ENVIRONMENTAL ASSESSMENT OF PROPOSED GEODUCK HARVEST
ALONG THE NORTHWESTERN SHORELINE OF HOOD CANAL
AT THE THORNDYKE GEODUCK TRACT (#20550)

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 -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 (DNR & WDFW, 2008) and the Final Supplemental Environmental Impact Statement (WDFW & DNR, 2001). The proposed harvest along the northwestern shoreline of the Hood Canal is described below.

Proposed Harvest Dates: Periodic harvest beginning in 2023-2024

Tract name: Thorndyke geoduck tract (#20550)

Description: (Figure 1, Tract vicinity map)

The Thorndyke geoduck tract is a subtidal area of approximately 169 acres (Table 1) along the western shoreline of the Hood Canal, in the Hood Canal Geoduck Management Region. The tract is located about 5 miles south of the Hood Canal Bridge in Thorndyke Bay along the western shoreline of Hood Canal, and it is north of and adjacent to the Brown Point geoduck tract (#20800). The Thorndyke tract is bounded by a line projected from a Control Point (CP) on the -29 foot (MLLW) water depth contour in the southwestern corner of the tract at 47°47.609’ N. latitude, 122°44.569’ W. longitude (CP 1), north along the -29 ft. (MLLW) water depth contour to a point at 47°48.797’ N. latitude, 122°42.850’ W. longitude (CP 2); then east to a point on the -70 ft. (MLLW) water depth contour at 47°48.776’ N. latitude, 122°42.823’ W. longitude (CP 3); then south along the -70 ft. (MLLW) water depth contour to a point at 47°47.620’ N. latitude, 122°44.507’ W. longitude (CP 4); then west to the point of origin (Figure 2).

This estimate of the tract boundary is made using GIS and the WDFW 2015 geoduck survey transect data. All contours are corrected to MLLW. Contour GIS layers from Dale Gombert (WDFW) were generated from NOAA soundings. Shoreline data is from DNR, digitized at 1:24000 scale in 1999. The -70 ft. (MLLW) water depth contour was used for the deep-water boundary, and the -29 ft. (MLLW) contour was used for the shallow boundary, due to eelgrass habitat nearshore of the tract. The latitude and longitude positions are reported in degrees and decimal minutes to the closest thousandths of a minute. Corner latitude and longitude positions were generated using GIS, and have not

been field verified to determine consistency with area estimates, landmark alignments, or water depth contours.

The delineation of the tract boundary will be field verified by DNR prior to any geoduck harvest. Any variance to the stated boundary will be coordinated between WDFW and DNR prior to geoduck harvest.

Substrate:

Geoducks are found in a wide variety of sediments ranging from soft mud to gravel. The most common sediments where geoducks are harvested are sand with varying amounts of mud and/or gravel. The specific sediment type of a subtidal bed is primarily determined by water current velocity. Coarse sediments are generally found in areas of fast currents and finer (muddier) sediments in areas of weak currents. The major impact of harvest will be the creation of small holes where the geoducks are removed. The holes fill in within a few days to several weeks and have no long-term effects. The substrate holes refill in areas with strong water currents much faster than in areas with weak water currents. Water currents tend to be moderate in the vicinity of the Thorndyke tract. At a water current station located near Thorndyke Bay, currents reach a projected maximum flood velocity of 1.4 knots and maximum ebb velocity of 1.7 knots (Tides and Currents software; South point station #1586).

Subsurface substrates were noted during geoduck weight sampling with gravel and shell being identified as hindrances to digging at stations 62 and stations 27, 32 and 84 respectively (Table 2). The relative abundance of surface substrates within this tract were also noted during the 2015 survey (Table 3). Sand was the predominant substrate type on most transects within this tract. Mud was predominant on transects in the southern portion of the tract. Cobble was noted on certain transects at the southern portion of the tract (transects #s 57, 58, 62, 67, and 68). Boulders were noted on two transects and gravel on one transect.

Water Quality:

Water quality is good at the Thorndyke geoduck tract. Water mixing at this tract is affected by the flood and ebb of currents in northern Hood Canal. 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 for the King Spit-Bangor station (HCB006) at 47°44.86’ N. latitude; 122°43.89’ W. longitude. In 2004 and 2005 (last year of data available at this location), at water depths between 29 and 70 feet (8.8 to 21.3 meters), the range of dissolved oxygen concentration was 4.1 mg/l to 9.0 mg/l. The range of salinity at this station and this depth range was 29.25 to

30.54 psu. The range of water temperature at this station was 8.4° C to 12.7° C. The range of pH was 7.50 to 8.10.

Water quality is considered acceptable for shellfish harvest at the Thorndyke geoduck tract, and the tract is classified by the Washington Department of Health (DOH) as "Approved". DNR will verify the health status of the Thorndyke tract prior to any geoduck harvest.

Biota:

Geoduck:

The Thorndyke geoduck tract is a subtidal area of approximately 169 acres. The abundance of geoducks on this tract is high, with a current estimated average density of 0.20 geoducks/sq.ft., compared to a Puget Sound tract pre-fishing average of 0.16 geoducks/sq.ft. This tract contains a current estimated biomass of 3,150,513 pounds of geoducks (Table 1). On all geoduck survey dig stations sampled in 2015, geoducks are considered commercial quality (Table 2). Digging difficulty ranged from "easy" to "very difficult." The factor which influenced the "very difficult" rating (dig station #42) was compact substrate. Compact substrate hindered digging on a total of 5 out of 9 dig stations (#s 18, 54, 27, 32, 42). Shell in the substrate hindered digging on 3 dig stations (#s 27, 32, 84). Gravel in the substrate hindered digging at one station (station #62).

The geoduck densities from the 2015 survey range from 0.009 geoducks/sq.ft. at transect #46 to 0.971 geoducks/sq.ft. at transect #29 (Table 3 and Figure 3). The geoducks at the Thorndyke tract average 2.1 pounds, which is the same as the Puget Sound average. The lowest average whole weight is 1.5 pounds at dig station #42 and the highest station average whole weight is 3.2 pounds at dig station #32, (Table 4). Transect locations and geoduck counts corrected with siphon "show factors" are listed in Table 5.

The Thorndyke geoduck tract was surveyed in 1968, 1972, 1979, 1980, 1986, 1990, 2007, 2008, and 2015. This tract was previously harvested from 1970 to 1980, and 2,784,000 pounds of geoduck clams were landed. The tract was harvested from 1992 to 1994 and 1,802,000 pounds were landed. This tract was most recently surveyed in 2015 by WDFW. A total of 63 transects and a dig sample of 89 geoducks from the 2015 survey are used in the preparation of this environmental assessment. The 2015 survey indicated that the tract had recovered to pre-fishing geoduck density and the tract is ready to harvest again. Commercial harvest of geoducks began in 2016 and a total of 1,285,982 pounds have been harvested through April, 2020.

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 Puget Sound. 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 Thorndyke tract is unknown. The research to empirically analyze tract recovery rates is ongoing.

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. On geoduck tracts, the bathymetry is typically relatively flat and the substrate is typically composed of soft sediments, which provide few attachments for macroalgae associated with rockfish and lingcod. The fish observed during the survey at the Thorndyke tract (Table 6) were various flatfish including rock soles, sanddabs, starry flounders, a C-O sole and a skate. Sculpins, greenlings and a gobie were also observed.

WDFW marine fish managers were asked of their concerns regarding possible impacts on groundfish and baitfish due to geoduck fishing. Greg Bargmann of WDFW stated that geoduck fishing would have no long-term detrimental impacts and may have some short-term benefits to flatfish populations by increasing the availability of food. Dan Penttila of the WDFW Fish Management Program recommended that eelgrass beds within the harvest tract should be preserved for any spawning herring. Eelgrass has been observed along this tract to a maximum depth of -27 ft. (MLLW) during a 2015 eelgrass survey. The nearshore tract boundary will be along the -29 ft. (MLLW) water depth to provide a vertical buffer between eelgrass beds and geoduck harvest.

There are no Pacific herring spawning grounds along the northwestern shoreline of Hood Canal in the vicinity of the Thorndyke tract (1996 Washington State Baitfish Stock Status Report, Figure 4). A pre-spawner holding area is located to the north of this tract, outside of Squamish Harbor (Figure 4). It is thought that this is part of the Port Gamble herring stock. The Port Gamble stock is considered the second largest spawning stock in Washington (1996 Washington State Baitfish Stock Status Report). Along the shorelines in the vicinity of Port Gamble, herring spawning timing is reported to occur between January 15 through April 15. Based on a nearshore tract boundary of -29 feet (MLLW) and large horizontal separation from herring spawning grounds, geoduck fishing on the Thorndyke tract should have no detrimental impacts on herring populations.

Surf smelt spawning habitat has not been identified in the vicinity of the proposed harvest area of the Thorndyke geoduck tract. Surf smelt spawning habitat occurs southerly of the Thorndyke geoduck tract between Thorndyke Bay and Brown Point (Figure 4). Surf smelt spawning habitat has also been found northerly of the Thorndyke tract in Squamish Harbor. 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 in water a few inches deep, around the time of the high water slack tide. There is substantial vertical separation between surf smelt spawning (slack high tide) and geoduck harvest activity (-29 feet to -70 feet, MLLW on the Thorndyke tract).

Sand lance spawning has been documented inshore of this tract. 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 along shorelines of the eastern Strait of Juan de Fuca 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. Spawning of sandlance occurs at tidal elevations ranging from +5 feet to approximately 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 zooplankton 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 diets are 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 (-29 feet to -70 feet, MLLW on the Thorndyke tract). Geoduck harvesting on the Thorndyke tract should have no detrimental impacts on sand lance 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 (renamed NOAA 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 includes 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. Recent recovery and supplementation efforts have reversed the trend of decline in Hood Canal summer run chum salmon stocks. Total escapement for Hood Canal summer run chum salmon has reached historic high levels and risk of extinction has decreased for all stocks (Adicks, K. *et al*., 2007). The Thorndyke tract is within the critical habitat range for Hood Canal summer run chum salmon. Salmon managers have indicated that geoduck harvest at this location would likely not affect Hood Canal summer run chum salmon stocks.

Critical habitat for Puget Sound Chinook salmon includes all marine, estuarine and river reaches accessible to listed Chinook salmon in Puget Sound. WDFW recognizes 27 distinct stocks of Chinook salmon; 8 spring-run, 4 summer-run, and 15 summer/fall and fall-run stocks. The existence of an additional five spring-run stocks is in dispute. The majority of Puget Sound Chinook salmon emigrate to the ocean as sub-yearlings.

There are no major tributaries in the immediate vicinity of the Thorndyke tract. However, Thorndyke Creek empties into Thorndyke Bay, and coho salmon and Fall chum salmon have been observed in this creek. Coho salmon found in Thorndyke Creek are considered part of the northeast Hood Canal stock. An unnamed creek also empties into Thorndyke Bay and coho salmon have also been observed in this creek. Another creek, Shine Creek, is near the Thorndyke tract and it empties into Squamish Harbor (approximately 4.3 miles from the tract). The sizes of the salmon runs in these creeks is unknown, but are presumed to be small. The 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+ ft. 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 major impacts 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. An unnamed creek empties into Thorndyke Bay and steelhead have been observed in this creek. The vertical separation between this creek and the Thorndyke tract reduces the risk that geoduck harvest will have an 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, it was proposed that the Southern DPS should be listed as threatened under the ESA. NOAA Fisheries Service published a final rule on April 7, 2006, listing the Southern DPS as threatened (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 Thorndyke 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:

Marine invertebrates, which are frequently found on geoduck beds, were also observed on this tract. The most common and obvious of these include: [1] mollusks (geoducks, horse clams, truncated mya clams, false geoducks, heart cockles, moon snail egg cases, squid eggs, and nudibranchs); [2] echinoderms (sea cucumbers, blood sea stars, false ochre stars, sand stars, short-spined stars, six-rayed stars, sun stars, and sunflower sea stars); [3] cnidarians (sea pens, sea whips, burrowing anemones, plumed anemones, and striped anemones); [4] arthropods (Dungeness crabs, red rock crabs, graceful crabs, decorator crabs, hermit crabs, and ghost shrimp); [5] annelid worms (chaetopterid, terebellid and sabellid worms); and [6] ascidians (sessile tunicates); [7] sponges; and [8] bryozoans (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 crabs were observed on 34 transects surveyed during the 2015 geoduck survey at Thorndyke.

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 ft. level and seaward out to -330 ft. (MLLW) water depth contour (Figure 5, Potential crab habitat map). Dr. Dave Armstrong at the University of Washington has determined that Dungeness crab utilize Puget Sound bottoms from the +1 ft. level out to the -330 ft. level. The entire crab habitat along this tract is approximately 1,785 acres. There were about 2,324,163 harvestable geoducks in the entire 169 acre tract, from the 2015 survey estimate. With a minimum harvest level of 65 percent, the total number harvested would be about 1,510,706 geoducks. Approximately 1.18 square feet of substrate is disturbed for every geoduck harvested, so 1,510,706 x 1.18 = 1,782,633 square feet of substrate. This equals about 40.9 acres. This is about 2 percent of the total available crab habitat in the vicinity of this tract. Based on the low amount of disturbance of potential crab habitat in the vicinity of the tract, and the lack of effects observed at the Thorndyke Bay study, we conclude that any effects on Dungeness crab 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 during the pre-fishing geoduck surveys (Table 7) include:

> Laminarian algae, large and small red algae, Desmarestiales algae, *Sargassum muticum*, sea lettuce, and a diatom layer.

John Boettner and Tim Flint, from the WDFW Habitat Division, have stated that as long as geoduck fishing was restricted to seaward of the eelgrass beds they have no concerns about the harvesting. 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. An eelgrass survey was done on this tract May 12 and 19, 2015, in which WDFW divers swam the entire shoreward boundary of the tract and documented eelgrass at a maximum depth of -27 ft. (MLLW). The shoreward boundary of this tract will be no shallower than the -29 ft. (MLLW) water depth contour, which should provide sufficient buffer for any eelgrass beds in the vicinity of the tract.

Marine Mammals:

Several species of marine mammals, including gray whales, seals, sea lions, and river otters may be observed in the vicinity of this geoduck tract. Killer whales may also be observed in the vicinity of this tract. The Southern Resident stock of killer whales reside mainly in the San Juan Islands throughout spring and summer, but incursions south into Puget Sound occur more frequently during winter months (Brent Norberg, NOAA, pers.

comm. 5/15/06). The Southern Resident stock of killer whales was listed as "endangered" under the federal Endangered Species Act (ESA) by the National Marine Fisheries Service on November 15, 2005. This is in addition to the designation of this stock in May 2003 as "depleted" under the Marine Mammal Protection Act. More information and a recovery plan for this stock can be found at the NOAA website (https://www.fisheries.noaa.gov/action/listing-southern-resident-killer-whale-under-esa). Hand pick shellfish fisheries, like geoduck harvesting, are considered Category III under the Marine Mammal Authorization Program for Commercial Fisheries. This means that there is a "rare or remote" likelihood of marine mammal "take" (Brent Norberg, NOAA, pers. comm. 5/15/06). Precautions should be taken by commercial divers, when marine mammals are in the area, to be aware of marine mammal movements and behavior to eliminate the remote risk of entanglement with diver hoses and lines.

Birds:

A variety of marine birds are common in Puget Sound and 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 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 primarily zoned as "rural residential", "commercial agriculture" and "inholding forest".

To minimize possible disturbance to adjacent residents, harvest vessels are not allowed shoreward of the 200 yards seaward of the ordinary high tide line (OHT). Harvest is allowed only during daylight hours and no harvest is allowed on Saturday, Sunday, or state holidays. The only visual effect of harvest is the presence of the harvest vessels on the tract. These boats (normally 35-40 feet long) are anchored during harvest and divers conduct all harvest out of sight. Noise from boats, compressors and pumps may not exceed 50 dB measured 200 yards from the noise source, which is 5 dBA below the state noise standard.

Fishing:

The waters around this tract are not prime sport fishing areas, however this area is popular for recreational crab harvest. Sport fishing is open year-round for surfperch. Rockfish is closed for recreational harvest. Lingcod can only be taken May 1 to June 15 by hook and line or May 21 to June 15 by spearfishing. This area is closed to salmon harvest except for shore fishing between Salsbury Point Park and the Hood Canal bridge. 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. 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 Hood Canal Treaty Tribes through state/tribal geoduck harvest management plans. The non-Indian geoduck fishery should not conflict with any concurrent tribal fisheries.

Navigation:

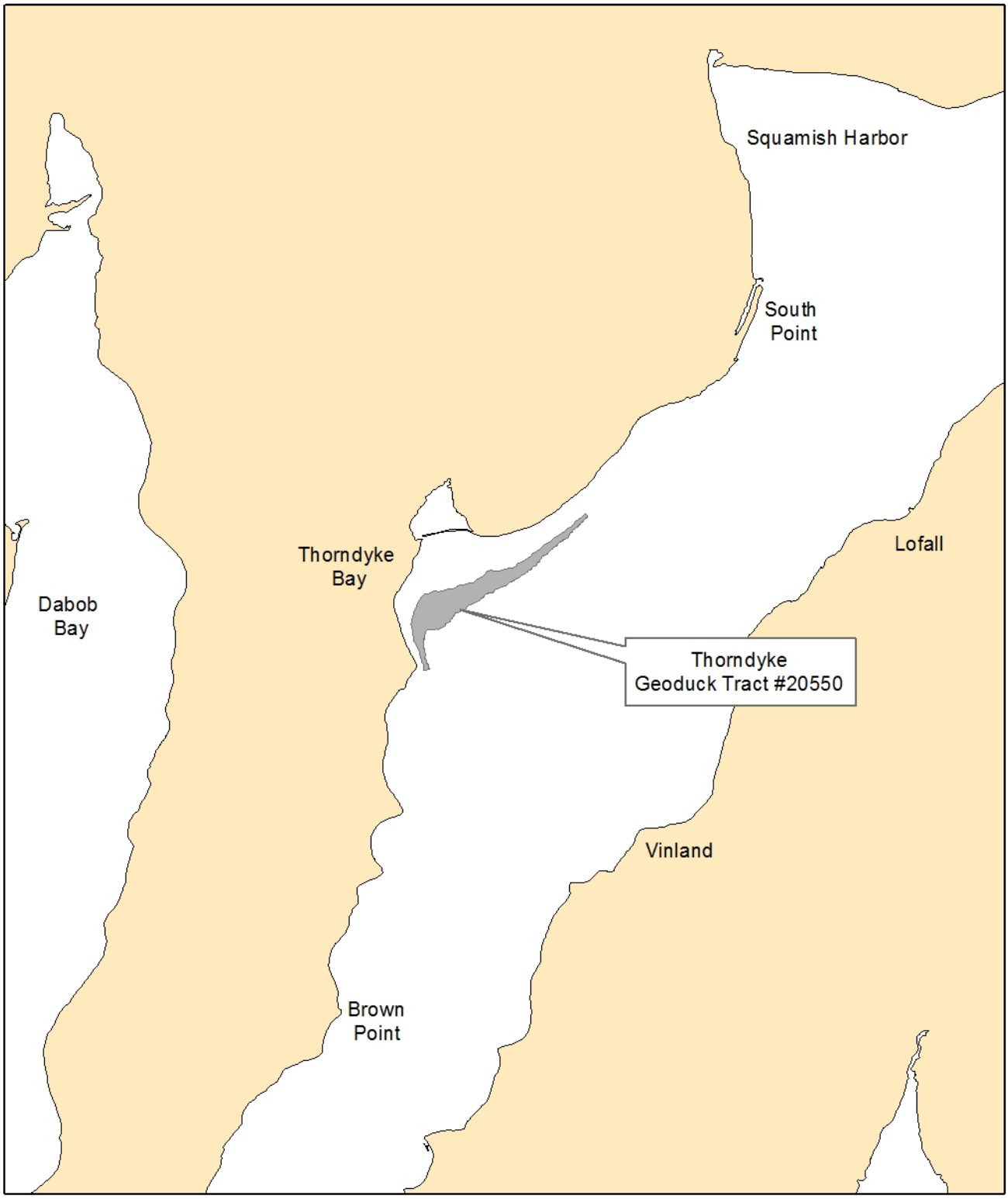
The Thorndyke Bay area is used by recreational and commercial vessels traveling in Hood Canal. Geoduck harvesting at this site should not result in any significant navigational conflicts. The Washington Department of Natural Resources will notify the local boating community prior to any harvest.

Summary:

Commercial geoduck harvest is proposed for one tract along the northeastern shoreline of Hood Canal. The tract was most recently surveyed in 2015 by WDFW and the current biomass estimate for the 169 acre harvest area is about 3,150,513 pounds. The most recent harvest cycle began in 2016 and harvest is on-going. The commercial tract is presently classified by DOH as “Approved” for shellfish harvest. An eelgrass survey was completed and eelgrass was observed to a maximum depth of -27 ft. (MLLW). The shoreward boundary of the tract will be set at -29 ft. (MLLW) or deeper to provide a buffer between forage fish spawning habitat and geoduck harvest. The anticipated environmental impacts of this harvest are within the range of conditions discussed in the 2001 Final Supplemental Environmental Impact Statement. No significant impacts are expected from this harvest.

File: 230126_Thorndyke_EA_20550.doc

Figure 1. Vicinity Map, Thorndyke Commercial Geoduck Tract #20550



N
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1:80,000

1 inch = 1.26 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 0.425 0.85 1.7 2.55 Miles

Washington Department of FISH and WILDLIFE

Map Date: June 21, 2017
Map Author: O. Working
File: Data\Ocean\Geoduck

Figure 2. Control Points Map, Thorndyke Commercial Geoduck Tract #20020

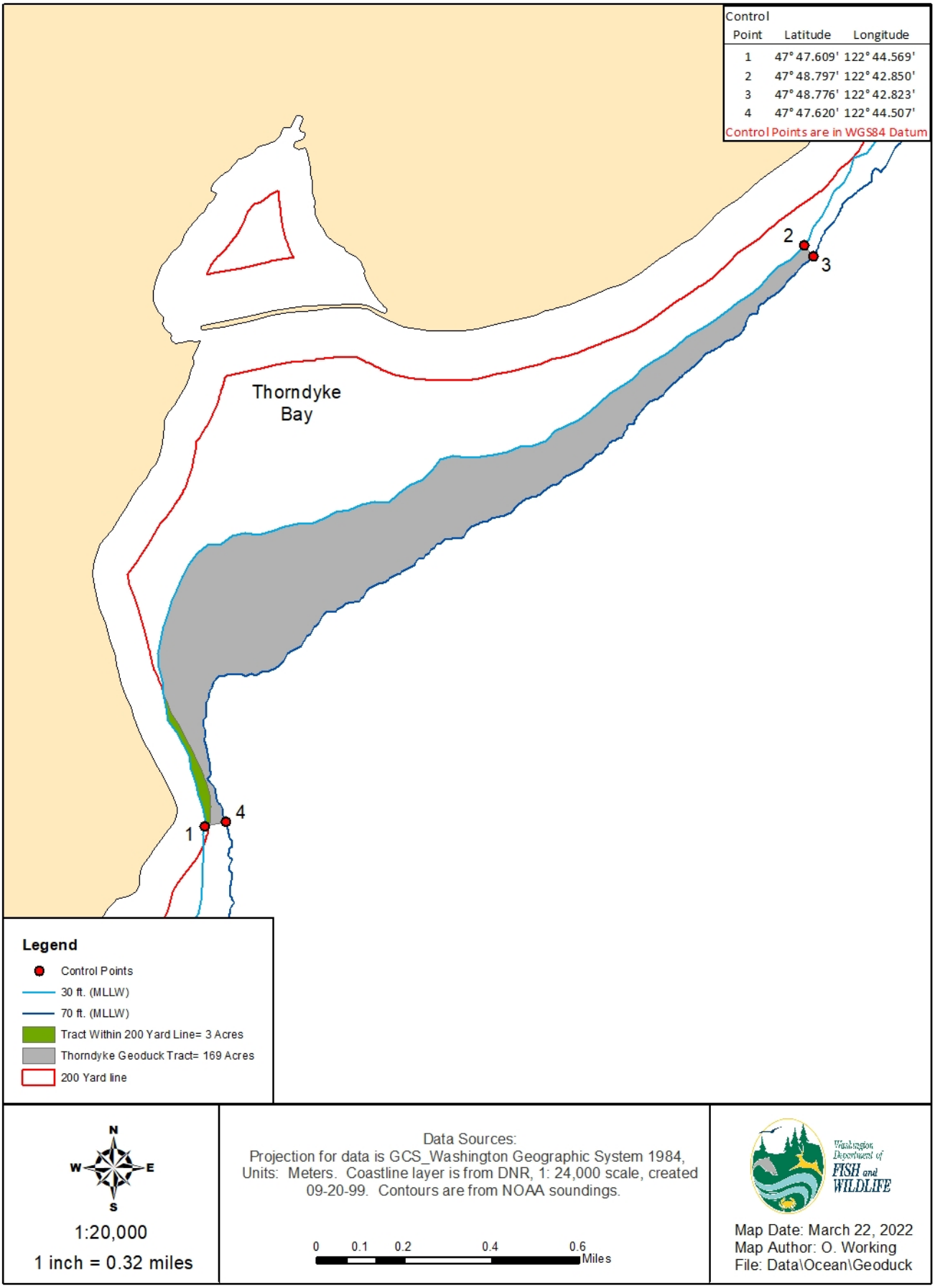
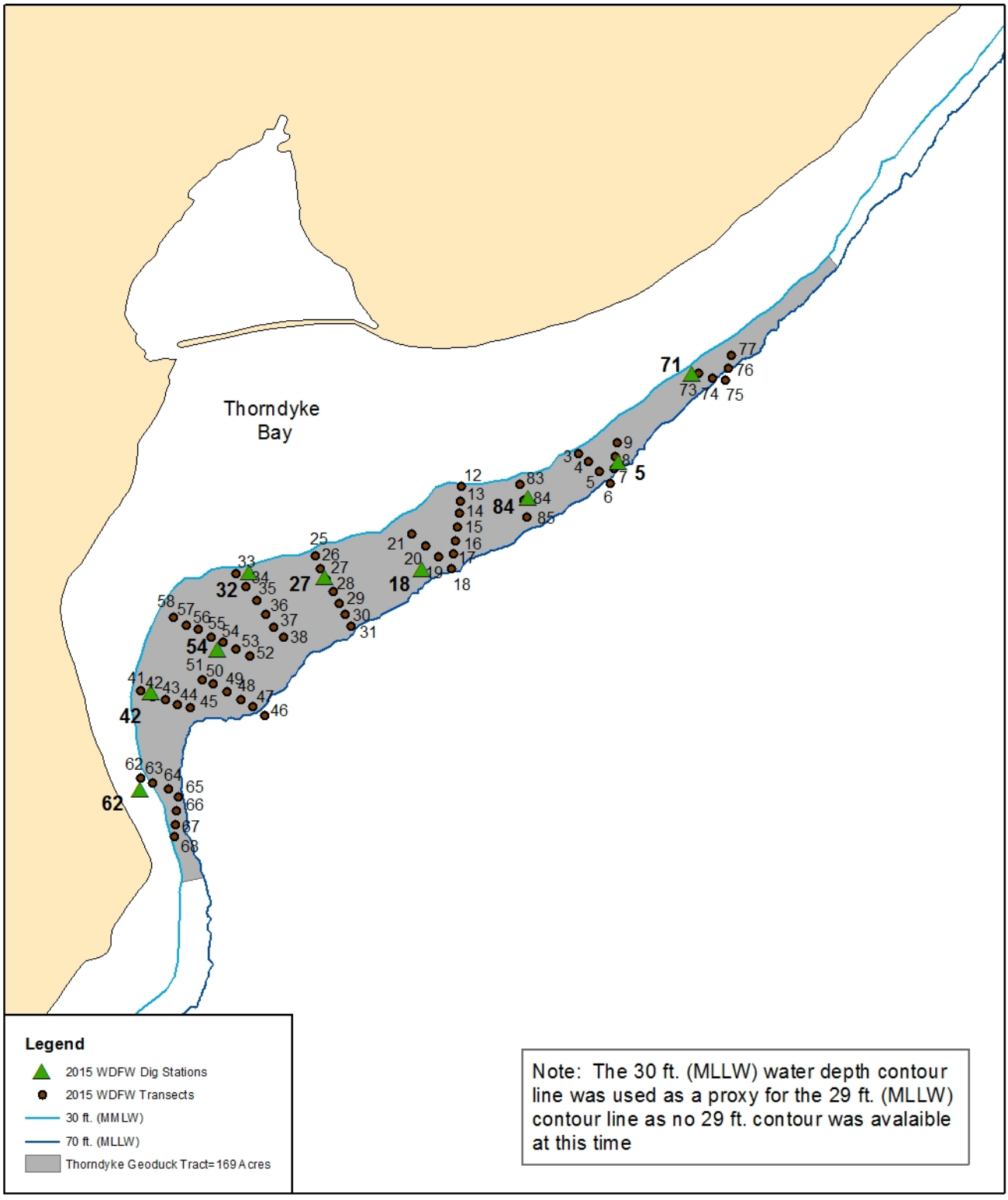


Figure 3. Transect and Dig Station Map, Thorndyke Commercial Geoduck Tract #20550



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1 inch = 0.32 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 0.1 0.2 0.4 0.6 Miles

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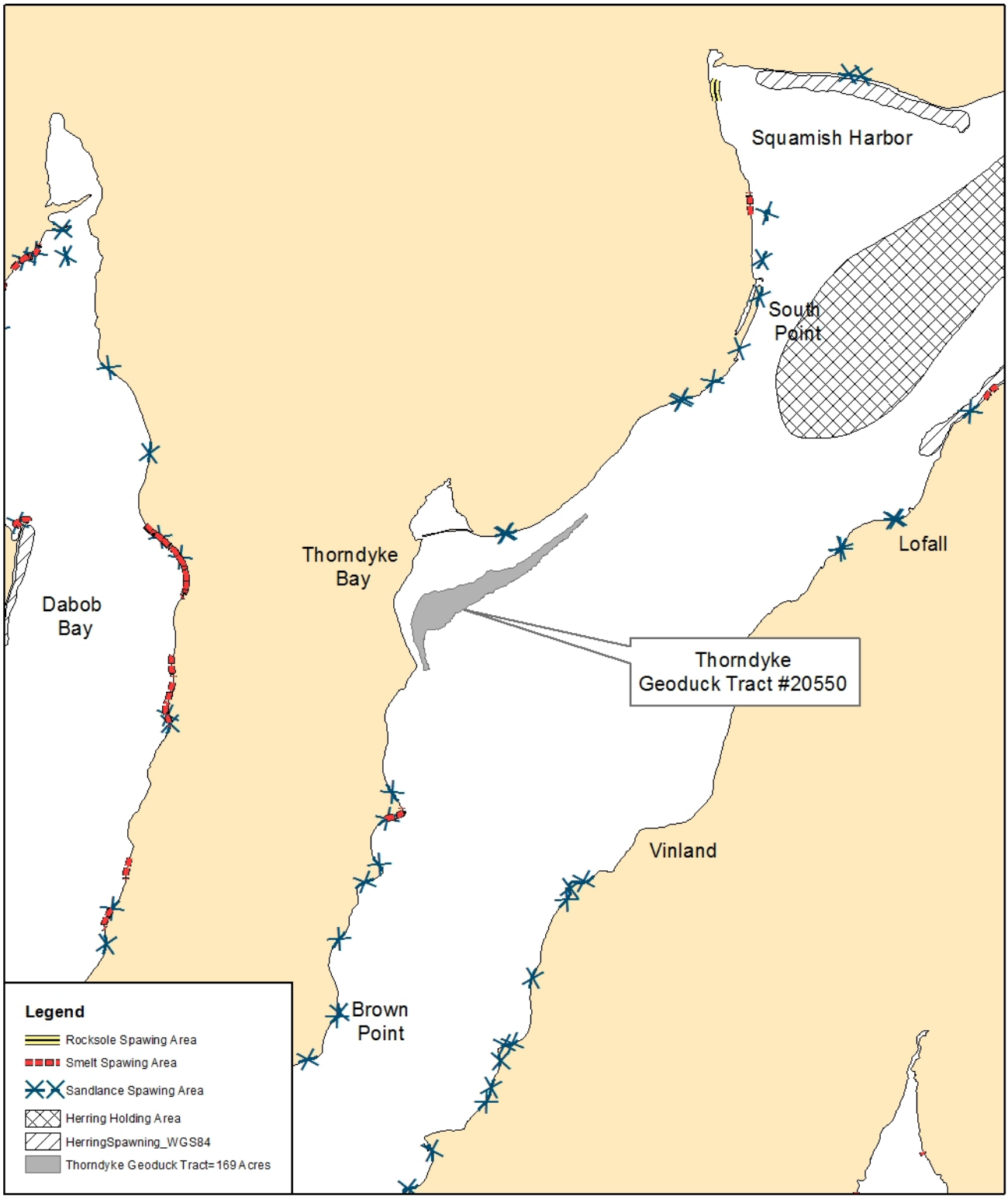
Map Date: June 21, 2017
Map Author: O. Working
File: Data\Ocean\Geoduck

Figure 4. Fish Spawning Areas Near the Thorndyke Commercial Geoduck Tract #20550



N
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1:80,000

1 inch = 1.26 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 0.425 0.85 1.7 2.55 Miles

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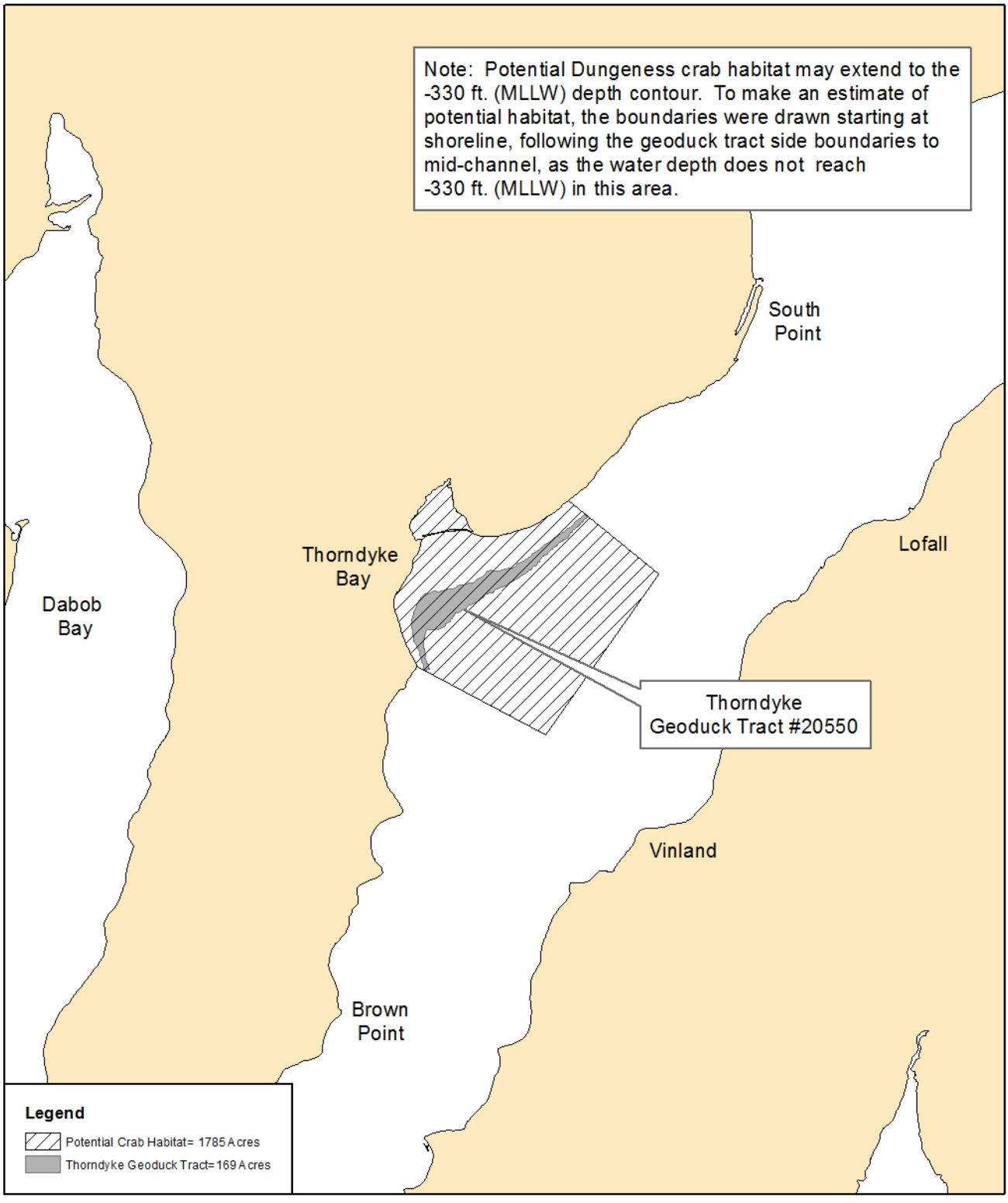
Map Date: June 21, 2017
Map Author: O. Working
File: Data\Ocean\Geoduck

Figure 5. Dungeness Crab Habitat Map, Thorndyke Commercial Geoduck Tract #20550



N
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1:80,000

1 inch = 1.26 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 0.425 0.85 1.7 2.55 Miles

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Map Date: June 21, 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 or	Some difficulty	Substrate may be compact or contain gravel, shell 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

Thorndyke geoduck tract # 20550.

Tract Name	Thorndyke
Tract Number	20550
Tract Size (acres)[a]	169
Density of geoducks/sq.ft.[b]	0.20
Total Tract Biomass (lbs.)[b]	3,150,513
Total Number of Geoducks on Tract[b]	1,469,294
Confidence Interval (%)	21.6%
Mean Geoduck Whole Weight (lbs.)	2.14
Mean Geoduck Siphon Weight (lbs.)	0.45
Siphon Weight as a % of Whole Weight	21%
Number of Transect Stations	63
Number of Geoducks Weighed	89

[a.] Tract area is between the -29 ft. and -70 ft. (MLLW) water depth contours

[b.] Biomass is based on the 2015 WDFW Prefishing geoduck survey biomass of 4,983,555 lbs. minus harvest of 1,833,042 lbs. through January 26, 2023

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Table 2. DIGGING DIFFICULTY TABLE

Thorndyke geoduck tract # 20550, 2015 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)
5	2	2	0	0	0	0	1	0	Y
18	1	2	1	1	0	0	1	0	Y
54	2	2	0	2	0	0	1	0	Y
62	2	1	0	0	2	0	0	0	Y
84	1	2	0	0	0	1	1	0	Y
27	2	1	0	2	0	1	1	0	Y
32	1	1	1	1	0	1	0	0	Y
42	4	1	0	1	0	0	0	0	Y
71	2	0	2	0	0	0	0	0	Y

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

Thorndyke geoduck tract # 20550, 2015 WDFW Pre-fishing geoduck survey

Transect	Start Depth (ft) [a]	End Depth (ft) [a]	Geoduck Density (no. / sq ft) [b]	Substrate [c]				
				sand	mud	cobble	boulder	gravel
3	29	40	0.0362	2				
4	40	52	0.4961	2				
5	52	77	0.8605	2	1			
6	70	60	0.6718	2	1			
7	60	51	0.5323	2				
8	51	43	0.3773	2				
9	43	32	0.4755	2				
12	29	34	0.1886	2	1			
13	34	41	0.1809	2	1			
14	41	48	0.1938	2	1			
15	48	54	0.3178	2	1			
16	54	60	0.4264	2	1			
17	60	66	0.4212	2	1			
18	65	57	0.6770	2				
19	57	49	0.2868	2				
20	49	43	0.1395	2				
21	43	35	0.0801	2				
25	30	39	0.1377	2	1			
26	39	45	0.3188	2	1			
27	45	49	0.7222	2	1			
28	49	53	0.7826	2	1			
29	52	58	0.9710	1	1			
30	58	65	0.5725	1	1			
31	65	70	0.1546	2	1			
33	32	43	0.1957	2				
34	42	47	0.3502	2				
35	47	51	0.4952	2	1			
36	51	56	0.3671	2				
37	56	59	0.1667	2	1			
38	59	63	0.0870	2	1			
41	36	44	0.0731	2	1			
42	43	52	0.5585	1	1		1	
43	52	58	0.5906	1	1			
44	58	64	0.1842	1	2			
45	64	66	0.0292	1	2			
46	70	66	0.0088		2			
47	66	63	0.0146		2			
48	63	61	0.0263		2			
49	61	62	0.0117		2			
50	62	61	0.0351		2			
51	61	57	0.1111	1	2			
52	59	56	0.0511		2			

Table 3. Continued

Transect	Start Depth (ft) [a]	End Depth (ft) [a]	Geoduck Density (no. / sq ft) [b]	Substrate [c]				
				sand	mud	cobble	boulder	gravel
53	57	54	0.0867		2			
54	54	51	0.2022		2			
55	51	47	0.5156	1	2			
56	47	42	0.6489		2			
57	42	34	0.0444	1	2	1		
58	34	29	0.0867	1	2	1	1	
62	30	40	0.3644	1	2	1		
63	40	58	0.8244	1	2			
64	58	69	0.5467	1	2			
65	69	67	0.5489	1	2			
66	67	63	0.5689	1	2			
67	63	52	0.2667	1	1	1		
68	52	33	0.0800	1	1	1		1
73	38	54	0.0818	2				
74	54	69	0.0107	2				
75	70	55	0.0107	2				
76	55	44	0.0338	2				
77	44	33	0.0800	2				
83	30	40	0.3147	2				
84	40	54	0.5760	2				
85	54	69	0.6027	2				

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

[b.] Densities were calculated using a daily siphon show factor

[c.] Substrate codes: 1 = present ; 2 = dominant

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Table 4. GEODUCK SIZE AND QUALITY

Thorndyke geoduck tract # 20550, 2015 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.
5	9	1.94	0.44	44%
18	10	1.70	0.37	10%
54	10	1.72	0.41	10%
62	10	2.27	0.64	90%
84	11	1.94	0.35	30%
27	10	2.05	0.39	50%
32	10	3.19	0.55	90%
42	10	1.47	0.25	10%
71	10	2.99	0.62	80%

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Table 5. TRANSECT CORRECTED GEODUCK COUNT AND POSITION TABLE

Thorndyke geoduck tract # 20550, 2015 WDFW Pre-fishing geoduck survey

Transect	Corrected Geoduck Count per 900 sq. ft. Transect	Geoduck Siphon Show Factor [a]	Latitude [b]	Longitude [b]
3	33	0.43	47° 48.419	122° 43.517
4	447	0.43	47° 48.405	122° 43.489
5	774	0.43	47° 48.387	122° 43.460
6	605	0.43	47° 48.367	122° 43.427
7	479	0.43	47° 48.393	122° 43.419
8	340	0.43	47° 48.416	122° 43.416
9	428	0.43	47° 48.441	122° 43.413
12	170	0.43	47° 48.353	122° 43.834
13	163	0.43	47° 48.326	122° 43.837
14	174	0.43	47° 48.303	122° 43.839
15	286	0.43	47° 48.278	122° 43.843
16	384	0.43	47° 48.253	122° 43.848
17	379	0.43	47° 48.229	122° 43.850
18	609	0.43	47° 48.200	122° 43.856
19	258	0.43	47° 48.222	122° 43.892
20	126	0.43	47° 48.242	122° 43.929
21	72	0.43	47° 48.262	122° 43.966
25	124	0.46	47° 48.218	122° 44.227
26	287	0.46	47° 48.194	122° 44.212
27	650	0.46	47° 48.174	122° 44.196
28	704	0.46	47° 48.153	122° 44.177
29	874	0.46	47° 48.131	122° 44.159
30	515	0.46	47° 48.111	122° 44.142
31	139	0.46	47° 48.089	122° 44.124
33	176	0.46	47° 48.180	122° 44.443
34	315	0.46	47° 48.158	122° 44.415
35	446	0.46	47° 48.132	122° 44.385
36	330	0.46	47° 48.108	122° 44.359
37	150	0.46	47° 48.084	122° 44.336
38	78	0.46	47° 48.066	122° 44.308
41	66	0.38	47° 47.959	122° 44.696
42	503	0.38	47° 47.950	122° 44.662
43	532	0.38	47° 47.944	122° 44.626
44	166	0.38	47° 47.937	122° 44.592
45	26	0.38	47° 47.931	122° 44.557
46	8	0.38	47° 47.921	122° 44.355
47	13	0.38	47° 47.936	122° 44.387
48	24	0.38	47° 47.948	122° 44.419
49	11	0.38	47° 47.962	122° 44.459
50	32	0.38	47° 47.977	122° 44.497
51	100	0.38	47° 47.983	122° 44.527
52	46	0.50	47° 48.030	122° 44.400

Table 5. Continued

Transect	Corrected Geoduck Count per 900 sq. ft. Transect	Geoduck Siphon Show Factor [a]	Latitude [b]	Longitude [b]
53	78	0.50	47° 48.041	122° 44.437
54	182	0.50	47° 48.053	122° 44.473
55	464	0.50	47° 48.063	122° 44.507
56	584	0.50	47° 48.076	122° 44.542
57	40	0.50	47° 48.083	122° 44.575
58	78	0.50	47° 48.096	122° 44.610
62	328	0.50	47° 47.800	122° 44.687
63	742	0.50	47° 47.790	122° 44.655
64	492	0.50	47° 47.781	122° 44.612
65	494	0.50	47° 47.767	122° 44.584
66	512	0.50	47° 47.741	122° 44.587
67	240	0.50	47° 47.716	122° 44.590
68	72	0.50	47° 47.693	122° 44.590
73	74	0.63	47° 48.573	122° 43.194
74	10	0.63	47° 48.565	122° 43.158
75	10	0.63	47° 48.562	122° 43.121
76	30	0.63	47° 48.585	122° 43.115
77	72	0.63	47° 48.609	122° 43.108
83	283	0.63	47° 48.360	122° 43.674
84	518	0.63	47° 48.331	122° 43.663
85	542	0.63	47° 48.300	122° 43.653

[a.] A daily 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

Thorndyke geoduck tract # 20550, 2015 WDFW Pre-fishing geoduck survey

# of Transects where Observed	Group	Common Name	Taxonomer
9	ANEMONE	BURROWING ANEMONE	*Pachycerianthus fimbriatus*
76	ANEMONE	PLUMED ANEMONE	*Metridium* spp.
11	ANEMONE	STRIPED ANEMONE	*Urticina* spp.
12	ASCIDIAN	SESSILE TUNICATE	Unspecified Tunicate
26	BIVALVE	FALSE GEODUCK	*Panomya* spp.
21	BIVALVE	HARDSHELL CLAMS	*Veneridae* spp.
2	BIVALVE	HEART COCKLE	*Clinocardium nuttalli*
63	BIVALVE	HORSE CLAM	*Tresus* spp.
5	BIVALVE	HORSE MUSSEL	*Modiolus rectus*
15	BIVALVE	TRUNCATED MYA	*Mya truncata*
1	CEPHALOPOD	SQUID EGGS	*Loligo opalescens*
34	CNIDARIA	SEA PEN	*Ptilosarcus gurneyi*
62	CNIDARIA	SEA WHIP	*Stylatula elongata*
23	CRAB	DECORATOR CRAB	*Oregonia gracilis*
34	CRAB	DUNGENESS CRAB	*Cancer magister*
5	CRAB	GRACEFUL CRAB	*Cancer gracilis*
50	CRAB	HERMIT CRAB	Unspecified hermit crab
17	CRAB	RED ROCK CRAB	*Cancer productus*
16	CUCUMBER	SEA CUCUMBER	*Parastichopus californicus*
1	FISH	C-O SOLE	*Pleuronichthys coenosus*
1	FISH	FISH	Unspecified Fish
29	FISH	FLATFISH	Unspecified flatfish
1	FISH	GOBIE	Unspecified Gobiidae
2	FISH	GREENLING	Unspecified *Hexagrammos* spp.
2	FISH	ROCK SOLE	*Lepidopsetta bilineata*
16	FISH	SANDDAB	*Citharichthys* spp.
18	FISH	SCULPIN	Unspecified Cottidae
1	FISH	SKATE	Unspecified *Raja* spp.
5	FISH	STARRY FLOUNDER	*Platichthys stellatus*
1	FISH	TUBESNOUT	*Aulorhynchus flavidus*
3	FISH EGGS	SKATE EGG CASE	*Raja* spp. egg case
1	GASTROPOD	MOON SNAIL EGGS	*Polinices lewisii* egg case
17	GASTROPOD	NUDIBRANCH	Unspecified nudibranch
38	MISC	BRYOZOAN COLONY	Unspecified Bryozoan
4	MISC	SPONGE	Unspecified Porifera
36	NUDIBRANCH	ARMINA	*Armina californica*
2	NUDIBRANCH	DENDRONOTUS	*Dendronotus* spp.
7	NUDIBRANCH	HERMISSENDA	*Hermissenda crassicornis*
17	NUDIBRANCH	ROSY TRITONIA	*Tritonia diomedea*
1	SEA STAR	BLOOD STAR	*Henricia leviuscula*
26	SEA STAR	FALSE OCHRE STAR	*Evasterias troschelli*
7	SEA STAR	SAND STAR	*Luidia foliolata*
1	SEA STAR	SEA STAR	Unspecified sea star
2	SEA STAR	SHORT-SPINED STAR	*Pisaster brevispinus*

Table 6. Continued

# of Transects where Observed	Group	Common Name	Taxonomer
1	SEA STAR	SIX-RAYED SEA STAR	*Leptasterias hexactis*
4	SEA STAR	SUN STAR	*Solaster* spp.
7	SEA STAR	SUNFLOWER STAR	*Pycnopodia helianthoides*
34	SHRIMP	GHOST SHRIMP	Unspecified ghost shrimp
3	SHRIMP	SHRIMP	Unspecified shrimp
63	WORM	ROOTS	Chaetopterid polychaete tubes
63	WORM	SABELLID TUBE WORM	*Sabellid* spp.
63	WORM	TEREBELLID TUBE WORM	*Terebellid* spp.

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Table 7. MOST COMMON AND OBVIOUS ALGAE OBSERVED
Thorndyke geoduck tract # 20550, 2015 WDFW Pre-fishing geoduck survey

# of Transects Where Observed	Taxonomer
27	*Desmarestia* spp.
26	Diatoms
41	*Laminaria* spp.
1	*Sargassum muticum*
52	*Ulva* spp.
8	Unspecified large red algae
63	Unspecified small red algae

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