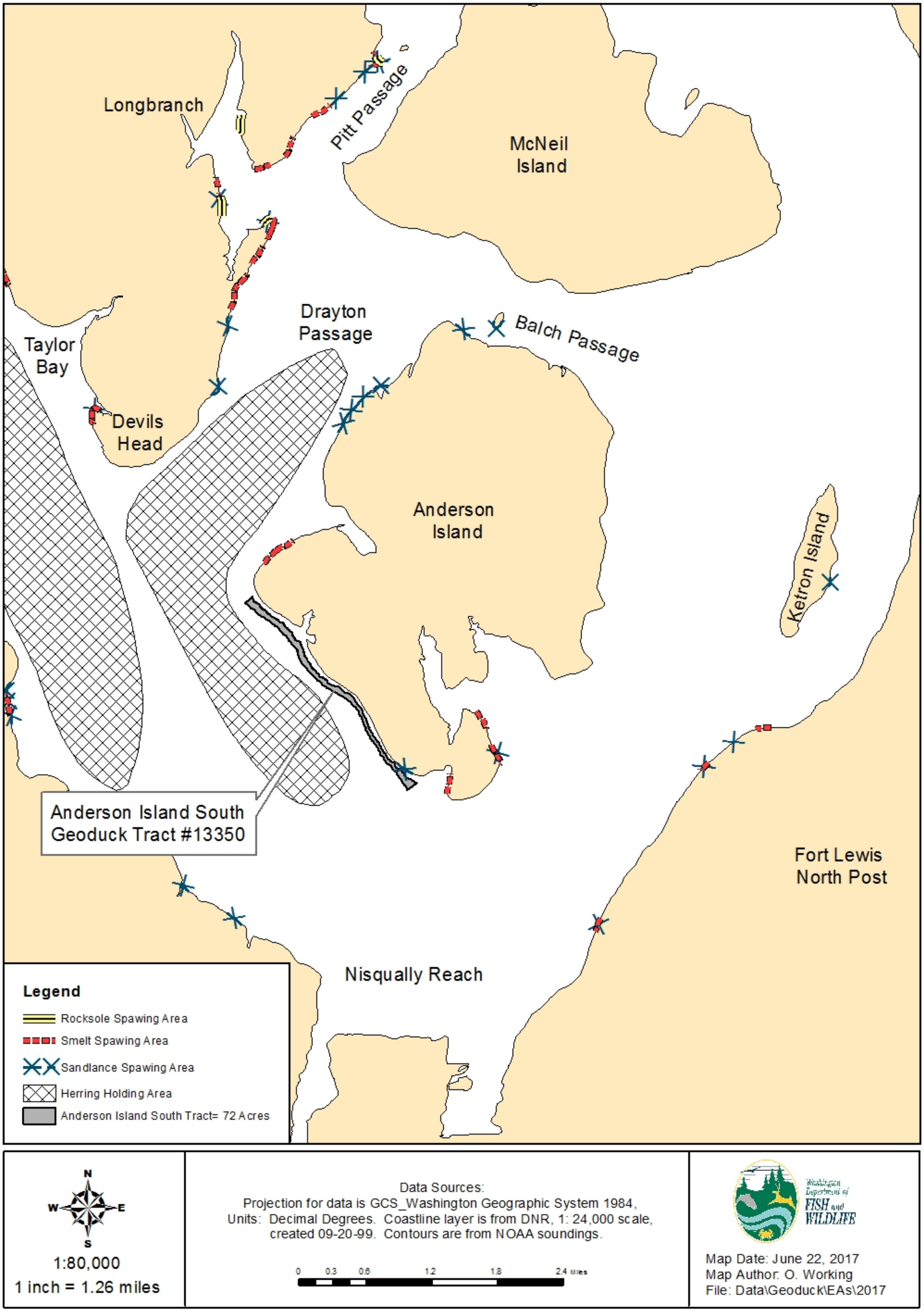
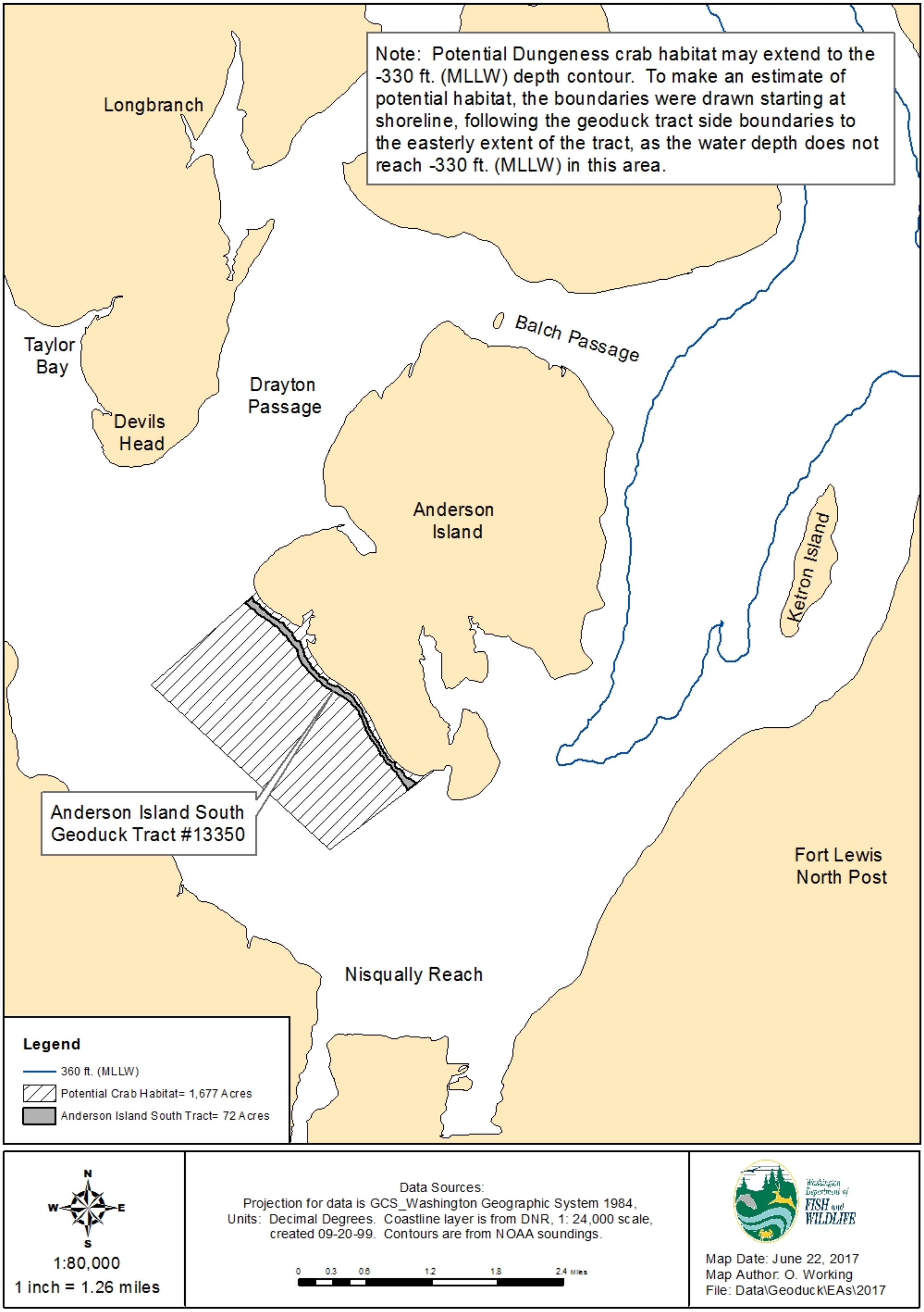


Figure 5. Dungeness Crab Habitat Map, Anderson Island South Commercial Geoduck Tract #13350



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 algae is listed in *Taxonomer*.

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Table 1. GEODUCK TRACT SUMMARY

Anderson Island South geoduck tract # 13350

Tract Name	Anderson Island South
Tract Number	13350
Tract Size (acres)[a]	72
Density of geoducks/sq.ft[b]	0.24
Total Tract Biomass (lbs.)[b]	1,415,843
Total Number of Geoducks on Tract[b]	761,580
Confidence Interval (%)	21.5%
Mean Geoduck Whole Weight (lbs.)	1.86
Mean Geoduck Siphon Weight (lbs.)	0.41
Siphon Weight as a % of Whole Weight	22%
Number of 900 sq.ft. Transect Stations	27
Number of Geoducks Weighed	40

[a.] Tract area is between the -18 ft. and -70 ft. (MLLW) water depth contours.

[b.] Biomass is based on the 2002 Nisqually Tribe geoduck survey pre-fishing biomass of 2,476,544 pounds, minus harvest of 1,060,071 pounds through January 30, 2020

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Table 2-A: DIGGING DIFFICULTY TABLE

Anderson Island South geoduck tract #13350, 2002 Nisqually Tribe pre-fishing survey.

Dig Station	Difficulty (0-5)	Abundance (0-2)	Compact (0-2)	Gravel (0-2)	Shell (0-2)	Turbidity (0-2)	Algae (0-2)	Commercial (Y/N)
1	1	4	0	0	0	1	0	Y
13	2	4	1	1	0	1	0	Y
18	1	4	0	1	0	0	0	Y
24	1	4	0	2	0	0	0	Y

Note: one dig station was eliminated as it was shallow of 18 ft. (MLLW)

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Table 2-B: DIGGING DIFFICULTY TABLE

Anderson Island South geoduck tract #13350, 2012 WDFW "in-season" 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)
2	4	2	1	0	0	1	0	0	Y
8	2	1	1	0	0	1	0	0	Y
32	2	2	0	0	0	0	0	0	Y
18	3	1	1	0	1	1	1	0	Y
20	1	2	1	1	0	1	0	0	Y
30	1	2	1	1	0	0	0	0	Y

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

Anderson Island South geoduck tract #13350, 2002 Nisqually Tribe pre-fishing 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	18	30	0.3674		2					
2	30	49	0.6933		2					
3	49	70	0.6178		2					
4	17	39	0.6356		2					
5	39	60	0.7437		2					
6	60	53	0.7333	1	2					
8	38	62	0.5319	1	2					
9	62	68	0.4267	1	2					
10	21	42	0.3822		2					
11	42	67	0.4993		2					
12	67	51	0.5704		2					
13	25	46	0.2400		2					
14	46	69	0.7244		2					
15	72	67	0.5556		2					
15a	67	33	0.4000		2					
16	29	58	0.4000		2					
18	28	54	0.3719		2	1				
20	28	67	0.5230		2	1				
21	67	53	0.4104		2	1				
22	24	66	0.2267		2	1	1		1	
23	66	44	0.1526		2	1	1		1	
24	23	57	0.2430		2	1	1		1	1
25	57	54	0.5037		2	1	1		1	
26	54	23	0.4533		2	1	1		1	
27	27	69	0.0059		1	2	1	1	1	1
28	69	61	0.0252		1	2	1	1	1	1
29	28	50	0.0207		1	2	1	1	1	1

[a.] All depths are corrected to mean lower low water (MLLW)
[b.] Densities were calculated using a daily siphon show factor
[c.] Substrate ratings: 1 = present; 2 = predominant; blank = not observed

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

Anderson Island South geoduck tract #13350, 2012 WDFW "in-season" survey.

Transect	Start Depth (ft.) [a]	End Depth (ft.) [a]	Geoduck Density (no. / sq.ft.) [b]	Substrate [c] sand	peagravel	gravel	cobble	boulder
1	18	39	0.1877	2	1	1		
2	39	57	0.3266	2	1	1		
3	58	68	0.4243	2	1	1		
4	18	25	0.2305	2				
5	25	42	0.5968	2				
6	42	64	0.5205	2			1	
7	65	65	0.4655	2			1	
8	65	45	0.5449	2				
9	45	19	0.2396	2			1	
10	19	28	0.1053	2			1	
11	28	36	0.3236	2				
12	18	27	0.0191	2				
13	27	35	0.0217	2				
14	36	53	0.2472	2				
15	53	56	0.3542	2				
16	56	43	0.3568	2				
17	43	33	0.2689	2				
18	34	29	0.1210	2				
19	18	29	0.2663	2				
20	29	45	0.4460	2				
21	45	61	0.4880	2				
22	62	64	0.4320	2				
23	64	58	0.4345	2				
24	59	50	0.4944	2				
25	18	23	0.0172	2				
26	23	28	0.0278	2				
27	28	35	0.0979	2				
28	35	42	0.4471	2				
29	42	54	0.5198	2				
30	54	48	0.4934	2				
31	48	35	0.4352	2				
32	18	35	0.2513	1		2		
33	35	46	0.1032	1		2	1	
34	47	61	0.0159	1		1	2	
35	61	42	0.0093	1		1	2	1
36	42	36	0.0079	1			2	
37	36	23	0.0066	1			2	
38	68	50	0.3202	1		2	1	
39	50	38	0.2405	1		2		
40	38	26	0.0244	2		1		

a. All depths are corrected to mean lower low water (MLLW)

b. Densities were calculated using a daily siphon show factor

c. Substrate ratings: 1 = present; 2 = predominant; blank = not observed

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Table 4-A: GEODUCK SIZE AND QUALITY

Anderson Island South geoduck tract #13350, 2002 Nisqually Tribe pre-fishing survey.

Dig Station	Number Dug	Avg. Whole Weight (lbs.)	Avg. Siphon Weight (lbs.)	% of geoducks on station greater than 2 lbs.
1	12	2.33	0.56	58%
13	11	1.71	0.38	18%
18	14	1.37	0.36	7%
24	20	2.03	0.45	25%

Note: one dig station was eliminated as it was shallow of 18 ft. (MLLW)

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Table 4-B: GEODUCK SIZE AND QUALITY

Anderson Island South geoduck tract #13350, 2012 WDFW "in-season" survey.

Dig Station	Number Dug	Avg. Whole Weight (lbs.)	Avg. Siphon Weight (lbs.)	% of geoducks on station greater than 2 lbs.
2	6	1.76	0.43	33%
8	10	2.44	0.50	100%
32	10	1.52	0.27	10%
18	30	1.89	0.37	10%
20	11	2.47	0.48	82%
30	10	2.17	0.46	70%

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Table 5: TRANSECT CORRECTED GEODUCK COUNT AND POSITION TABLE

Anderson Island South geoduck tract #13350, 2002 Nisqually Tribe pre-fishing survey.

Transect	Corrected Count	Show Factor [a]	Latitude [b]	Longitude [b]
1	331	0.75	47° 8.958	122° 44.469
2	624	0.75		
3	556	0.75	47° 8.882	122° 44.475
4	572	0.75	47° 8.862	122° 44.296
5	669	0.75		
6	660	0.75	47° 8.819	122° 44.308
8	479	0.75		
9	384	0.75	47° 8.755	122° 44.199
10	344	0.75	47° 8.652	122° 43.982
11	449	0.75		
12	513	0.75	47° 8.594	122° 43.987
13	216	0.75	47° 8.508	122° 43.86
14	652	0.75	47° 8.401	122° 43.787
15	500	0.75	47° 8.406	122° 43.785
15a	360	0.75	47° 8.392	122° 43.686
16	360	0.75	47° 8.394	122° 43.705
18	335	0.75	47° 8.301	122° 43.478
20	471	0.75	47° 8.200	122° 43.303
21	369	0.75	47° 8.168	122° 43.298
22	204	0.75	47° 8.067	122° 43.196
23	137	0.75	47° 8.986	122° 43.157
24	219	0.75	47° 7.929	122° 43.075
25	453	0.75		
26	408	0.75	47° 7.903	122° 43.055
27	5	0.75	47° 7.797	122° 42.944
28	23	0.75	47° 7.745	122° 42.924
29	19	0.75	47° 7.683	122° 42.770

[a.] Default show factor (0.75) was used to correct combined geoduck counts

[b.] Latitude and longitude positions are in degrees and decimal minutes (NAD27), and have not been transformed into WGS84 datum

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Table 6: MOST COMMON AND OBVIOUS ANIMALS OBSERVED

Anderson Island South geoduck tract #13350, 2002 Nisqually Tribe pre-fishing survey.

# of Transects where Observed	Group	Common Name	Taxonomer
28	ANEMONE	BURROWING ANEMONE	*Pachycerianthus fimbriatus*
23	ANEMONE	PLUMED ANEMONE	*Metridium spp.*
7	ANEMONE	STRIPED ANEMONE	*Urticina spp.*
18	BIVALVE	HORSE CLAM	*Tresus spp.*
4	BIVALVE	FALSE GEODUCK	*Panomya spp.*
1	BIVALVE	JINGLESHELL OYSTER	*Pododesmus macrochisma*
8	BIVALVE	PIDDOCK	Unspecified *Pholadidae*
5	BIVALVE	HEART COCKLE	*Clinocardium nuttalli*
14	CNIDARIA	SEA PEN	*Ptilosarcus gurneyi*
9	CRAB	DUNGENESS CRAB	*Cancer magister*
30	CRAB	HERMIT CRAB	Unspecified hermit crab
16	CRAB	DECORATOR CRAB	*Oregonia gracilis*
12	CRAB	RED ROCK CRAB	*Cancer productus*
14	CRAB	GRACEFUL CRAB	*Cancer gracilis*
1	CRAB	HELMET CRAB	*Telmessus cheiragonus*
12	CUCUMBER	SEA CUCUMBER	*Parastichopus californicus*
20	FISH	SCULPIN	Unspecified Cottidae
22	FISH	FLATFISH	Unspecified flatfish
9	FISH	SANDDAB	*Citharichthys spp.*
7	FISH	STARRY FLOUNDER	*Platichthys stellatus*
3	FISH	FISH	Unspecified Fish
7	GASTROPOD	MOON SNAIL EGGS	*Polinices lewisii* egg case
7	GASTROPOD	NUDIBRANCH	Unspecified nudibranch
1	GASTROPOD	MOON SNAIL	*Polinices lewisii*
3	MISC	SPONGE	Unspecified Porifera
10	NUDIBRANCH	ARMINA	*Armina californica*
24	SEA STAR	SUNFLOWER STAR	*Pycnopodia helianthoides*
1	SEA STAR	SPINY STAR	*Hippasteria spinosa*
7	SEA STAR	SUN STAR	*Solaster spp.*
1	SEA STAR	BLOOD STAR	*Henricia leviuscula*
17	SEA STAR	SHORT-SPINED STAR	*Pisaster brevispinus*
10	SEA STAR	SAND STAR	*Luidia foliolata*
10	SEA STAR	SAND STAR	*Luidia foliolata*
1	SEA STAR	BRITTLE STAR	Unspecified brittle star
6	SEA STAR	ROSE STAR	*Crossaster papposus*
6	WORM	SABELLID TUBE WORM	*Sabellid spp.*
8	WORM	ROOTS	*Chaetopterid polychaete tubes*

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Table 7: MOST COMMON AND OBVIOUS PLANTS OBSERVED

Anderson Island South geoduck tract #13350, 2002 Nisqually Tribe pre-fishing survey.

# of Transects where observed	Taxonomer
38	Unspecified small red algae
1	Unspecified large red algae
3	*Desmarestia spp.*
7	Diatoms
22	*Laminaria spp.*
28	*Ulva spp.*

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