ENVIRONMENTAL ASSESSMENT OF PROPOSED GEODUCK HARVEST
NISQUALLY GEODUCK TRACT (#13800)

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 along the shoreline of Nisqually Reach is described below.

Proposed Harvest Dates: 2024-2025

Tract name: Nisqually tract (Tract #13800)

Description: (Figure 1, Tract vicinity map)

The Nisqually geoduck tract is a subtidal area of approximately 145 acres (Table 1) along the northwestern shoreline of the Nisqually Reach in the South Puget Sound Geoduck Management Region. The western boundary of the tract begins approximately 1,500 yards east of the geographic landmark, Dogfish Bight and continues southeasterly approximately 3,500 yards. The commercial tract area lies between the minus 18 foot and minus 70 foot (MLLW) water depth contours.

The Nisqually geoduck tract is bounded by a line projected westerly and then southerly from a Control Point (CP) on the -18 foot (MLLW) water depth contour at 47°07.171' N Latitude, 122°44.746' W Longitude (CP1) along the -18 foot (MLLW) water depth contour to a point on the -18 foot MLLW water depth contour at 47°07.106' N Latitude, 122°45.190' W Longitude (CP2); then southwesterly to a point on the -18 foot (MLLW) water depth contour at 47°07.016' N Latitude, 122°45.347' W Longitude (CP 3); then northwesterly along the -18 foot (MLLW) water depth contour to a point at 47°07.329' N Latitude, 122°45.904' W Longitude (CP 4); then northerly to a point on the -70 foot (MLLW) water depth contour at 47°07.485' N Latitude, 122°45.911' W Longitude (CP 5); then easterly to a point on the -70 foot (MLLW) water depth contour at 47°07.231' N Latitude, 122°44.692' W Longitude (CP 6); then southwesterly to the point of origin (Figure 2). All positions are in WGS84 datum.

Commercial harvest 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, and are most commonly harvested in 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 Nisqually tract. Currents reach an estimated average flood velocity of 1.1 knots and an estimated average ebb velocity of 1.1 knots (Tides and Currents software; station #1821; Nisqually Reach).

Substrate types vary greatly across this tract with sand and mud being the predominant surface substrate types observed on the tract. Additionally, boulders were observed on three transects.

Water Quality:

Water quality is good at the Nisqually 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 varied between 6.1 and 13.1 mg/l with an average of 9.2 mg/l. The pH ranged from 7.6 to 8.7 with an average of 8.1. Salinities ranged from 16.2 to 30.3 psu, with an average of 27.4 psu. Water temperatures ranged from 5.5 to 15.1ºC with an average temperature of 10.8ºC.

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 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. Prior to opening the tract, DNR will take biotoxin samples to confirm acceptable levels.

Biota:

Geoduck:

The Nisqually geoduck tract was surveyed (53 transects) by the Nisqually Tribe in 2014 and 2015 and the Nisqually Tribe began harvest in May of 2020. The tract received a “supplemental” survey by WDFW in 2016 (Tables 6 and 7) to collect additional information about animals and algae on the tract. The results of the 2014-2015 survey are used for this tract biomass estimate.

The Nisqually geoduck tract is approximately 145 acres and currently contains an estimated 2,251,294 pounds of geoduck (Table 1). The geoduck biomass estimate at this tract is based on a 2014-2015 Nisqually Tribe survey estimate of 2,864,823 subtracting reported commercial harvest of 613,529 lbs. of geoduck since that survey. No geoduck dig station difficulty information was provided.

The current geoduck density on this tract is high, averaging 0.14 geoducks/sq.ft. during the 2014-2015 prefishing survey. The geoducks at the Nisqually tract averaged 2.59 pounds which is above the average weight of 2.42 pounds in Puget Sound.. The lowest average whole weight was 1.79 pounds per geoduck at station #b2 and the highest average whole weight was 3.24 pounds per geoduck at station #e3 (Table 4). 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 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 Nisqually 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 which provide few attachments for macroalgae, which is also associated with rockfish and lingcod. The fish observed during the surveys at the Nisqually tract were various species of sculpins and flatfishes, including sand dabs, and starry flounder.

WDFW marine fish managers were asked of their concerns regarding possible impacts of geoduck fishing on groundfish and baitfish. 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 Nisqually 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 in the vicinity of the Nisqually tract (Figure 4). However, a herring pre-spawner 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 Nisqually tract should have no detrimental impacts on herring spawning.

Sand lance spawning has been documented inshore of the Nisqually 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 approximately four weeks. Sand lances are an important part of the trophic link between zooplankton and larger predators in the local marine food webs. Like all forage fish, sand lance 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 lance 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 (-18 ft. to -70 ft., MLLW). Geoduck harvest on the Nisqually tract should have no detrimental impacts on sand lance spawning.

There are two areas of surf smelt spawning habitat that have been identified just inshore of the proposed harvest area of the Nisqually tract. 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 Nisqually 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 Nisqually 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 Nisqually geoduck tract are McAllister Creek (approximately 2 miles west of the tract), Nisqually River (approximately 3 miles from the tract), and Chambers Creek (approximately 7 miles from the tract). 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. 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. There are no identified streams or rivers in the vicinity of Nisqually Reach that support steelhead stocks. The horizontal separation between tributaries that support steelhead runs and the Nisqually tract will ensure 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, they 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 Nisqually geoduck tract is outside of the critical habitat range of green sturgeon; therefore geoduck harvest at this location will have no adverse effects on ESArecovery efforts for green sturgeon populations.

Invertebrates:

Many different types of invertebrates 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 2 out of 42 transects on the Nisqually tract during the 2015 supplemental 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 -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 692 acres. There were about 1,108,098 harvestable geoducks on this tract, from the 2014-2015 pre-fishing survey estimate. With a minimum harvest level of 65 percent, the total number harvested would be 720,264 geoducks. Approximately 1.18 square feet of substrate is disturbed for every geoduck harvested, so 720,264 x 1.18 = 849,911 square feet of substrate. This equals approximately 20 acres, or roughly 2.8 percent of the total available crab habitat in the vicinity of this tract.

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), diatoms, and small and large foliose red algae.

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 they believe 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 was completed 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 a sufficient buffer for any eelgrass beds in the vicinity of the tract.

Marine Mammals:

Several species of marine mammals, including seals, sea lions, river otters, and killer whales (*Orcinus orca*) may be observed in the vicinity of this geoduck 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 National Marine Fisheries Service listed the Southern Resident stock of killer whales as "endangered" under the federal Endangered Species Act (ESA) on November 15, 2005. This is in addition to the designation of this stock as "depleted" under the Marine Mammal Protection Act in May 2003. More information and a draft conservation 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, such as 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 along the Nisqually tract has Thurston 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 that 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.

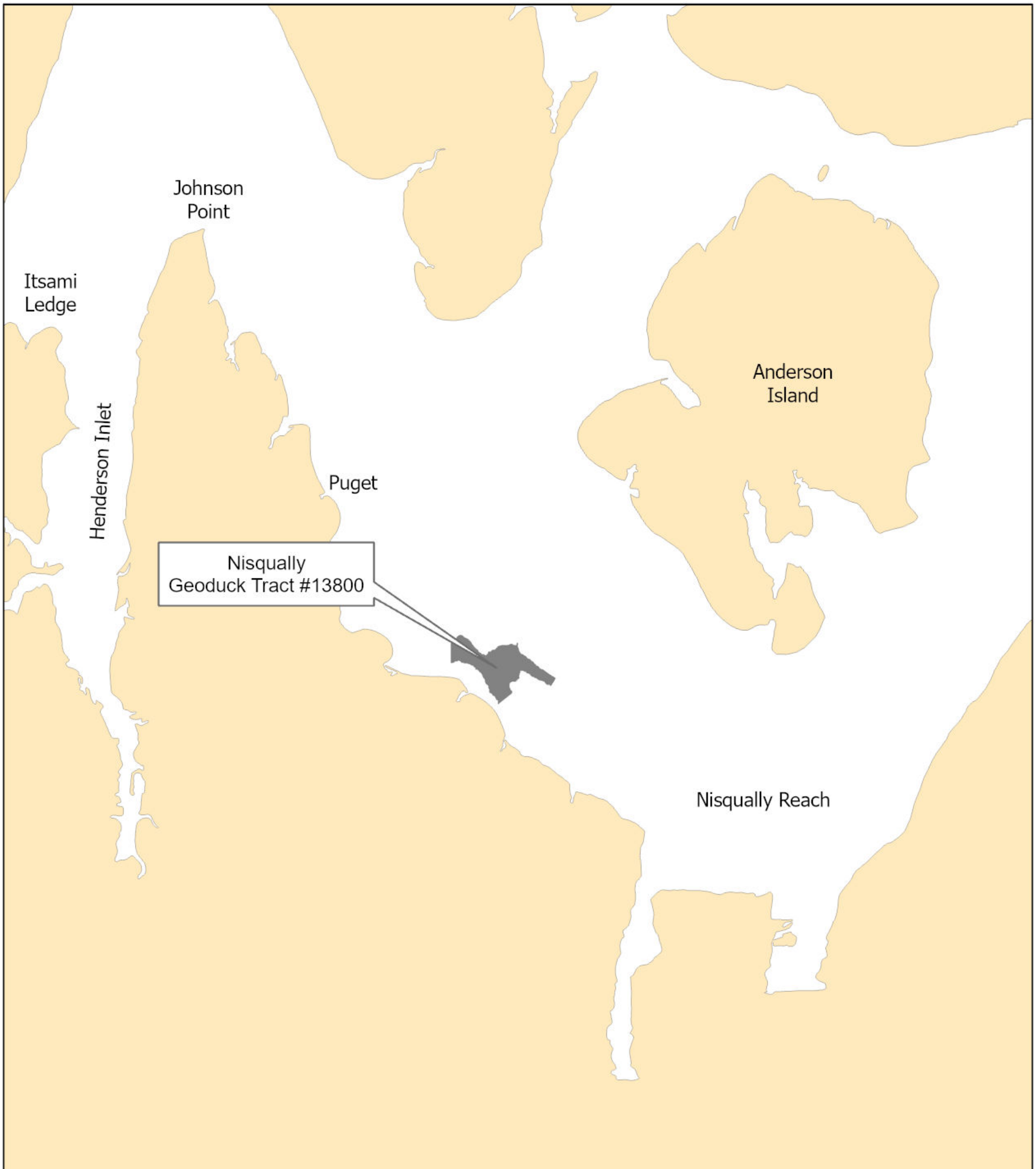
Navigation:

Nisqually Reach experiences moderate recreational and commercial vessel traffic, with seasonal fluctuations. The Nisqually 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 Nisqually geoduck tract located along the shoreline of Nisqually Reach. The tract was most recently surveyed in the years 2014-2015. The tract biomass estimate is based on the 2014-2015 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.

Figure 1. Vicinity Map, Nisqually Commercial Geoduck Tract #13800



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1:80,000

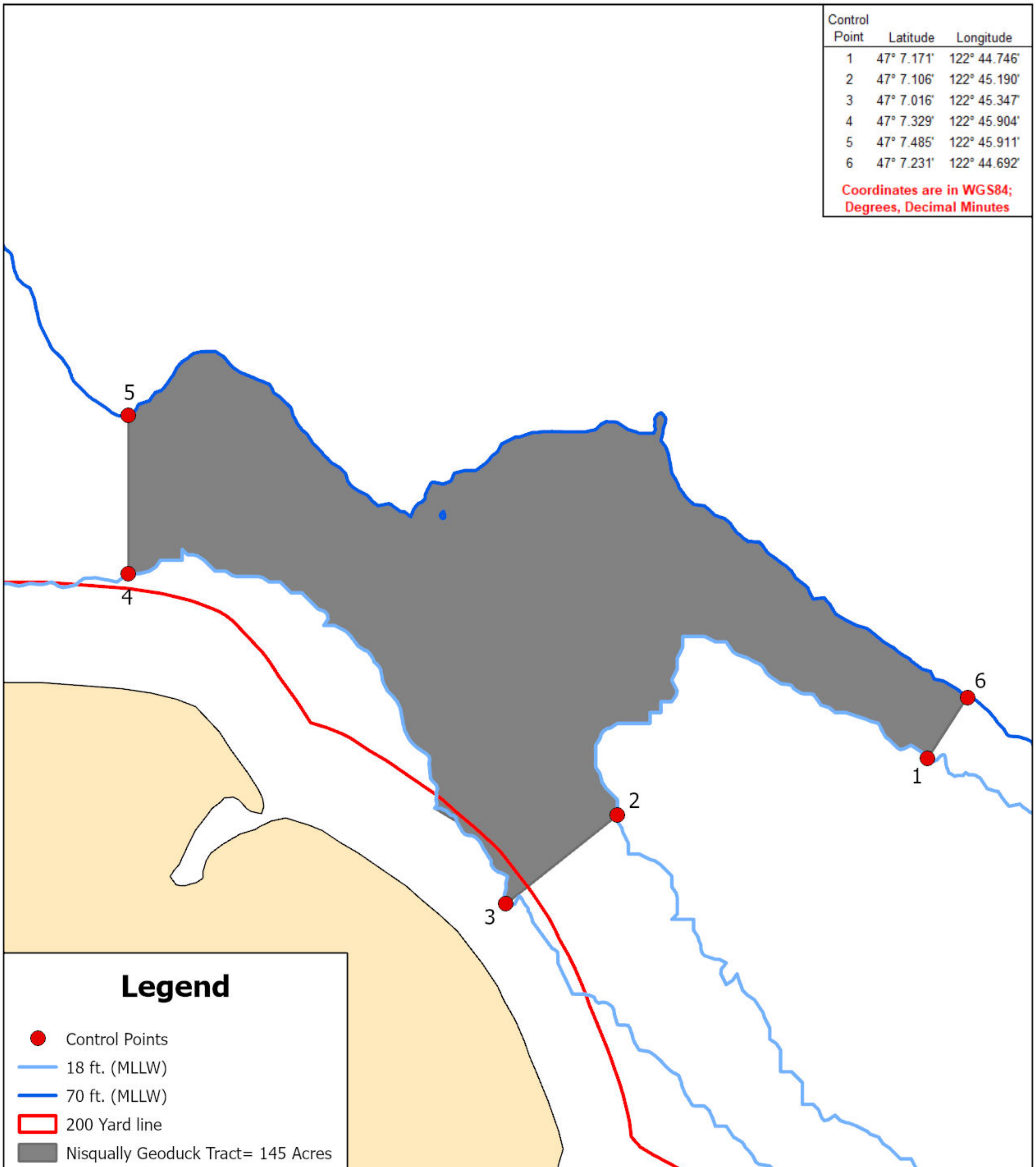
Data Sources:
Projection for data is GCS_Washington Geographic System 1984, Units: Meters. Coastline layer is from DNR, 1: 24,000 scale, created 09-20-99. Contours are from NOAA soundings.

0 0.5 1 2 3 Miles

Washington Department of FISH and WILDLIFE

Map Date: May 17, 2024
Map Author: O. Working
File: Data\Ocean\Geoduck

Figure 2. Control Points Map, Nisqually Commercial Geoduck Tract #13800



Control Point	Latitude	Longitude
1	47° 7.171'	122° 44.746'
2	47° 7.106'	122° 45.190'
3	47° 7.016'	122° 45.347'
4	47° 7.329'	122° 45.904'
5	47° 7.485'	122° 45.911'
6	47° 7.231'	122° 44.692'

Coordinates are in WGS84; Degrees, Decimal Minutes

N W E S

1:10,000

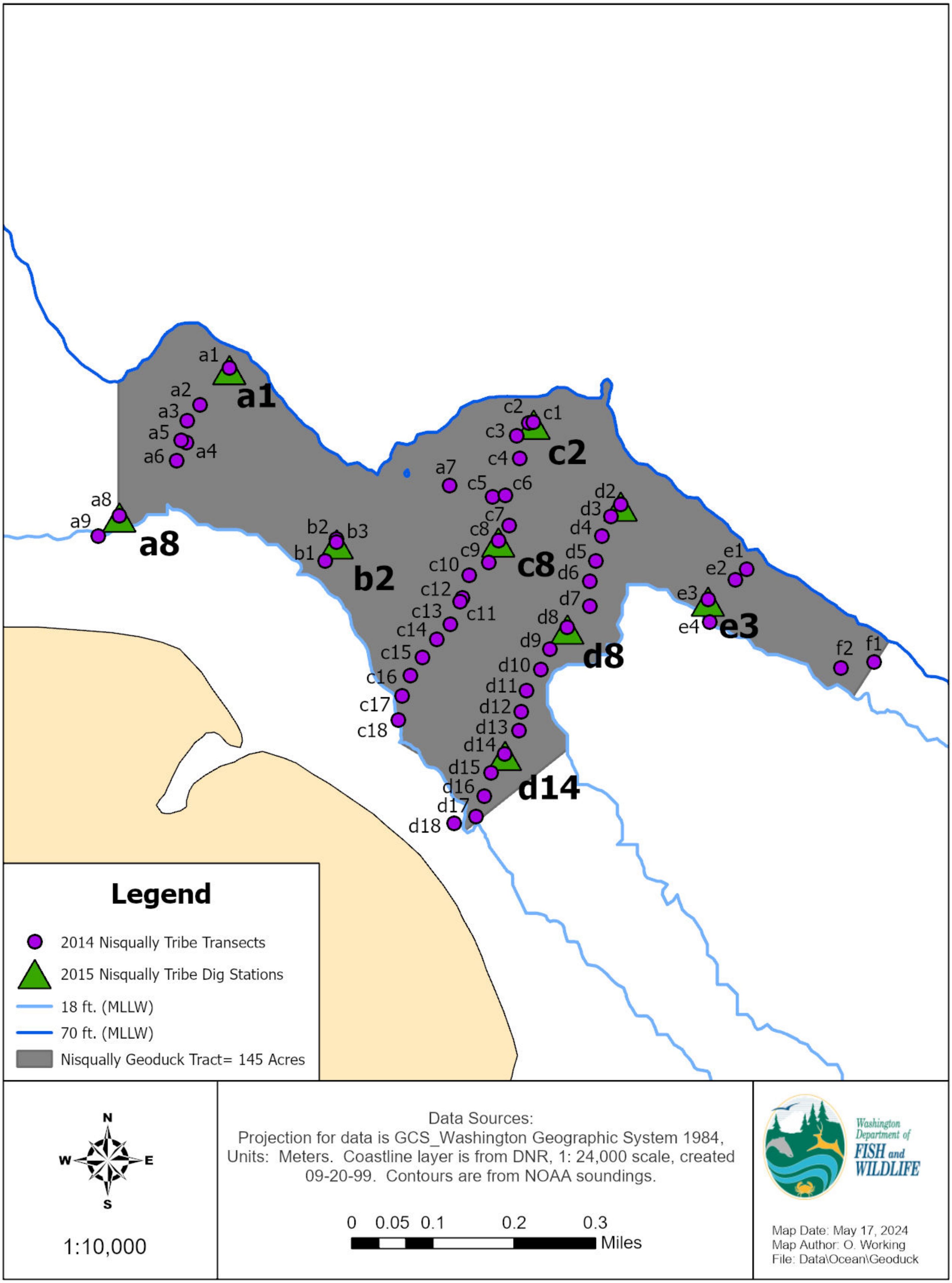
Data Sources:
Projection for data is GCS_Washington Geographic System 1984, Units: Meters. Coastline layer is from DNR, 1: 24,000 scale, created 09-20-99. Contours are from NOAA soundings.

0 0.05 0.1 0.2 0.3 Miles

Washington Department of FISH and WILDLIFE

Map Date: May 17, 2024
Map Author: O. Working
File: Data\Ocean\Geoduck

Figure 3. Transect and Dig Station Map, Nisqually Commercial Geoduck Tract #13800



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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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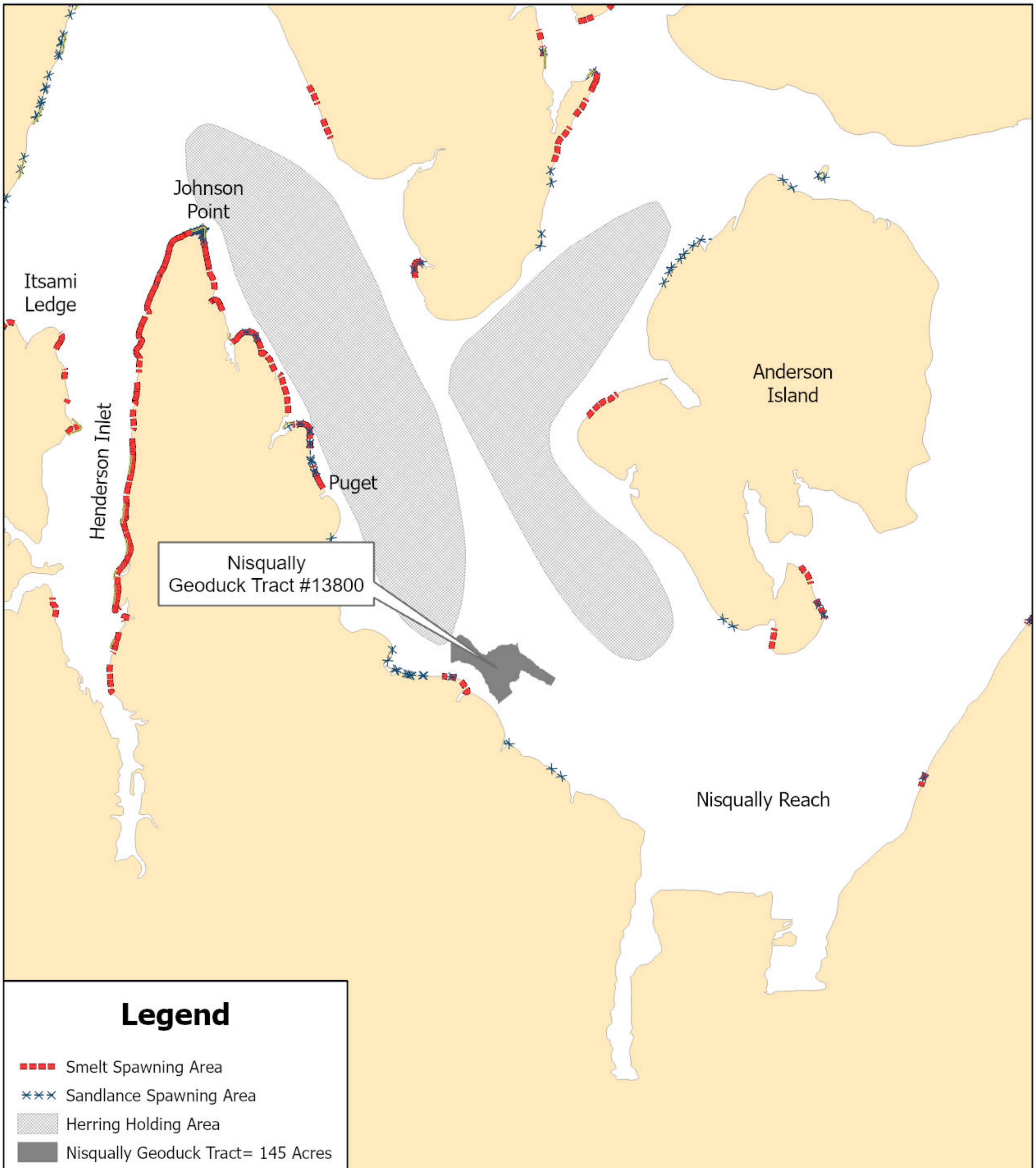
Map Date: May 17, 2024
Map Author: O. Working
File: Data\Ocean\Geoduck

Figure 4. Fish Spawning Areas Near the Nisqually Commercial Geoduck Tract #13800



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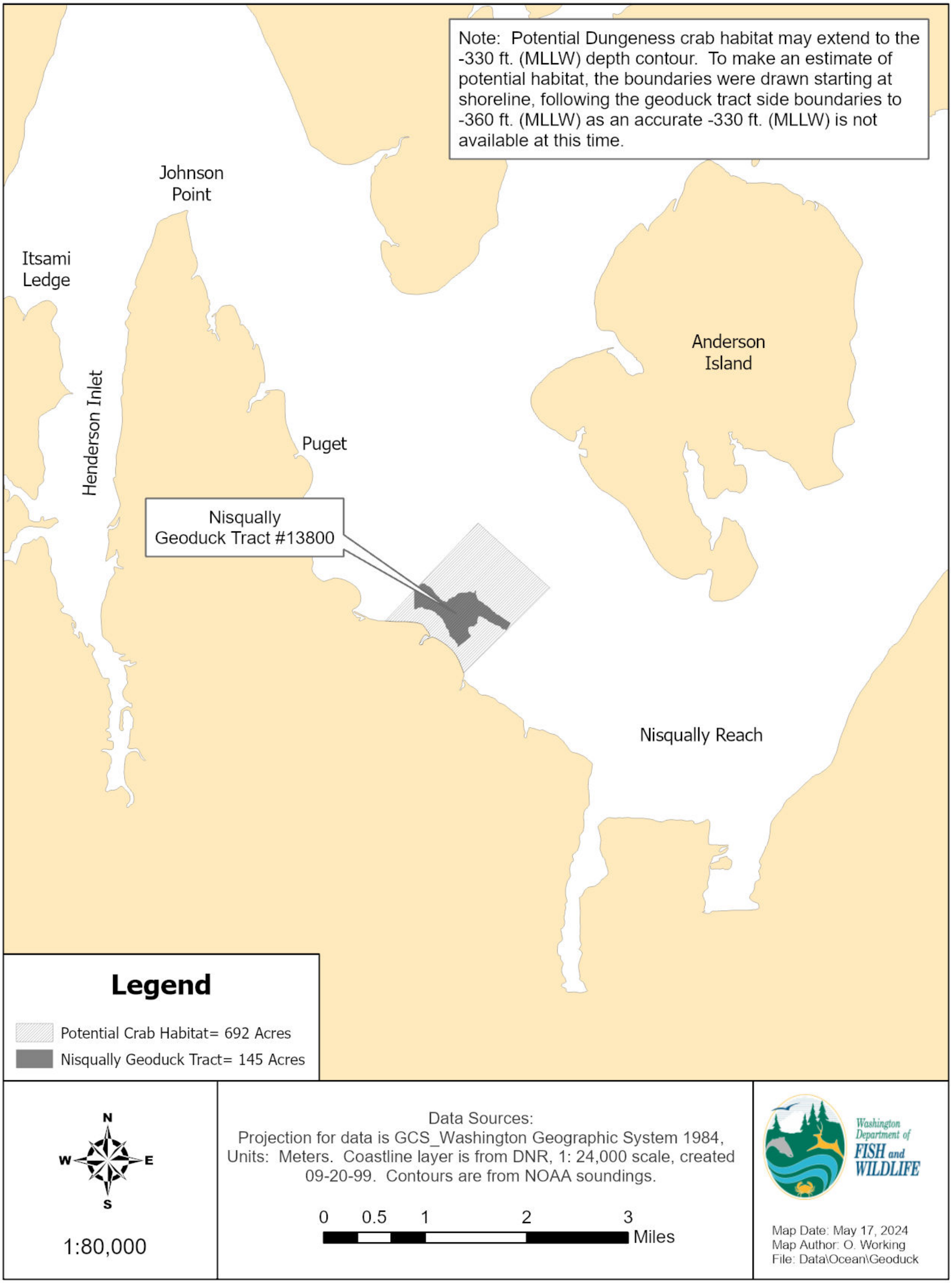
Data Sources:
Projection for data is GCS_Washington Geographic System 1984, Units: Meters. Coastline layer is from DNR, 1: 24,000 scale, created 09-20-99. Contours are from NOAA soundings.

0 0.5 1 2 3 Miles

Washington Department of FISH and WILDLIFE

Map Date: May 17, 2024
Map Author: O. Working
File: Data\Ocean\Geoduck

Figure 5. Potential Dungeness Crab Habitat Map, Nisqually Commercial Geoduck Tract #13800



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*.

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Table 1. GEODUCK TRACT SUMMARY

Nisqually geoduck tract # 13800.

Tract Name	Nisqually
Tract Number	13800
Tract Size (acres)[a]	145
Density of geoducks/sq.ft[b]	0.138
Total Tract Biomass (lbs.)[b]	2,251,294
Total Number of Geoducks on Tract[b]	870,788
Confidence Interval (%)	22.1%
Mean Geoduck Whole Weight (lbs.)	2.59
Mean Geoduck Siphon Weight (lbs.)[c]	58%
Siphon Weight as a % of Whole Weight[c]	22%
Number of 900 sq.ft. Transect Stations	53
Number of Geoducks Weighed	88

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

[b.] Biomass is based on the 2014 Nisqually Tribe Pre-fishing survey biomass of 2,864,823 minus harvest of 613,529 lbs. through May 17, 2024

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Table 2. DIGGING DIFFICULTY TABLE

Nisqually geoduck tract #13800, 2014-2015 Nisqually Tribe pre-fishing 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)

Digging diffuculty data were not provided

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

Nisqually geoduck tract #13800, 2014-2015 Nisqually Tribe pre-fishing survey.

Transect	Start Depth (ft.)[a]	End Depth (ft.)[a]	Geoduck Density (no. / sq.ft.)[b]	Substrate[c] mud	sand	boulder
a1	64	55	0.2544	1	2	
a2	55	49	0.3135	1	2	
a3	49	48	0.2860	1	2	
a4	45	39	0.2269	1	2	
a5	39	34	0.1760	1	2	
a6	34	36	0.2847	2	1	
a7	36	34	0.1953	2	1	1
a8	35		0.1911		2	1
a9		18	0.2200		2	1
b1	67	40	0.3139	2	1	
b2	40	32	0.5556	2	1	
b3	32	18	0.4347	2	1	
c1	69	67	0.6014	2	1	
c2	66	59	0.3167	2	1	
c3	58	54	0.3194	2	2	
c4	54	50	0.3486	1	2	
c5	50	45	0.2389	1	2	
c6	45	43	0.3097	2	1	
c7	43	40	0.4111	2	1	
c8	40	35	0.2139	2	1	
c9	35	34	0.2208	2	1	
c10	34	31	0.2167	1	2	
c11	31	41	0.1681	1	2	
c12	41	45	0.0569	1	2	
c13	45	49	0.1778	1	2	
c14	49	49	0.1903	1	2	
c15	49	42	0.2083	1	2	
c16	42	35	0.0792	1	2	
c17	35	28	0.0000	1	2	
c18	28	20	0.0000	1	2	
d2	62	56	0.1292		2	
d3	56	47	0.1097		2	
d4	47	24	0.1139		2	
d5	24	24	0.1667		2	
d6	24	24	0.1556		2	
d7	24	24	0.1264	2	2	
d8	24	22	0.0542	2	2	
d9	22	22	0.0542	2	2	
d10	22	20	0.0306	2	2	
d11	20	24	0.0000	2	2	
d12	23	25	0.0653	2	1	
d13	25	33	0.1153	2	2	
d14	33	43	0.1236	2	1	
d15	42	44	0.0222	2	1	
d16	43	37	0.0028	2	1	
d17	36	25	0.0000	2	1	
d18	25	18	0.0000	2	1	
e1	69	47	0.1164		2	
e2	46	25	0.1614		2	

Table 3. Continued

Transect	Start Depth (ft.)[a]	End Depth (ft.)[a]	Geoduck Density (no. / sq.ft.)[b]	Substrate[c]		
				mud	sand	boulder
e3	24	19	0.0313		2	
e4	19	18	0.0688		2	
f1	63	27	0.0863		2	
f2	27	19	0.0263		2	

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; blank = not observed

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Table 4. GEODUCK SIZE AND QUALITY

Nisqually geoduck tract #13800, 2014-2015 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.
a1	11	2.50	0.63	82%
a8	10	2.78	0.60	100%
c2	10	2.42	0.52	80%
c8	11	2.14	0.49	64%
d2	10	2.78	0.54	80%
d8	10	2.59	0.72	90%
d14	10	2.49	0.55	80%
e3	10	3.24	0.57	100%
b2	12	1.79	0.44	25%

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Table 5. TRANSECT CORRECTED GEODUCK COUNT AND POSITION TABLE

Nisqually geoduck tract #13800, 2014-2015 Nisqually Tribe pre-fishing survey.

Transect	Corrected Count	Show Factor[a]	Latitude[b]		Longitude[b]	
a1	229	0.81	47	7.503	122	45.737
a2	282	0.81	47	7.463	122	45.781
a3	257	0.81	47	7.445	122	45.800
a4	204	0.81	47	7.422	122	45.802
a5	158	0.81	47	7.424	122	45.810
a6	256	0.81	47	7.402	122	45.815
a7	176	0.81	47	7.384	122	45.387
a8	172	0.81	47	7.342	122	45.903
a9	198	0.81	47	7.319	122	45.935
b1	283	0.80	47	7.323	122	45.561
b2	500	0.80	47	7.320	122	45.561
b3	391	0.80	47	7.300	122	45.578
c1	541	0.80	47	7.453	122	45.266
c2	285	0.80	47	7.454	122	45.258
c3	288	0.80	47	7.439	122	45.284
c4	314	0.80	47	7.415	122	45.278
c5	215	0.80	47	7.373	122	45.319
c6	279	0.80	47	7.375	122	45.299
c7	370	0.80	47	7.343	122	45.292
c8	193	0.80	47	7.327	122	45.308
c9	199	0.80	47	7.303	122	45.322
c10	195	0.80	47	7.289	122	45.352
c11	151	0.80	47	7.264	122	45.362
c12	51	0.80	47	7.260	122	45.365
c13	160	0.80	47	7.236	122	45.379
c14	171	0.80	47	7.219	122	45.400
c15	188	0.80	47	7.199	122	45.422
c16	71	0.80	47	7.180	122	45.440
c17	0	0.80	47	7.158	122	45.452
c18	0	0.80	47	7.132	122	45.456
d2	116	0.80	47	7.369	122	45.118
d3	99	0.80	47	7.356	122	45.132
d4	103	0.80	47	7.335	122	45.146
d5	150	0.80	47	7.308	122	45.154
d6	140	0.80	47	7.286	122	45.163
d7	114	0.80	47	7.259	122	45.161
d8	49	0.80	47	7.236	122	45.196
d9	49	0.80	47	7.212	122	45.222
d10	28	0.80	47	7.190	122	45.235
d11	0	0.80	47	7.167	122	45.257
d12	59	0.80	47	7.144	122	45.264
d13	104	0.80	47	7.124	122	45.267
d14	111	0.80	47	7.099	122	45.288
d15	20	0.80	47	7.078	122	45.309
d16	3	0.80	47	7.053	122	45.318
d17	0	0.80	47	7.031	122	45.331
d18	0	0.80	47	7.023	122	45.365

Table 5. Continued

Transect	Corrected Count	Show Factor[a]	Latitude[b]		Longitude[b]	
e1	105	0.89	47	7.304	122	44.918
e2	145	0.89	47	7.292	122	44.935
e3	28	0.89	47	7.270	122	44.977
e4	62	0.89	47	7.246	122	44.973
f1	78	0.89	47	7.208	122	44.714
f2	24	0.89	47	7.201	122	44.766

[a.] Daily siphon show factor was used to correct geoduck counts

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

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Table 6. MOST COMMON AND OBVIOUS ANIMALS OBSERVED

Nisqually geoduck tract #13800, 2015 WDFW supplemental survey.

# of Transects where Observed	Group	Common Name	Taxonomer
34	ANEMONE	PLUMED ANEMONE	*Metridium* spp.
1	BACTERIA	BEGGIATOA	*Unspecified thiotrichacae*
2	BIVALVE	FALSE GEODUCK	*Panomya* spp.
5	BIVALVE	HEART COCKLE	*Clinocardium nuttalli*
30	BIVALVE	HORSE CLAM	*Tresus* spp.
3	BIVALVE	HORSE MUSSEL	*Modiolus rectus*
1	BIVALVE	TRUNCATED MYA	*Mya truncata*
8	CNIDARIA	HYDROIDS	Unspecified Hydroid
39	CNIDARIA	SEA PEN	*Ptilosarcus gurneyi*
7	CNIDARIA	SEA WHIP	*Stylatula elongata*
2	CRAB	DUNGENESS CRAB	*Cancer magister*
37	CRAB	GRACEFUL CRAB	*Cancer gracilis*
34	CRAB	HERMIT CRAB	Unspecified hermit crab
6	CRAB	RED ROCK CRAB	*Cancer productus*
1	CRAB	SHARP-NOSED CRAB	*Scyra acutifrons*
9	CUCUMBER	SEA CUCUMBER	*Parastichopus californicus*
2	CUCUMBER	WHITE CUCUMBER	*Eupentacta quinquesemita*
1	FISH	C-O SOLE	*Pleuronichthys coenosus*
17	FISH	FLATFISH	Unspecified flatfish
2	FISH	ROCK SOLE	*Lepidopsetta bilineata*
9	FISH	SANDDAB	Citharichthys *spp* .
25	FISH	SCULPIN	*Unspecified Cottidae*
6	FISH	STARRY FLOUNDER	*Platichthys stellatus*
9	GASTROPOD	MOON SNAIL EGGS	*Polinices lewisii* egg case
22	NUDIBRANCH	ARMINA	*Armina californica*
1	NUDIBRANCH	HERMISSENDA	*Hermissenda crassicornis*
7	NUDIBRANCH	ROSY TRITONIA	*Tritonia diomedea*
2	NUDIBRANCH	TRITONIA	Unspecified Tritoniidae
5	SEA STAR	BRITTLE STAR	Unspecified brittle star
8	SEA STAR	FALSE OCHRE STAR	*Evasterias troschelli*
3	SEA STAR	SUNFLOWER STAR	*Pycnopodia helianthoides*
13	SHRIMP	GHOST SHRIMP	Unspecified ghost shrimp
23	WORM	ROOTS	Chaetopterid polychaete tubes
26	WORM	SABELLID TUBE WORM	*Sabellid* spp.
18	WORM	TEREBELLID TUBE WORM	*Terebellid* spp.

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Table 7. MOST COMMON AND OBVIOUS ALGAE OBSERVED

Harper geoduck tract #08340, 2012 WDFW supplemental survey.

# of Transects where observed	Taxonomer
5	*Desmarestia* spp.
13	Diatoms
14	*Laminaria* spp.
20	Large red algae
37	*Ulva* spp.
30	Small red algae

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