ENVIRONMENTAL ASSESSMENT OF PROPOSED GEODUCK HARVEST
IN PIERCE COUNTY, FOX ISLAND SOUTH GEODUCK TRACT (#11260)

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 harvest management plans. Harvest is conducted by divers from subtidal beds between the -18 foot and the -70 foot water depth contours (corrected to mean lower low water, hereafter MLLW). Harvest is rotated around Puget Sound in six geoduck management regions. The fishery, its management, and its environmental impacts are presented in the Final Supplemental Environmental Impact Statement for the Puget Sound Commercial Geoduck Fishery (WDFW & DNR, 2001) and the Puget Sound Commercial Geoduck Fishery Management Plan (DNR & WDFW, 2008). The proposed harvest in Pierce County is described below.

Proposed Harvest Dates: 2019 - 2020

Tract name: Fox Island South Tract (#11260)

Description (Figure 1, Tract vicinity map):

The Fox Island South tract was surveyed for subtidal geoduck clams in the years 2016 and 2017 by the WDFW. The tract area is approximately 48 subtidal acres along the southwestern shoreline of Fox Island, South Puget Sound. The tract extends northwesterly for about 1.7 miles beginning just west of Gibson Point at the south end of Fox Island.

The entire commercial tract area is between the -20 foot (MLLW, depth corrected to mean lower low water) and the -70 foot (MLLW) water depth contour. The Fox Island South geoduck tract is described by a polygon and is bounded by a line projected southeasterly from a Control Point (CP) on the -20 foot (MLLW) water depth contour at 47°14.317’ N. latitude, 122°37.943' W. longitude (CP 1) along the -20 foot (MLLW) water depth contour to a point at 47°13.096' N. latitude, 122°36.638' W. longitude (CP 2); then southerly to a point on the -70 foot (MLLW) contour line at 47°13.019 N. latitude, 122°36.667' W. longitude (CP 3); then northwesterly along the -70 foot (MLLW) contour to point at 47°14.317' N. latitude, 122°37.983' W. longitude then easterly to the point of origin (Figure 2).

This estimate of the tract boundary is made using GIS and field data. Contour GIS layers from Dale Gombert (WDFW) were generated from NOAA soundings. Shoreline data was from DNR, digitized at 1:24000 scale in 1999. The latitude and longitude positions are in WGS84 datum and reported in degrees decimal minutes to the closest thousandths of a minute.

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 the water current velocity. Coarse sediments are generally found in areas of fast currents and finer (muddier) sediments are found 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 currents.

Water currents are moderately strong in Pitt Passage (Fox Island South tract is northeasterly of Pitt Passage). Currents reach a maximum flood velocity of 1.7 knots per hour and maximum ebb velocity of 2.4 knots (Tides and Currents software; station #1831; Pitt Passage, east of Pitt Island; estimated timeframe June 24, 2019 to June 24, 2020).

The Fox Island South tract has a nearly uniform sand surface substrate. Sand was present on the majority survey transects and was the predominant substrate type on 43 of the 49 survey transects. Mud, wood debris and cobble were also present (Table 3).

Water Quality:

Water quality is good at the Fox Island South geoduck tract. Water mixing at this tract is affected by the convergence of currents from Carr Inlet and Pitt Passage, which prevents stratification (water layering) and brings deeper nutrient-rich waters to the surface. As a result, the marine waters in this area are well oxygenated and productive. The following data on water quality has been provided by the Washington Department of Ecology (DOE) for Puget Sound at the Gordon Point station (GOR 001) at 47.1833° N. latitude; 122.6333° W. longitude. The DOE latitude and longitude positions are recorded in decimal degrees. For data years 1996 to 2015 (the most current data set available), at water depths between 6 and 23 meters, the mean reported dissolved oxygen concentration was 8.3 mg/l with a range between 5.8 mg/l and 14.4 mg/l. The mean salinity at this station was 29.1 psu with a range between 26.9 psu and 30.5 psu. The mean water temperature at this station was 10.9° C with a range between 7.5° C and 14.8° C.

This geoduck tract status has been reviewed by the Washington Department of Health (DOH) and the tract has been classified as “approved”.

Biota:

Geoduck:

The Fox Island South tract was surveyed in 1971 by WDFW, in 1997 by the Medicine Creek tribes and again in 1998 by WDFW. Between September 1999 and April 2016, there were 1,274,721 pounds reported harvest from the tract. Subsequent to the harvest the tract was re-surveyed in 2016 and 2017 by WFDW for pre-fishing information. The 2016 and 2017 WDFW surveys are used to estimate geoduck biomass on this tract.

The Fox Island South tract is approximately 49 acres and the pre-fishing estimate was 306,542 lbs. of geoduck. The tract currently contains an estimated 198,593 pounds of geoducks (Table 1) after harvest of 107,949 lbs. through June, 2019. Digging difficulty was reported to be very easy, divers noted all zeros from a range of zero to five in degree of digging difficulty (Table 2). The pre-fishing geoduck density on this tract was 0.071 geoducks/sq.ft. The average density range from the 2016 survey was 0.000 geoducks/square foot on transects #50 and 51 to 0.579 geoducks/square foot on transect #56 (Figure 3; Table 3). Most likely due to harvest in the shallows and mid-depths on this tract, transects show that remaining geoducks are now mostly located on the deep section of the tract. The geoducks on the Fox Island South tract are moderate weight, averaging 2.2 pounds, compared to the Puget Sound average of 2.1 pounds per geoduck clam. The lowest average whole weight was 1.97 pounds per geoduck at stations #1 and 2, and the highest average whole weight was 2.42 pounds per geoduck at station #3 (Table 4).

Geoducks are managed for long term sustainable harvest. No more than 2.7% of the commercially fishable stocks are harvested (total fishing mortality) each year, in each harvest management region, throughout Puget Sound. The fishable portion of the total Puget Sound population includes geoducks that are between the -18 feet and -70 feet water depth contours (MLLW). Other geoducks, which are not harvestable, are found inshore and offshore of the harvest areas. Observations in South Puget Sound show that 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 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. The longest regeneration time is 73 years, and the shortest regeneration time is 11 years. The recovery time for the Fox Island South tract is unknown. 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 or support fish. The bottoms are relatively flat and composed of soft, unstable sediments which provide few attachments for macroalgae and few vertical structures which attract fish. Fish species observed on this tract were various flatfish including C-O soles, rock soles, sand dabs, starry flounders and unspecified flatfish, bay pipefish, sculpins, and unspecified fish eggs (Table 6).

WDFW marine fish managers were asked of their concerns of any possible impacts on marine fish that geoduck fishing may have. Marine Fish Managers Greg Bargmann and Duane Day have stated that no problems should occur to marine fish stocks or fisheries due to geoduck fishing. Geoduck harvest should not affect any recreational or commercial groundfish fisheries in the vicinity of this tract. Proposed geoduck harvest at this tract is not in the vicinity of any documented herring spawning grounds (Figure 4). There is no concern among WDFW marine fish managers to this proposed geoduck harvest, as long as the minimum harvest depth of -18 ft. (MLLW) is adhered to.

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. A five year status review reaffirmed the threatened status of chinook salmon on 8/15/2011 (76FR50448). 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 Fox Island South tract is outside of the critical habitat range for Hood Canal summer run chum salmon.

Critical habitat for Puget Sound chinook salmon include 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 majority of Puget Sound chinook salmon emigrate to the ocean as subyearlings.

Streams or tributaries near the Fox Island South geoduck tract are McAllister Creek (approximately 9.5 miles from the tract), Nisqually River (approximately 9.5 miles from the tract), and Chambers Creek (4.7 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 from the University of Washington School of Fisheries stated that the "exclusionary principle of not allowing leasing/harvesting in water shallower than -18 ft. MLLW, 2 ft. vertically from elevation of 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 Fox Island that

support steelhead stocks. The horizontal separation between tributaries that support steelhead runs and the Fox Island South 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 Fox 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 marine invertebrates are found on geoduck beds throughout Puget Sound. Marine invertebrates observed during the 2017 WDFW Supplemental survey of the Fox Island South tract include: [1] mollusks - horse clams, geoducks, and false geoducks, and nudibranchs (*Armina* sp., *Hermissenda* sp., *Dendronotus* sp., *Dirona albolineata*, and *Tritonia diomedea*), and unspecified opisthobranchs, moonsnail egg cases, and squid eggs; [2] crustaceans - graceful crabs, Dungeness crabs, red rock crabs, hermit crabs, and decorator crabs; [3] echinoderms - sunflower stars, short-spined stars, false ochre stars, brittle stars, leather stars, and sea cucumbers; [4] cnidarians - sea pens, plumed anemones, and burrowing anemones; and [5] other marine invertebrates including sessile tunicates, ghost shrimp, and sabellid and terrebellid tube dwelling worms, (Table 6). Geoduck harvest has not been shown to have long-term adverse effects on these invertebrates. Geoduck harvest can depress some local populations of benthic invertebrates; however, most of these populations recover within one year.

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 Dungeness crab may experience peak molt in mid-April, based on data from the Kingston area (Cain, 10/15/01). Dungeness crab were observed twice on transects during the 2016 survey of the Fox Island South tract.

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 Carr Inlet in the vicinity of the tract the tract deeper than the +1 foot tide level (Figure 5). 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 entire crab habitat in the vicinity of this geoduck bed is approximately 470 acres. From the most recent survey in 2016, there was an estimated 141,700 harvestable geoducks on this tract. With a minimum harvest level of 65 percent of these geoducks, the total number harvested would be 92,105 geoducks. Approximately 1.18 square feet of substrate is disturbed for every geoduck harvested, so 92,105 x 1.18 = 108,684 square feet of substrate. This equals 2.5 acres. This is about 0.5 percent of the total available crab habitat in the vicinity of this tract. This represents a low amount of disturbance to the potential crab habitat in the immediate vicinity of this geoduck tract. Since this tract is on the lower fringe of the principle range of distribution of Dungeness crab in Puget Sound, no Dungeness crab were observed during scuba surveys at Fox Island South, combined with the lack of effects observed on Dungeness crab populations at the Thorndyke Bay study, we conclude that any effects on Dungeness crab will be very minor, if they occur at all.

Red rock crab (*Cancer productus*) were observed on 31 of 49 transects done in 2016 on the Fox Island South tract. The crab catch study at Thorndyke Bay in Hood Canal (Armetta Cain, January 1995) found no significant difference in red rock crab Catch Per Unit Effort (CPUE) on a tract prior to geoduck fishing, during geoduck fishing, and following geoduck fishing. Based on this study, there is a low potential for impacts to red rock crab populations in the vicinity of this tract.

In a note dated July 18, 2005 the WDFW Region 6 Shellfish Manager, Brad Sele, stated that there are no specific shellfish concerns regarding the proposed geoduck harvest in this vicinity.

Aquatic Plants:

Large quantities of attached aquatic plants are not generally found in geoduck beds. Light restriction often limits plant growth to areas shallower than where most geoduck harvest occurs. Red algae, sea lettuce (*Ulva* sp.), Laminarian algae, diatoms, and Desmarestia algae were the main algae types observed during the 2016 survey (Table 7).

WDFW conducted eelgrass surveys at the Fox Island South tract on June 8, 2017. Eelgrass was observed down to a maximum depth of -18 foot level (corrected to MLLW). The shallow boundary line of this tract is set at no shallower than the -20 foot level

(MLLW) to conform with state statute (RCW 77.60.070) and also to provide a 2 foot vertical buffer between eelgrass beds and geoduck harvest.

Marine Mammals:

Several species of marine mammals, including seals, sea lions, and river otters may be observed in the vicinity of this geoduck tract. There have also been sporadic reports of gray whales feeding near the eastern shoreline of the Kitsap Peninsula and rare reports of humpback whales near the eastern shoreline of the Kitsap Peninsula. Killer whales may also be observed in the vicinity of this tract, particularly between November and March. 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 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 herons, bald eagles, and ospreys are also 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 commercial geoduck clam harvest is unlikely to have any adverse impacts on bald eagle productivity.

Other uses:

Adjacent Upland Use:

The upland properties adjacent to the tract are designated as a “semi-rural” shoreline environmental designation.

To minimize possible disturbance to adjacent residents, harvest vessels are not allowed within 200 yards of the ordinary high tide line (OHT). 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 harvest vessels (typically 30-40 feet in overall length) 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 for sport fishing, however, some recreational salmon fishing could occur seasonally in proximity to the geoduck bed. The WDFW Sport Fishing Rules pamphlet describes seasons, size limits, daily limits, specific closed areas, and other fishing 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 state/tribal harvest management plans. The non-Indian geoduck fishery should not be in conflict with any concurrent tribal fisheries.

Navigation:

Carr Inlet is not a major navigational route for recreational or commercial vessels traveling between ports in southern Puget Sound. Geoduck harvesting at this site should not result in any significant navigational conflicts. The Washington Department of Natural Resources will notify the local boating community prior to harvests.

Summary:

Commercial geoduck harvest is proposed for the Fox Island South geoduck tract, located along the southwestern shoreline of Fox Island. The geoduck population on the tract was most recently surveyed in the years 2016 and 2017 and the current tract biomass estimate is based on those surveys minus subsequent harvest. The anticipated environmental impacts of this harvest are within the range of conditions discussed in the Final Supplemental Environmental Impact Statement for the commercial geoduck clam fishery. To reduce potential impacts to baitfish and eelgrass, harvest will be deeper and seaward of the -20 foot (MLLW) contour. Harvest vessels will remain at least 200 yards from OHT during harvest operations. There effects on marine invertebrates in the vicinity of the tract are expected to be minimal. No other significant impacts are expected from this harvest.

Date prepared: June 24, 2019

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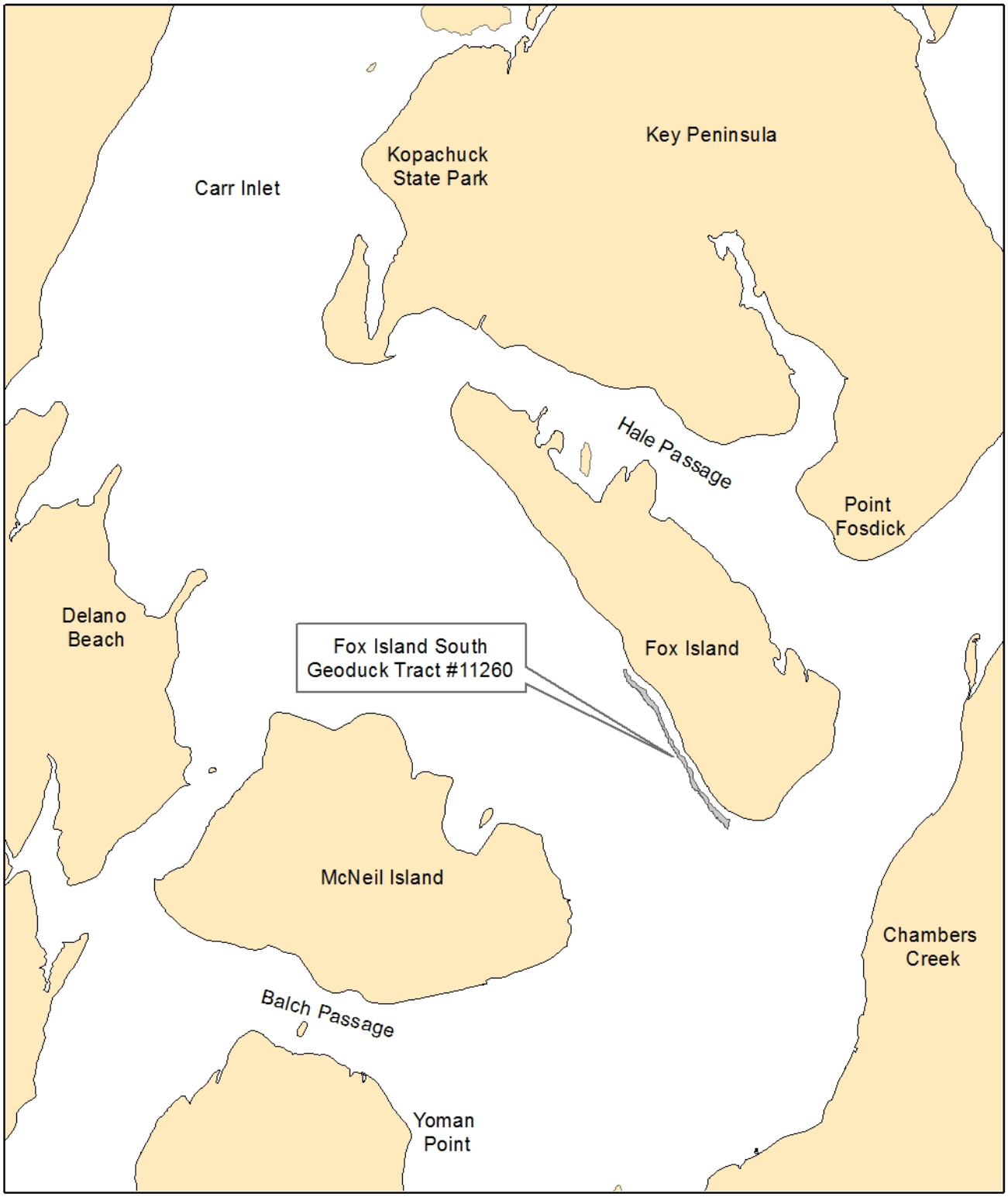
Figure 1. Vicinity Map, Fox Island South Commercial Geoduck Tract #11260



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1 inch = 1.42 miles

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 0.475 0.95 1.9 2.85 Miles

Washington Department of FISH and WILDLIFE

Map Date: June 15, 2017
Map Author: O. Working
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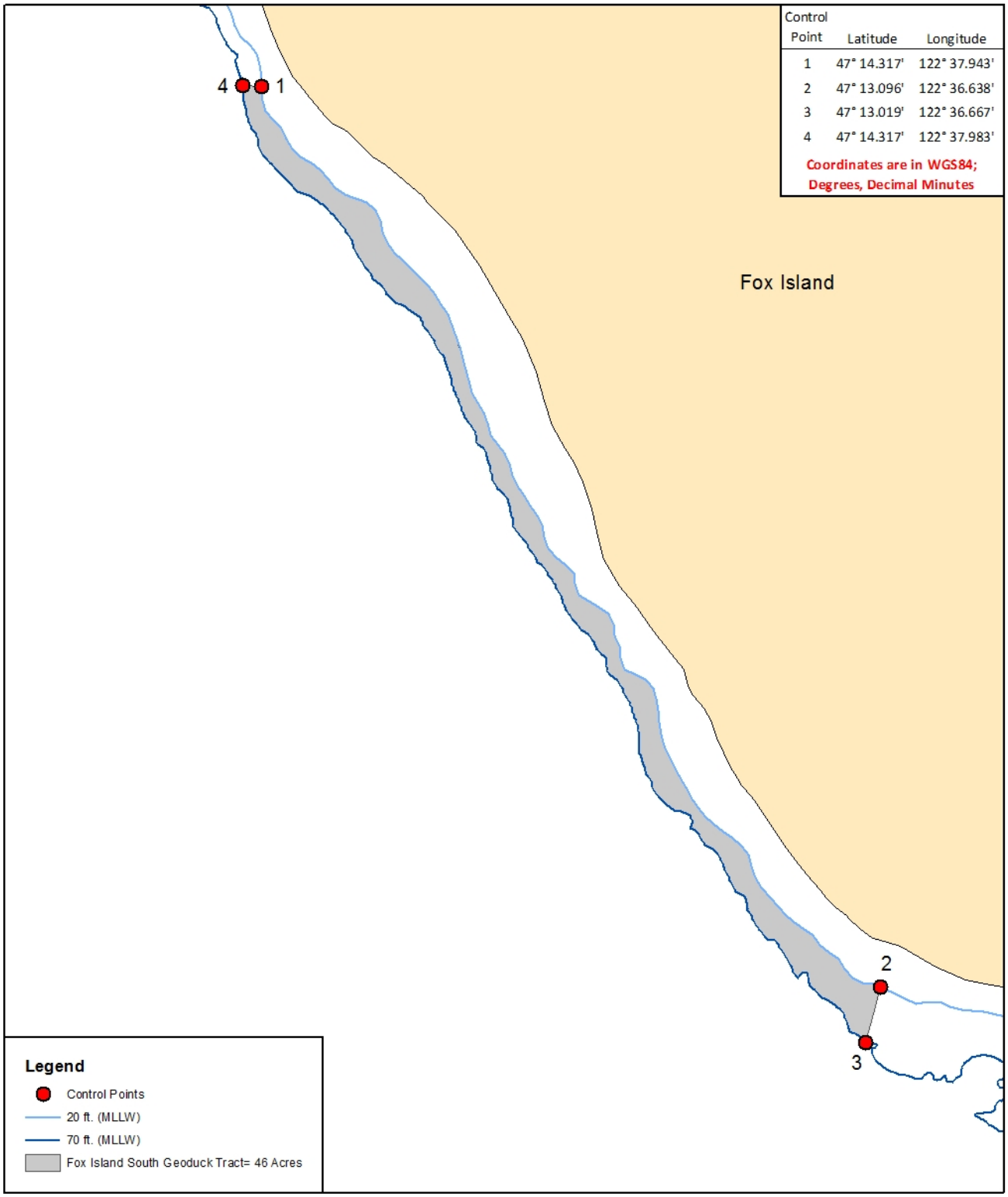
Figure 2. Control Points Map, Fox Island South Commercial Geoduck Tract #11260



Control Point	Latitude	Longitude
1	47° 14.317'	122° 37.943'
2	47° 13.096'	122° 36.638'
3	47° 13.019'	122° 36.667'
4	47° 14.317'	122° 37.983'

Coordinates are in WGS84; Degrees, Decimal Minutes

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1 inch = 0.24 miles

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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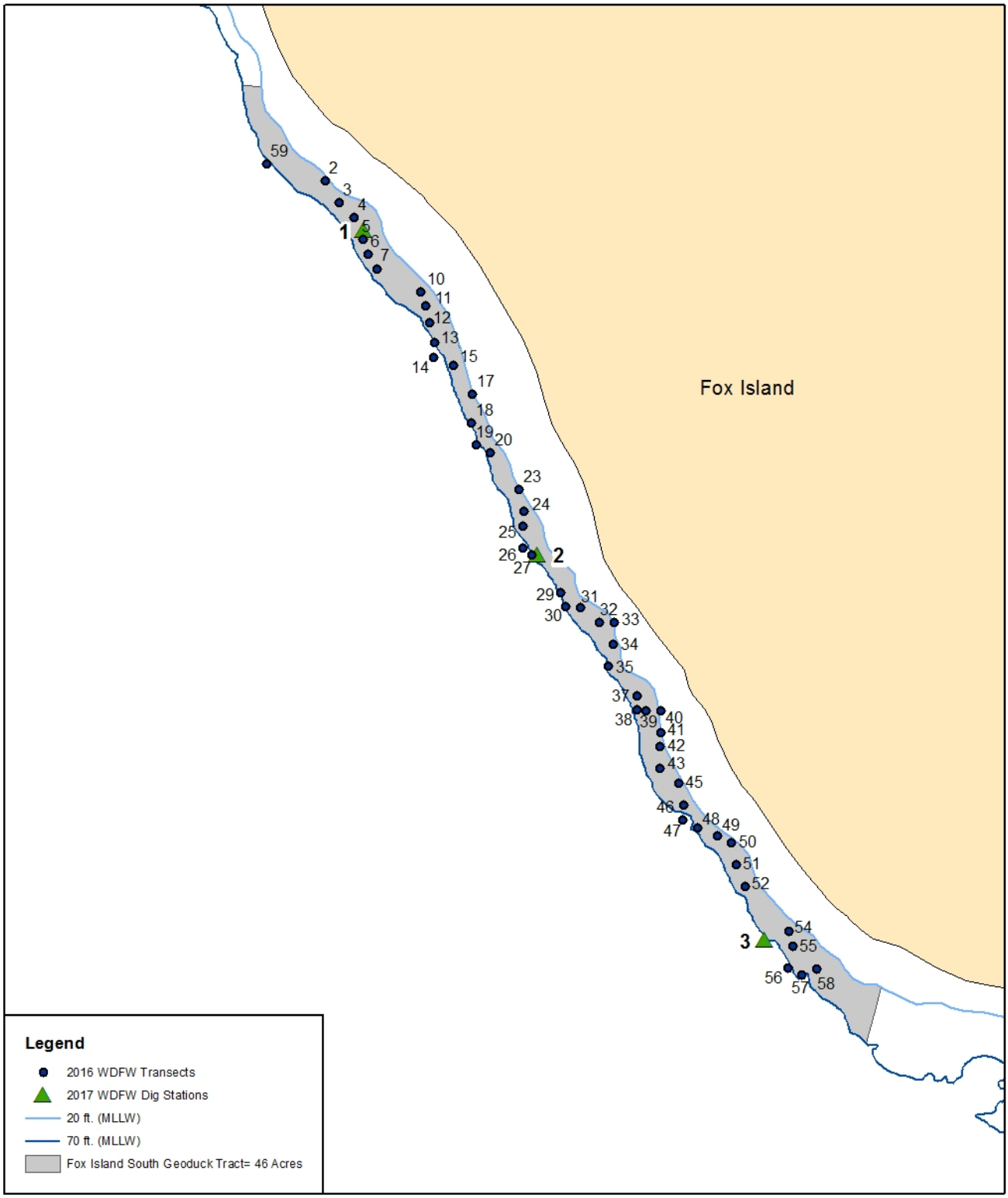
Map Date: June 15, 2017
Map Author: O. Working
File: Data\Ocean\Geoduck

Figure 3. Transect and Dig Station Map, Fox Island South Commercial Geoduck Tract #11260



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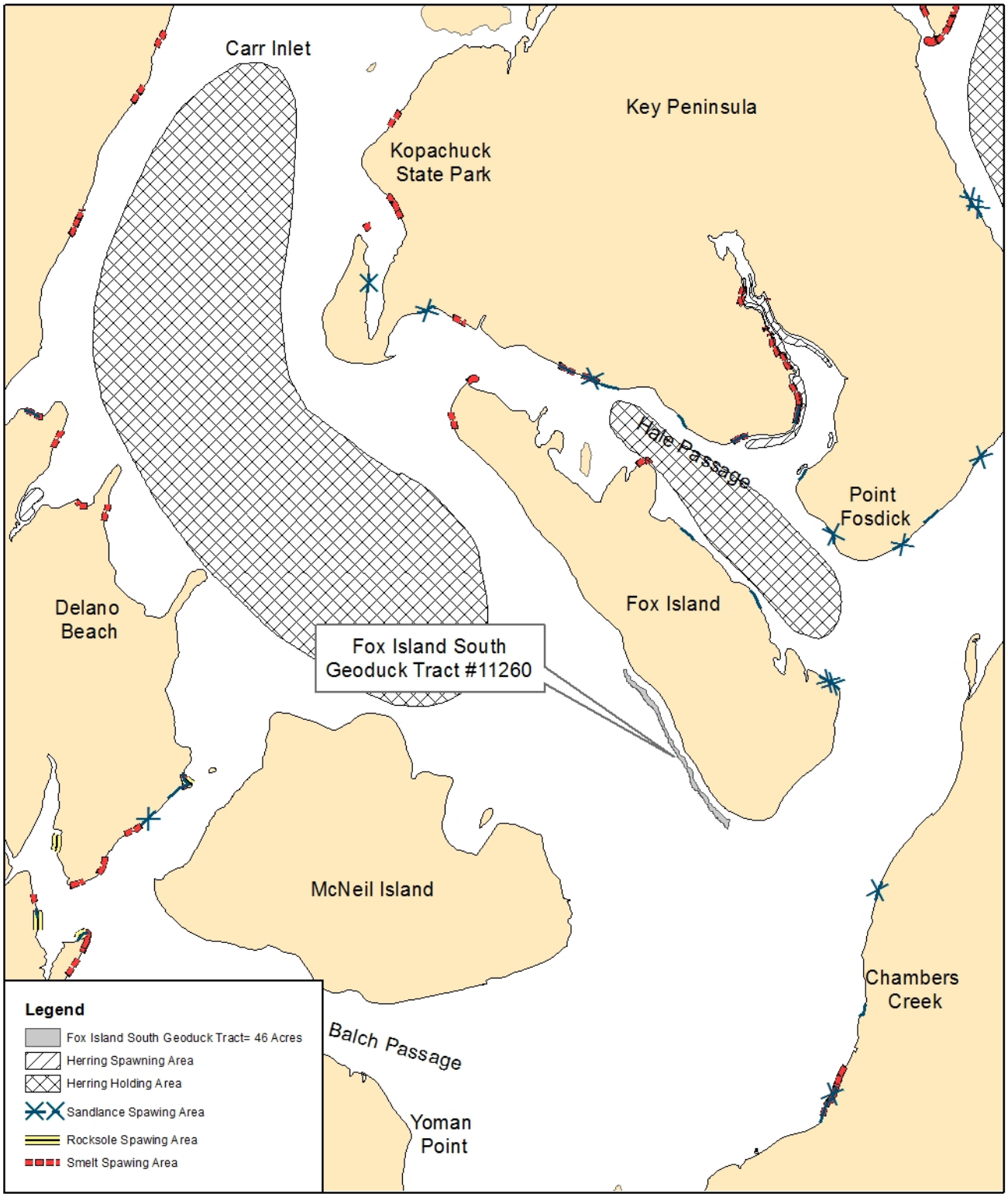
Washington Department of FISH and WILDLIFE

Map Date: June 15, 2017
Map Author: O. Working
File: Data\Ocean\Geoduck

Figure 4. Fish Spawning Areas Near the Fox Island South Commercial Geoduck Tract #11260



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0 0.475 0.95 1.9 2.85 Miles

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Map Date: June 15, 2017
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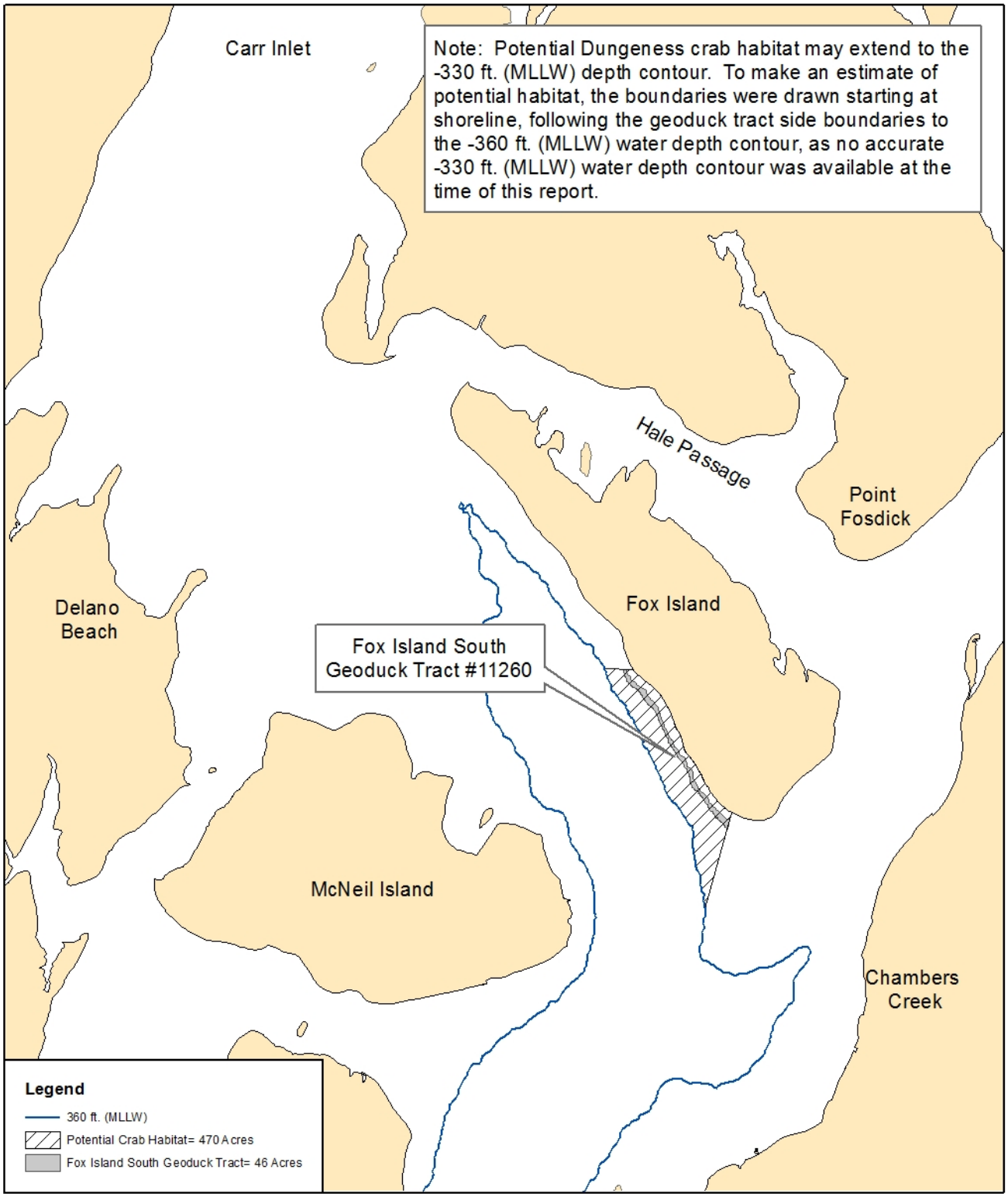
File: Data\Ocean\Geoduck

Figure 5. Dungeness Crab Habitat Map, Fox Island South Commercial Geoduck Tract #11260



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0 0.475 0.95 1.9 2.85 Miles

Washington Department of FISH and WILDLIFE

Map Date: June 15, 2017
Map Author: O. Working
File: Data\Ocean\Geoduck

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

Fox Island Central geoduck tract # 11250

Tract Name	Fox Island South
Tract Number	11260
Tract Size (acres)[a]	46
Density of geoducks/sq.ft.[b]	0.046
Total Tract Biomass (lbs.)[b]	198,593
Total Number of Geoducks on Tract[b]	91,800
Confidence Interval (%)	42.67%
Mean Geoduck Whole Weight (lbs.)	2.16
Mean Geoduck Siphon Weight (lbs.)	0.54
Siphon Weight as a % of Whole Weight	25.18%
Number of Transect Stations	49
Number of Geoducks Weighed	28

[a.] Tract area is between the -20 ft. and -70 ft. (MLLW) water depth contours

[b.] Biomass is based on the 2016 and 2017 WDFW Pre-fishing survey biomass of 306,542 lbs. minus harvest of 107,949 lbs. through June 24, 2019

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Table 2: DIGGING DIFFICULTY TABLE

Fox Island South geoduck tract # 11260, 2017 WDFW 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	0	2	0	0	0	0	0	0	Y
2	0	1	0	0	0	0	0	0	Y
3	0	2	0	0	0	0	0	0	Y

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

Fox Island South geoduck tract # 11260, 2016 WDFW pre-fishing geoduck survey

Transect	Start Depth (ft) [a]	End Depth (ft) [a]	Geoduck Density (no. / sq ft) [b]	Substrate			
				sand	mud	wood debris	cobble
2	27	37	0.0092	2	1		
3	37	45	0.0066	2	1		
4	46	51	0.0329	2	1		
5	50	61	0.1460	2	1		
6	61	68	0.2235	2	1		
7	68	41	0.0868	2	1		
10	27	33	0.0381	2			
11	33	41	0.0079	2			
12	41	52	0.0421	2	1		
13	52	67	0.1354	2	1		
14	68	50	0.1144	2	1		
15	50	26	0.0197	2			
17	33	49	0.0139	2	1		
18	50	70	0.0636	1	1		
19	70	43	0.0856	2	1		
20	43	33	0.0069	2	1		
23	21	34	0.0012	2			
24	34	51	0.0012	2	1		
25	50	62	0.2220	2	1		
26	62	62	0.1538	2	1		1
27	62	20	0.0035	2			
29	45	66	0.0786	1	1		
30	66	42	0.0248	2	1		
31	42	27	0.0110	2	1		
32	27	31	0.0055	1	1	1	
33	32	47	0.0124	2	1	1	
34	47	57	0.0372	2	1		
35	57	63	0.1310	1	1		
37	44	69	0.0731	2	1		
38	69	38	0.0441	2	1		
39	38	27	0.0124	2	1		
40	27	35	0.0083	2	1		
41	34	51	0.0028	2	1		
42	51	65	0.0041	2	1		
43	65	61	0.0819	2	1		
45	31	42	0.0013	2	1		
46	42	60	0.0026	1	1		
47	60	63	0.1088	1	1		
48	64	38	0.0026	2	1		
49	38	25	0.0013	2	1		
50	25	33	0.0000	2			
51	33	51	0.0000	2			
52	52	67	0.0499	2	1		

Table 3. Continued

Transect	Start Depth (ft) [a]	End Depth (ft) [a]	Geoduck Density (no. / sq ft) [b]	Substrate			
				sand	mud	wood debris	cobble
54	35	46	0.0128	2			
55	46	62	0.2714	2			
56	62	59	0.5786	2			
57	59	43	0.2829	2			
58	44	26	0.1178	2			
59	70	50	0.0909	2	1		

a. All depths are corrected to mean lower low water (MLLW)
b. Densities were calculated using a daily geoduck siphon show factor

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Table 4: GEODUCK SIZE AND QUALITY

Fox Island South geoduck tract # 11260, 2017 WDFW 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	1.97	0.49	40%
2	8	1.97	0.53	38%
3	11	2.42	0.61	73%

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Table 5: TRANSECT CORRECTED GEODUCK COUNT AND POSITION TABLE

Fox Island South geoduck tract # 11260, 2016 WDFW pre-fishing geoduck survey

Transect	Corrected Geoduck Count per 900 sq. ft. Transect	Geoduck Siphon Show Factor [a]	Latitude [b]	Longitude [b]
2	8	0.845	47° 14.189	122° 37.810
3	6	0.845	47° 14.160	122° 37.780
4	30	0.845	47° 14.140	122° 37.750
5	131	0.845	47° 14.110	122° 37.730
6	201	0.845	47° 14.090	122° 37.720
7	78	0.845	47° 14.070	122° 37.700
10	34	0.845	47° 14.040	122° 37.610
11	7	0.845	47° 14.020	122° 37.600
12	38	0.845	47° 13.997	122° 37.590
13	122	0.845	47° 13.970	122° 37.580
14	103	0.845	47° 13.950	122° 37.580
15	18	0.845	47° 13.940	122° 37.540
17	12	0.961	47° 13.900	122° 37.500
18	57	0.961	47° 13.860	122° 37.500
19	77	0.961	47° 13.830	122° 37.490
20	6	0.961	47° 13.820	122° 37.460
23	1	0.961	47° 13.770	122° 37.400
24	1	0.961	47° 13.740	122° 37.390
25	200	0.961	47° 13.720	122° 37.390
26	138	0.961	47° 13.690	122° 37.390
27	3	0.961	47° 13.680	122° 37.370
29	71	0.806	47° 13.630	122° 37.310
30	22	0.806	47° 13.610	122° 37.300
31	10	0.806	47° 13.610	122° 37.270
32	5	0.806	47° 13.590	122° 37.230
33	11	0.806	47° 13.590	122° 37.200
34	33	0.806	47° 13.560	122° 37.200
35	118	0.806	47° 13.530	122° 37.210
37	66	0.806	47° 13.490	122° 37.150
38	40	0.806	47° 13.470	122° 37.150
39	11	0.806	47° 13.470	122° 37.130
40	7	0.806	47° 13.470	122° 37.100
41	2	0.806	47° 13.440	122° 37.100
42	4	0.806	47° 13.420	122° 37.100
43	74	0.868	47° 13.390	122° 37.100
45	1	0.868	47° 13.370	122° 37.060
46	2	0.868	47° 13.340	122° 37.050
47	98	0.868	47° 13.320	122° 37.050
48	2	0.868	47° 13.310	122° 37.020
49	1	0.868	47° 13.300	122° 36.980
50	0	0.868	47° 13.290	122° 36.950
51	0	0.868	47° 13.260	122° 36.940
52	45	0.868	47° 13.230	122° 36.920
54	12	0.868	47° 13.170	122° 36.830

Table 5. Continued

Transect	Corrected Geoduck Count per 900 sq. ft. Transect	Geoduck Siphon Show Factor [a]	Latitude [b]	Longitude [b]
55	244	0.868	47° 13.150	122° 36.820
56	521	0.868	47° 13.120	122° 36.830
57	255	0.868	47° 13.110	122° 36.800
58	106	0.868	47° 13.120	122° 36.770
59	82	0.868	47° 14.210	122° 37.930

[a.] A daily geoduck siphon 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

Fox Island South geoduck tract # 11260, 2016 WDFW pre-fishing geoduck survey

# of Transects where Observed	Group	Common Name	Taxonomer
11	ANEMONE	BURROWING ANEMONE	*Pachycerianthus fimbriatus*
12	ANEMONE	PLUMED ANEMONE	*Metridium spp.*
3	ASCIDIAN	SESSILE TUNICATE	Unspecified Tunicate
3	BIVALVE	FALSE GEODUCK	*Panomya spp.*
15	BIVALVE	HORSE CLAM	*Tresus spp.*
2	CEPHALOPOD	SQUID EGGS	*Loligo opalescens*
2	CNIDARIA	SEA PEN	*Ptilosarcus gurneyi*
1	CRAB	DECORATOR CRAB	*Oregonia gracilis*
2	CRAB	DUNGENESS CRAB	*Cancer magister*
40	CRAB	GRACEFUL CRAB	*Cancer gracilis*
49	CRAB	HERMIT CRAB	Unspecified hermit crab
31	CRAB	RED ROCK CRAB	*Cancer productus*
6	CUCUMBER	SEA CUCUMBER	*Parastichopus californicus*
1	FISH	BAY PIPEFISH	*Syngnathus leptorhynchus*
8	FISH	C-O SOLE	*Pleuronichthys coenosus*
6	FISH	FLATFISH	Unspecified flatfish
7	FISH	ROCK SOLE	*Lepidopsetta bilineata*
13	FISH	SANDDAB	*Citharichthys spp.*
15	FISH	SCULPIN	Unspecified Cottidae
4	FISH	STARRY FLOUNDER	*Platichthys stellatus*
1	FISH EGGS	FISH EGGS	Unspecified Fish Eggs
1	GASTROPOD	MOON SNAIL EGGS	*Polinices lewisii* egg case
1	GASTROPOD	OPISTHOBRANCH	Unspecified Opisthobranch
1	NUDIBRANCH	ARMINA	*Armina californica*
3	NUDIBRANCH	DENDRONOTUS	*Dendronotus spp.*
3	NUDIBRANCH	DIRONA	*Dirona albolineata*
2	NUDIBRANCH	HERMISSENDA	*Hermissenda crassicornis*
1	NUDIBRANCH	ROSY TRITONIA	*Tritonia diomedea*
13	SEA STAR	BRITTLE STAR	Unspecified brittle star
1	SEA STAR	FALSE OCHRE STAR	*Evasterias troschelli*
3	SEA STAR	LEATHER STAR	*Dermasterias imbricata*
7	SEA STAR	SHORT-SPINED STAR	*Pisaster brevispinus*
18	SEA STAR	SUNFLOWER STAR	*Pycnopodia helianthoides*
9	SHRIMP	GHOST SHRIMP	Unspecified ghost shrimp
11	WORM	ROOTS	Chaetopterid polychaete tubes

Table 6. Continued

# of Transects where Observed	Group	Common Name	Taxonomer
7	WORM	SABELLID TUBE WORM	*Sabellid spp.*
5	WORM	TEREBELLID TUBE WORM	*Terebellid spp.*

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Table 7: MOST COMMON AND OBVIOUS ALGAE OBSERVED
Fox Island South geoduck tract # 11260, 2016 WDFW pre-fishing geoduck survey

# of Transects Where Observed	Taxonomer
10	*Desmarestia spp.*
33	Diatoms
22	*Laminaria spp.*
49	*Ulva spp.*
28	Small red algae

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