Washington Department of Fish and Wildlife Contribution to the 2019 Meeting of the Technical Sub-Committee (TSC) of the Canada-U.S. Groundfish Committee: Reporting for the period from May 2018-April 2019

April 23rd-24th, 2019

Edited by:
Dayv Lowry

Contributions by:
Dayv Lowry, Robert Pacunski, Lorna Wargo, Todd Sandell, Jen Blaine, Rob Davis, Larry LeClair, Jennifer Lanksbury, Theresa Tsou, Corey Niles

Washington Department of Fish and Wildlife
1111 Washington St SE
Olympia, WA 98504-3150

DRAFT April 2019

Contents

I. Agency Overview

The Washington Department of Fish and Wildlife is divided into three major resource management Programs (Fish, Habitat, and Wildlife) and three major administrative support programs (Enforcement, Technology & Financial Management, and Capital & Asset Management). Within the Fish Program, research and management of marine fishes is housed within the Fish Management Division, which also oversees research and management of shellfish, warmwater species, and aquatic invasive species. The Marine Fish Science (MFS) Unit, in turn, is broadly separated into two groups that deal with distinct geographic regions (Puget Sound and the Outer Coast), though there is some overlap of senior staff. The Unit is overseen by Dr. Theresa Tsou and (until recently) supported by Phil Weyland (programming and data systems). Lisa Hillier oversees the Unit budget, participates in various fieldwork projects, and has recently been modeling stocks both on the coast and in Puget Sound. Phill Dionne oversees statewide marine forage fish research and management. Together with Phill, this Marine Forage Fish (MFF) Unit is composed of Dr. Todd Sandell, Adam Lindquist, Patrick Biondo, and Kate Olson. During herring spawning season the unit receives staff support from members of the Intertidal Shellfish Unit as needed (i.e., the "loan" of four staff at approximately half time for four months).

Staff of the Puget Sound Marine Fish Science (PSMFS) Unit during the reporting period included Dr. Dayv Lowry (lead), Robert Pacunski, Larry LeClair, Jen Blaine, Andrea Hennings, Mark Millard, and Amanda Philips. In addition, Courtney Adkins and Peter Sergeeff work as PSMFS employees during the annual spring bottom trawl survey (April through June). Within the Fish Management Division of the Fish Program a second work unit also conducts considerable marine forage fish and groundfish research in Puget Sound, but focuses on the accumulation of toxic contaminants in these species. The Toxics-focused Biological Observation System for the Salish Sea (TBiOS) (formerly Puget Sound Ecosystem Monitoring Program or PSEMP) consists of Dr. Jim West (lead), Dr. Sandy O'Neill, Jennifer Lanksbury (recently moved to King Co. DNR), Mariko Langness, and Rob Fisk.

PSMFS Unit tasks are primarily supported by supplemental funds from the Washington State Legislature for the recovery of Puget Sound bottomfish populations, and secondarily by a suite of collaborative external grants. The main activities of the unit include the assessment of marine fish populations in Puget Sound, study of marine fish ecology and demography, evaluation of bottomfish in marine reserves and other fishery-restricted areas, and development of conservation plans for particular species (and species groups) of interest. Forage fish in Puget Sound are managed under the auspices of the Puget Sound Forage Fish Management Plan (Bargmann 1998) and managed by members of the statewide MFF Unit described above. Groundfish in Puget Sound are managed under the auspices of the Puget Sound Groundfish Management Plan (Palsson, et al. 1998) and management has become increasingly sensitive to the ESA-listing of Canary Rockfish, Yelloweye Rockfish, and Bocaccio, in Puget Sound since 2010 (National marine Fisheries Service 2010). In 2017 Canary Rockfish were delisted, but Yelloweye Rockfish and Bocaccio still very much drive management of all groundfish species.

Since December of 2016 Dr. Dayv Lowry has also served as the Washington State representative on the Scientific and Statistical Committee (SSC) of the North Pacific Fishery Management Council (NPFMC), and members of the PSMFS Unit are occasionally called upon to assist with

evaluation of documents pertinent to fisheries in federal waters off Alaska. Bill Tweit, who reports straight to the Assistant Director of the Fish Program, serves as a member of the NPFMC.

Primary Contacts – Puget Sound:
Groundfish Monitoring, Research, and Assessment – *Contact: Dr. Dayv Lowry 360-902-2558, dayv.lowry@dfw.wa.gov; Dr. Theresa Tsou 360-902-2855, tien-shui.tsou@dfw.wa.gov.*
Forage Fish Stock Assessment and Research – *Contact: Phill Dionne 360-902-2641, phillip.dionne@dfw.wa.gov; Dr. Todd Sandell 425- 379-2310, todd.sandell@dfw.wa.gov.*
Toxics-focused Biological Observation System for the Salish Sea (TBiOS) (formerly Puget Sound Ecosystem Monitoring Program or PSEMP) – *Contact: Dr. Jim West 360-902-2842, james.west@dfw.wa.gov).*
For complete staff contact information see section VIII of this report.

Staff of the Coastal Marine Fish Science (CMFS) Unit during the reporting period included Lorna Wargo (lead), Rob Davis, Donna Downs, Bob Le Goff (retired in 2018), Kristen Hinton, Jamie Fuller, Michael Sinclair, and Tim Zepplin. In early 2019 a cohort of non-permanent survey staff were also hired to conduct nearshore hook-and-line surveys, including Janna Goulding, Bryce Blumenthal, Douglas Howe, Gordon Verbos, Glen beck, Thomas Hargrove, Mark Dailey, Walter Smith, And Dan Wolfley. Unit tasks are supported through a combination of state general and federal funds. Long-standing activities of the unit include the assessment of groundfish populations off the Washington coast, the monitoring of groundfish commercial and recreational landings, and the coastal rockfish tagging project. In the last two years unit activity has expanded to include forage fish management and research, though this responsibility is shared and coordinated with the statewide MFF Unit.

The MFS Unit contributes technical support for West Coast groundfish and forage fish management via participation on the Coastal Pelagic Species Management Team (CPSMT, Lorna Wargo), the Scientific and Statistical Committee (SSC, Dr. Theresa Tsou), and the Habitat Steering Group (HSG) of the Pacific Fishery Management Council (PFMC). Landings and fishery management descriptions for PFMC-managed groundfish and coastal pelagic species are summarized annually by the GMT and the CPSMT in the Stock Assessment and Fishery Evaluation (SAFE) document. Additional West Coast fishery management support is provided by the Intergovernmental Ocean Policy Unit, which consists of Michele Culver (lead), Corey Niles, Heather Hall, and Jessi Doerpinghaus. Both Heather and Jessi serve on the PFMC's Groundfish Management Team (GMT).

Primary Contacts – Coastal Washington:
Groundfish Management, Monitoring, Research, and Assessment – *Contact: Dr. Theresa Tsou 360-902-2855, tien-shui.tsou@dfw.wa.gov; Lorna Wargo 360- 249-1221 lorna.wargo@dfw.wa.gov; Corey Niles, 360-902-2733, corey.niles@dfw.wa.gov (Coastal Marine Policy Lead).*
Forage Fish Management, Monitoring, Research, and Assessment – *Contact: Lorna Wargo 360-249-1221 lorna.wargo@dfw.wa.gov; Phill Dionne 360-902-2641, phillip.dionne@dfw.wa.gov.*
For complete staff contact information see section VIII of this report.

II. Surveys

Puget Sound Bottom Trawl – Since 1987, the Washington Department of Fish and Wildlife (WDFW) has conducted bottom trawl surveys in Puget Sound—defined as all marine waters of the State of Washington east of a line running due north from the mouth of the Sekiu River in the Strait of Juan de Fuca—that have proven invaluable as a long-term, fisheries-independent indicator of population abundance for benthic fishes living on low-relief, unconsolidated habitats. These surveys have been conducted at irregular intervals and at different geographic scales since their initiation (Quinnell et al. 1991; Quinnell et al. 1993; Palsson et al. 1998; Palsson et al. 2002; Palsson et al. 2003). Surveys in 1987, 1989, and 1991 were semi-stratified random surveys of the majority of Puget Sound. From 1994-1997 and 2000-2007, surveys were annual, stratified random surveys focusing on individual sub-basins (WDFW unpublished data; Palsson et al. 1998; Blaine et al., in prep). Starting in 2008, surveys became synoptic again, sampling annually at fixed index sites throughout Puget Sound (Blaine et al., in prep).

The specific objectives of the annual index trawl survey are to estimate the relative abundance, species composition, and biological characteristics of bottomfish species at pre-selected, permanent index stations. Key species of interest include Pacific Cod, Walleye Pollock, Pacific Hake, English Sole, North Pacific Spiny Dogfish, and all species of skates; however, all species of fishes and invertebrates are identified to the lowest taxonomic level practicable, weighed, and recorded. For the index survey, the study area is subdivided into eight regions (eastern Strait of Juan de Fuca, western Strait of Juan de Fuca, San Juan Islands, Georgia Basin, Whidbey Island sub-basin, Central Puget Sound, Hood Canal, and South Puget Sound) and four depth strata ("S"= 5-20 fa, "T"= 21-40 fa, "U"= 41-60 fa, "V"= >60 fa), and 51 fixed index stations throughout the study area are sampled each spring (late April-early June) (Figure 1).

Index stations were originally selected from trawl stations sampled during previous survey efforts at randomized locations throughout Puget Sound. Station selection was based on known trawlability and other logistical concerns, and was informed by previously obtained biological data. Stations are named using a four-letter system with the first two letters designating the region, the third letter indicating the sub-region, or position within the region (north, south, middle, east, west), and the final letter designating the depth stratum. The index stations have remained relatively consistent since 2008, with a few exceptions: starting in 2009, 5 stations were added to make the current 51-station design; in 2012 and 2013, stations in the shallowest stratum (S) were not surveyed because of concerns from NOAA about impacts to juvenile salmonids; and in 2014 and 2015, stations JEWU and CSNV, respectively, were moved slightly to accommodate concerns raised by fiber-optic cable companies.

The trawling procedure of the survey has remained largely consistent and complete details can be found in Blaine et al. (2016). The 57-foot *F/V Chasina* is the chartered sampling vessel, and it is equipped with an agency-owned 400-mesh Eastern bottom trawl fitted with a 1.25-inch codend liner. The net is towed at each station for a distance of ~0.40 nautical miles at a speed of 1-3 knots, and the tows last approximately 11 minutes. The resulting catch is identified to the lowest taxonomic level possible, weighed, counted, and most of the catch is returned to the sea. The density of fish at each station is determined by dividing the catch numbers or weight by the area sampled with the net, which is based on a mensuration study conducted in 1994 (WDFW unpublished data). A small portion of the catch is retained for biological sampling, either when

fresh on deck or after being preserved (freezing, ethyl alcohol, or formalin) for processing in the laboratory. Samples collected may include: fin clips (genetics); scales, spines, and otoliths (ageing); stomachs and intestines (gut contents); and muscle tissue (stable isotopes). When necessary, whole specimens may also be retained for positive identification or special projects being conducted by the WDFW or its collaborators.

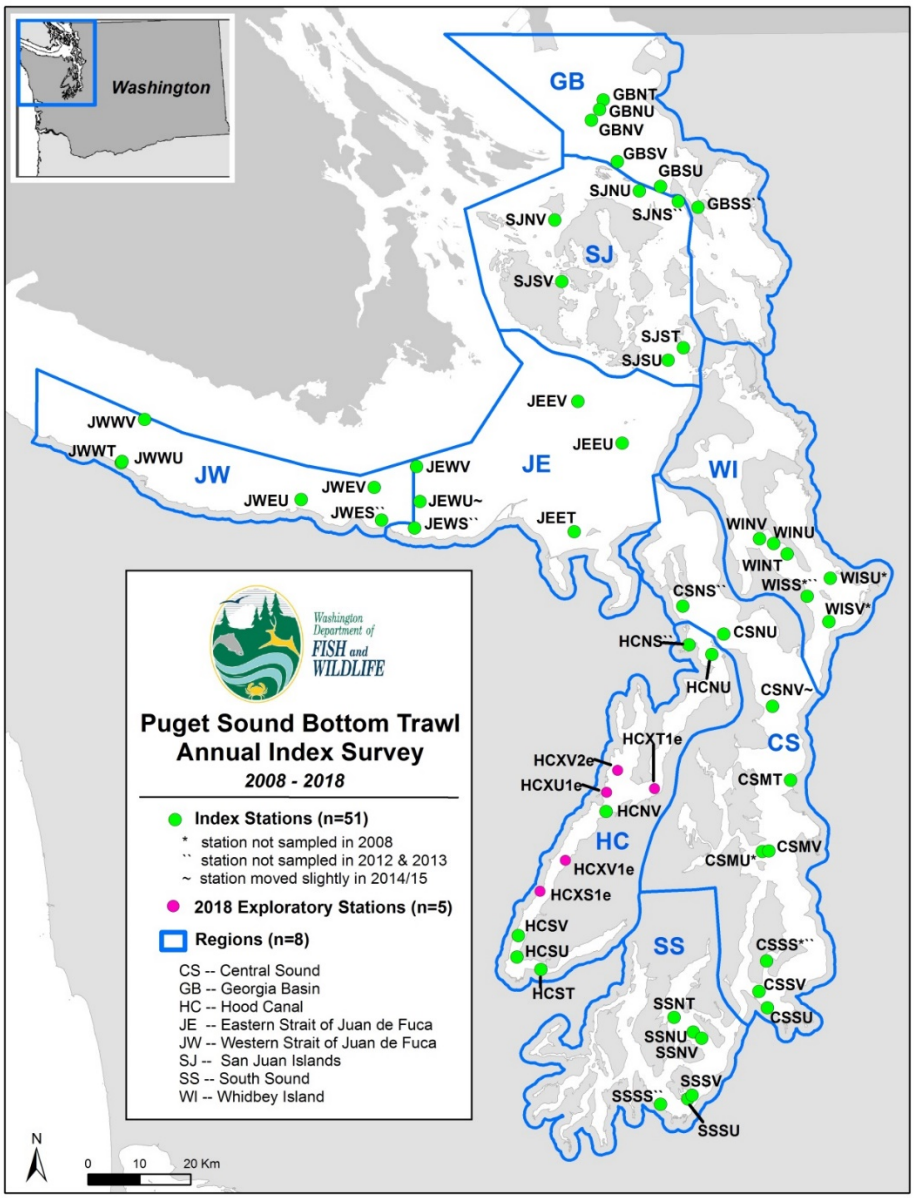


Figure 1. Trawl site locations for the index survey, sampled 2008-2018. Stations CSNV and JEWU were moved several hundred yards in 2014/15 to reduce the potential for interactions of trawl gear with previously unknown submarine cables. Five exploratory stations were conducted in 2018 to compare with index stations (see section "Exploratory Tows").

From 2008 to 2013, two trawl samples were collected at each station and were spaced several hundred meters apart to be close to each other but not directly overlapping. However, based on the similarity of catches in these paired tows at most stations, and in the interest of minimizing bottomfish mortality associated with the trawl survey, the protocol was altered in 2014. After the first tow is completed, the processed catch is compared to the average catch at that station since 2008. If the species comprising the majority (>75% by weight) of the catch fall within the previous years' average (+/- standard deviation), no second tow is conducted at that station. If it is determined that the species composition was substantially different than expected, a second tow is conducted. This greatly improves the efficiency of the survey, as an average of only 4 stations have required a second tow each year. This newly gained efficiency has allowed institution of a new sampling program, conducting vertical plankton tows, to assess primary prey availability. In 2014 bottom-contact sensors were also added to the footrope to improve understanding of net performance and increase the accuracy of density estimates from the trawl, and a mini-CTD was deployed on the headrope to collect water quality data at each station and provide more accurate depth readings. In 2017, a Marport unit was also attached to the headrope to provide real-time data regarding the net's depth, bottom status, and opening height.

2018 At-A-Glance

In 2018, WDFW conducted the 11th Index trawl survey of Puget Sound from April 30 through May 24. During the 16 survey days, all 51 index stations were occupied, and a total of 54 index bottom trawls were conducted as 3 stations required a second tow. An estimated 63,855 individual fish belonging to 92 species/taxa and weighing 9.8 mt were collected (2017: 55,183 fish; 76 species; 9.4 mt). Similar to previous years, Spotted Ratfish constituted 57% of the total fish catch by weight and 22% of the total number of individual fish, followed by English Sole at 18% and 21%, respectively. The remaining fish species contributed 4% or less to the total fish catch weight and 11% or less to the total number of individual fish. For invertebrates, an estimated 57,078 individual invertebrates (those species catchable in the bottom trawl) from 89 different species/taxa weighing 2.0 mt were caught in the 2018 survey. By weight, the most dominant species were Dungeness Crab and Metridium anemones, comprising a respective 35% and 31% of the total invertebrate catch weight. By number of individuals, Alaskan Pink Shrimp and Dock Shrimp comprised 39% and 24%, respectively, of the invertebrate catch. The remaining species contributed 8% or less to the total invertebrate catch by weight or by number.

ESA-Listed Species

Pacific Eulachon was, as per usual, the most abundant ESA-listed species encountered during the 2018 survey; 19 individuals were caught (29 in 2017) in regions CS, GB, JE, SJ, and WI. Two juvenile Chinook Salmon, both wild, were caught in Hood Canal; fin clips were taken for genetics samples and were sent to the WDFW Genetics Lab. Bocaccio (rockfish) were also encountered for the fourth time in the history of the bottom trawl survey (2012, 2016, 2017). One 22 cm subadult was found in JE, just west (i.e., outside) of the species' Puget Sound Distinct Population Segment (DPS) geographic boundary. The other two individuals caught, however, were found inside the DPS boundary and were both adults. One was a 33 cm male caught in SJ and the other a 35 cm female in GB. Both were weighed, measured, fin clipped (for genetics), and descended as quickly as possible after being recognized in the catch, and both are believed to

have survived. NOAA officials were also contacted to ensure proper reporting of the take, and the captures were well within the limits of the survey's Section 10 collection permit.

Flatfish

English Sole, as previously mentioned, were the most prevalent species of flatfish, with estimates of 15,923 mt and 124 million individuals; these estimates are 16% and 33% higher than those in 2017, and are at their highest since 2010. Among regions, WI supported the highest population density of English Sole at 600 fish/ha while CS supported the highest biomass density at 64 kg/ha; the smallest population was found in JW at 1.6 kg/ha and 5 fish/ha. In terms of other flatfish species, Rock Sole, Starry Flounder, and Pacific Sanddab were once again the most dominant by weight with 4386 mt, 2167 mt, and 2034 mt, respectively. By abundance, Pacific Sanddab (24.7 million), Rock Sole (23.0 million), and Slender Sole (9.9 million) were the most dominant after English Sole.

While these estimates are for all of Puget Sound, each region supported its own composition of flatfish species, although English Sole accounted for over half of the flatfish biomass in 6 of the 8 regions. Dover Sole comprised the majority (33%) of flatfish biomass in JW while Starry Flounder (38%) did so in SS. Starry Flounder also made up 38% of flatfish biomass in HC, and Southern Rock Sole accounted for a quarter of it in WI. Otherwise, all other flatfish species comprised 20% or less of a region's flatfish biomass. Overall, Central Sound supported the highest biomass density of flatfish among the regions of 93.2 kg/ha, while WI supported the highest population density of 864.5 individuals/ha—25% higher than in 2017.

Codfishes (Gadiformes)

Pacific Cod catch increased for the first time since 2013; 17 were caught, weighing a total of 16 kg, in this 2018 survey from three regions. This catch rate resulted in an estimated population density of 1.4 ind/ha in JW, 0.95 ind/ha in GB, and 0.52 ind/ha in SJ (Figure 2). While the density in JW was similar to that from the 2017 estimates, the density in GB tripled, and it was also the first year that Pacific Cod were caught in SJ since 2014. Additionally, 14 of the 17 total individuals were 40 cm or less, which is the strongest showing of this size range since 2014, and could indicate the start of some recovery.

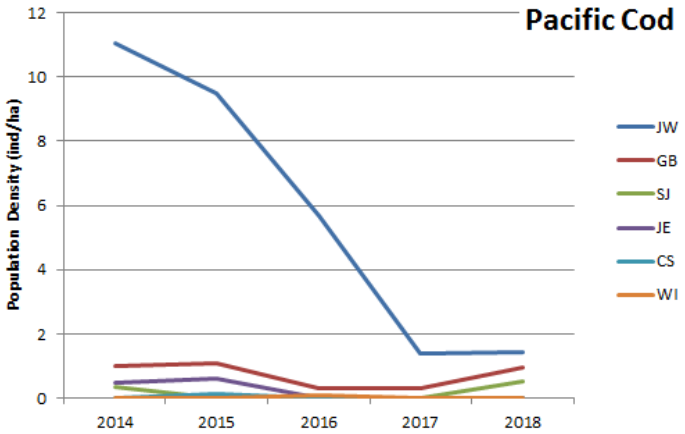


Figure 2: Population density (fish/hectare) of Pacific Cod caught in the 2014-2018 bottom trawl surveys, by region.

Pacific Hake biomass estimates more than doubled from 2017 (1404 mt) to 2018 (3290 mt) and abundance estimates increased from 23.6 million individuals to 40.3 million; hake were found in each of the eight regions except JW. Walleye Pollock also had a substantial increase and were found in all regions; biomass and abundance estimates increased 91% and 135%, respectively, from 2017 to 2704 mt and 55.6 million individuals.

Sharks and Skates (Elasmobranchs)

Compared to 2017, the 2018 North Pacific Spiny Dogfish catch was lower in terms of individuals, with 87 dogfish caught versus 123 in 2017, but higher in terms of weight, with 142 kg caught versus 131 kg. Dogfish populations can be migratory, however, and individuals are frequently in the water column rather than on the bottom, so their catchability in the bottom trawl is variable. Nevertheless, dogfish were found in seven of the eight regions, with 73% of the weight and 64% of the individuals being caught in GB; this was the first time in the trawl survey, however, that no dogfish were caught in JW. Brown catsharks were caught for the first time since 2014. Two females were found in GB and one male was found in HC; all were 40-50 cm and kept for researchers at WDFW and Moss Landing Marine Labs for further analysis.

Big Skate biomass and abundance estimates decreased 49% and 35%, respectively, to 2239 mt and 1.5 million individuals. Encounter rates of Big Skates were highest in SJ, which accounted for over 50% of the biomass and abundance. Longnose Skate biomass estimates also decreased 12% to 1255 mt, while abundance estimates increased 43% to 1.3 million individuals; estimates were highest in CS, JE, and GB. Nineteen Sandpaper Skates were caught in 2018, which is the highest catch in the bottom trawl survey since 2007. As in 2017, Sandpaper Skates were caught in JE, JW, and GB.

Other Fishes/Notable Finds

Because rockfish tend to exhibit preferences for rocky, untrawlable habitats, the bottom trawl survey is rarely used as an indicator of rockfish populations. With this in mind, however, there was a noticeably higher catch of rockfish in the 2018 survey compared to recent years; twice as many, in fact, as in 2017 (Table 1). Eleven different species were caught, including a Shortspine Thornyhead for the first time since 2010. Quillback Rockfish were, as usual, the most abundant species, followed by Copper and Yellowtail Rockfishes; these three species were actually caught in the highest densities found to date in the bottom trawl survey. While all but one of the Yellowtail were caught in just one tow in WI, the Coppers and Quillbacks were found in at least 5 of the regions.

Sablefish (*Anoplopoma fimbria*; aka “Black Cod”), which were caught last year in the survey for the first time since 2011, were again found in the survey this year but in fewer numbers. Only two Sablefish were caught, a 43-cm one in JW and a 46-cm one in GB. These are likely the same cohort found last year, as fish then ranged from 31 to 39 cm. Fin clips were taken for genetic analysis, and both individuals were released alive.

A few other less-frequently caught species found in the 2018 survey include Brown Irish Lord, Pacific Spiny Lumpsucker, and Red Brotula.

Table 1: Rockfish species counts caught in the bottom trawl survey from 2014-2018.

Species	2014	2015	2016	2017	2018
Black Rockfish	1	-	-	-	-
Bocaccio	-	-	11	7	3
Brown Rockfish	2	13	15	16	42
Canary Rockfish	-	1	-	2	3
Copper Rockfish	27	7	4	4	123
Greenstriped Rockfish	2	5	2	8	5
Puget Sound Rockfish	9	2	-	-	1
Quillback Rockfish	41	34	117	235	344
Redbanded Rockfish	-	-	1	-	-
Redstripe Rockfish	5	4	6	8	4
Shortspine Thornyhead	-	-	-	-	1
Splitnose Rockfish	-	-	2	-	3
Yellowtail Rockfish	-	7	-	13	59
Total	**87**	**73**	**158**	**293**	**588**

Exploratory Tows

In addition to the 51 index stations, we also conducted 5 exploratory tows in Hood Canal, the data from which are not included in the above summaries. When the index survey design was developed in 2008, stations were selected from tows of previous surveys that would, in theory, represent the species composition for a given region-depth stratum when averaged. Since the implementation of the index survey design, however, the stations have not been tested to determine whether they are still representative of their respective region-depth stratum; additionally, we are not sure how repeatedly towing in the same area can affect the site's environment and species composition over time. With a limited budget and survey timeline, we are not able to incorporate sufficient exploratory stations in each region each year, but we hope to implement some on a region-by-region basis as time and budget allow.

For the 2018 survey, we determined that we would be able to sample 5 exploratory stations in Hood Canal with minimal impact to the normal survey schedule and budget. This allotted one extra station for each of the four depth strata, and the additional station was attributed to the "V" (>60 fa) stratum as that constitutes the majority of the area in the region. The stations were chosen from tows of previous Hood Canal surveys (2002 & 2005), excluding those used to determine index stations and those on which the net had hung up in the past. The Hood Canal region is narrow east-to-west but long north-to-south, with the inlet on the north end; due to these features, the extra stations were selected to represent a different part of the region than their index counterparts. For example, the index "S" station (HCNS) is located north of the Hood Canal Bridge, so a previous "S" tow in the southern area of the Canal was selected as the exploratory station. Final station selections are included on the map in Figure 1.

A cluster analysis was used to compare the catch compositions from the exploratory stations with those from the index stations. On a whole, the stations clustered by each of the four depth strata, and the deeper two strata clustered separately from the shallower two strata, all with the

exception of station HCNU. This index station was the only 'independent' station and had, at best, a ~45% similarity with other stations. Excluding HCNU, there was an average of 65% similarity between the exploratory and index stations. Each exploratory station was most similar to the index station(s) in the same depth stratum. The same analysis was conducted using biomass data, and the results were almost identical. The density data were further examined with a SIMPER analysis to look at the species contributing to the differences between stations; station comparisons were focused on the similarities/differences between each exploratory station and the index station(s) in the same depth stratum. Overall, with the exception of HCNU, the index stations and exploratory stations were reasonably similar within depth strata. The SIMPER comparisons showed that sometimes it was the smaller, more random species that contributed to a number of the dissimilarities among stations rather than the target species. Thus, the stations were likely more similar in terms of the fish species for which the survey was designed to sample. This effort seems to be a promising first step to assessing the long-standing index stations. Further efforts like this should be continued in other regions and to a greater degree to enable better comparisons.

Summary

The WDFW bottom trawl survey is the largest, and longest-running, fishery-independent survey of benthic organisms in Puget Sound. As such, this dataset provides an invaluable monitoring opportunity for populations of bottomfish and select benthic invertebrates, particularly given the inter-annual variation of many fish species. Continued collection of these data is important, as they can serve as a baseline for evaluating future population shifts due to fishery management actions, disease outbreaks, catastrophic events, and/or environmental shifts. Additionally, the data, samples, and estimates from the trawl survey are not only important for the WDFW's marine fish monitoring efforts, but are also used by other entities both within and outside the agency. The estimates of Dungeness Crab and Spot Prawns are presently being used by the WDFW's Shellfish Team to better inform fishery management decisions; a researcher and his students at the University of Puget Sound are analyzing the amount of microplastics ingested by multiple bottomfish species through our collected samples; and a University of Washington researcher is studying parasite loading in English Sole. These are just a few examples of how the bottom trawl survey includes such far-reaching applications that influence the knowledge and management of other species and supports other research efforts.

If you are interested in reading the full cruise report from the 2018 bottom trawl survey, please contact Jen Blaine (Jennifer.blaine@dfw.wa.gov). The 2019 Index bottom trawl survey is scheduled to occur from April 22 – May 31 and will be the biennial joint survey during which vessel time is shared between the Marine Fish Science Unit (this reporting group) and the Toxics-focused Biological Observation System Team.

Threatened and Endangered Species Surveys at Naval Installations – The U.S. Navy controls multiple restricted areas throughout Puget Sound that have been exempted from ESA-listed rockfish critical habitat designation by the NMFS. As a prerequisite, the Navy maintains an Integrated Natural Resource Management Plan (INRMP) to fulfill the requirements that authorize these exemptions. From 2013-17 the PSMFS Unit surveyed Naval Base (NAVBASE) Kitsap Bangor, Bremerton, and Keyport; Naval Air Station (NAS) Whidbey Island Crescent

Harbor; Naval Magazine (NAVMAG) Indian Island; and Naval Station (NAVSTA) Everett using a combination of ROV, scuba, beach seine, hydroacoustic, and lighted fish trap methods to establish baseline densities, distributions, and habitat classification for rockfish and other groundfish at each installation. A series of annual reports was submitted with the ultimate conclusions that: no ESA-listed rockfish were observed at any facility; no deep-water critical habitat (>30m) for adult rockfish is present within the secured areas of any of the facilities; and some nearshore critical habitats (<30m) with hard substrates and vegetation for juvenile rockfish exist within the surveyed areas.

Though both natural and artificial habitats occurring within navigable waters were thoroughly surveyed from 2013-17, NAVBASE Bremerton also contains six extensive dry docks that are used to clean, inspect, and service ships ranging from small submarines to aircraft carriers (Figure 3). These dry docks are completely man-made and are episodically flooded to move ships in and out of them. Prior sampling for salmonids at NAVBASE Bangor has shown that a variety of groundfish may also entrained during these operations, though no ESA-listed rockfish were encountered. Fish that are entrained may be killed when passing through the inflow/outflow turbines, consumed by birds during dewatering, or left to die after dewatering is complete. While some salvage efforts do occur, they are infrequent and poorly documented.

Figure 3: Locations of the six service dry docks at Naval Base (NAVBASE) Bremerton on the Kitsap Peninsula in central Puget Sound.

During the reporting period members of the PSMFS Unit conducted two inspections of the dry dock facilities in order to formulate a sampling plan for surveys in 2019 and 2020. A variety of catch bags are being constructed that will sit atop, or hang below, various filter grates associated with inflow/outflow tunnels. Staff will observe bird predation during dewatering, retrieve fish from the catch bags for speciation and measurement, and also employ beach seining and kicknetting techniques to collect fish not captured in the bags. The goal will be to collect and

identify all fish impacted by dry dock dewatering over 5-8 such events by the end of 2020. If no ESA-listed species are encountered during these efforts the provisions of the INRMP will be considered met and operations of the dry docks will continue as planned for another five years.

Annual Pacific Herring Assessment in Puget Sound – Annual herring spawning biomass was estimated in Washington in 2018 using spawn deposition surveys. The WDFW recognizes twenty one different herring stocks in Puget Sound and two coastal stocks, based primarily on timing and location of spawning activity; there are currently three distinct genetic groupings (Cherry Point, Squaxin Pass, and the "all other stocks" complex). MFF Unit staff based in the Olympia, Mill Creek, and Port Townsend offices attempt to conduct spawn deposition surveys of all herring populations in Washington annually (acoustic-trawl surveys were discontinued in 2009 due to budget cuts; as a result, we are no longer able to estimate the age structure of the herring stocks). Locations sampled in 2018 are shown in Figure 4. Stock biomass assessment activities for the 2019 spawning season are in progress.

The herring spawning biomass estimate for all Puget Sound stocks combined in 2018 was 10,279 metric tonnes, a 16.5% increase from 2017 (8,587 tonnes) (Table 2). The 2018 total is a 35% increase from the recent 2013 low point of 6,651 tonnes and is slightly above the previous ten year average (9,816 tonnes). The stability of the overall Puget Sound estimated biomass continues to be driven by significant gains in the Quilcene Bay stock (Hood Canal), which has increased over 209% between 2013 (1,880 tonnes) and 2018 (5,816 tonnes) and again comprises over half of the total herring biomass for the region (Table 2).

Table 2: Pacific Herring spawning biomass estimates (metric tonnes) in Puget Sound by stock and year

Stock and Region	Genetic grouping	PUGET SOUND HERRING SPAWNING BIOMASS ESTIMATES (Metric Tonnes), 2009-2018									
South/Central Puget Sound		**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
	Squaxin Pass	748	463	513	534	503	357	294	236	271	381
Purdy		113	454	645	122	236	75	29	0	20	15
Wollochet Bay		327	10	19	28	9	35	0	0	5	0
Quartermaster Harbor		765	130	87	98	142	40	50	0	0	11
Elliot Bay		0	0	0	263	194	26	122	99	68	199
Port Orchard-Port Madison		1,604	318	112	197	167	82	83	0	0	13
South Hood Canal		142	194	142	239	181	102	256	226	90	58
Quilcene Bay		2,780	1,825	4,031	2,382	1,880	2,810	3,717	6,496	4,482	5,816
Port Gamble		965	393	1,328	367	248	154	313	163	164	451
Kilisut Harbor		0	0	0	0	0	5	0	0	0	0
Port Susan		229	138	125	55	26	62	64	55	103	67
Holmes Harbor		948	611	2,724	615	531	416	414	448	70	341
Skagit Bay		940	365	425	402	412	267	259	44	176	310
South/Central Puget Sound Total		9,559	4,899	10,150	5,303	4,528	4,431	5,600	7,767	5,450	7,662
North Puget Sound		**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Fidalgo Bay		14	93	108	81	91	200	73	5	5	0
Samish/Portage Bay		290	589	351	390	629	706	507	929	451	379
Semiahmoo Bay		898	825	1,456	797	516	2,566	5,309	1,631	2,097	1,603
	Cherry Point	1,217	702	1,180	1,016	824	910	475	468	337	249
Interior San Juan Islands		0	22	0	5	0	5	34	0	0	61
NW San Juan Islands		0	0	0	0	0	0	0	0	0	0
North Puget Sound Total		2,419	2,231	3,095	2,289	2,059	4,386	6,398	3,033	2,890	2,292
Strait of Juan de Fuca		**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Discovery Bay		186	24	0	95	0	5	11	221	93	232
Dungeness/Sequim Bay		42	68	94	39	64	65	7	40	153	93
Strait of Juan de Fuca Total		228	92	94	134	64	70	18	261	247	326
All Other Stocks total (excluding Cherry Pt. and Squaxin)		10,241	6,056	11,647	6,176	5,325	7,620	11,247	10,356	7,979	9,649
Puget Sound Total		12,205	7,221	13,340	7,726	6,651	8,888	12,017	11,060	8,587	10,279

The combined spawning biomass of South/Central Puget Sound herring stocks in 2018 was 7,662 metric tonnes, a 29% increase from the 2017 total of 5,450 tonnes and 15% above the ten

year average (6,535 tonnes). The three Hood Canal stocks, of which Quilcene Bay is the major contributor (Table 2), made up 97% of the total for the South/Central Puget Sound region in 2018 (Figure 5). A number of stocks in this region that were previously abundant continue to hold at low levels, particularly the Purdy, Quartermaster Harbor, Port Orchard-Port Madison, and Port Susan stocks. The Wollochet Bay stock had no spawn detected in 2018 and has only had spawn once in the past 4 years, and the Kilisut Harbor stock is now considered a disappearance, with only one year of spawn detected in the past decade.

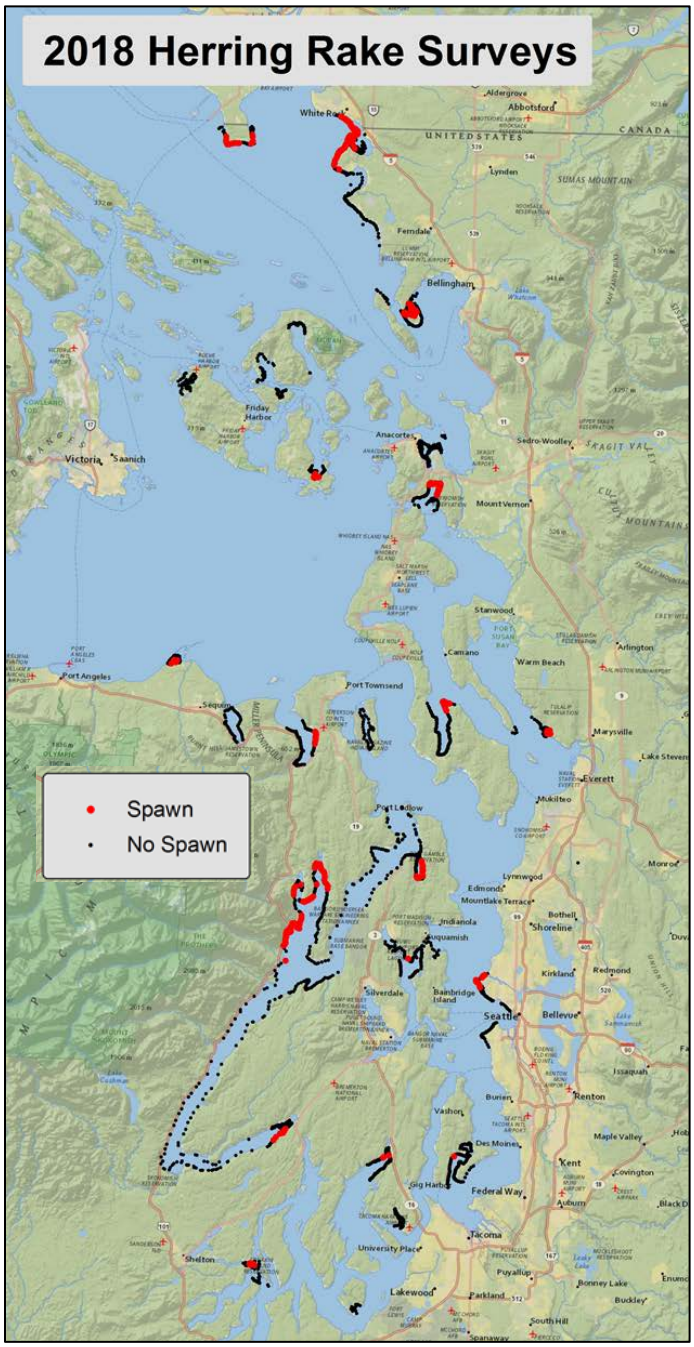


Figure 4: Locations of all rake surveys conducted in 2018, with red dots indicating detection of eggs.

The cumulative biomass of North Puget Sound stocks (2,292 tonnes) remained much lower than the recent peak in 2015 (6,398 tons), but remains close to the ten year average for this region (3,109 tonnes) (Table 2). This was primarily the result of a more normal year (1,603 tonnes in 2018) for the Semiahmoo Bay stock, which had a record year in 2015 (5,309 tonnes). However, the spawning biomass of the Cherry Point stock again declined in 2018 to 249 tonnes, a decrease of 26% from 2017 (337 tonnes) and only 66% of the ten year average for this site (738 tonnes). This stock, which is genetically distinct from other herring stocks in Puget Sound and British Columbia, continues to be at critically low levels of abundance and has declined over 96% since the initial estimate in 1973 (13,606 tonnes).

Estimated herring spawning biomass for the Strait of Juan de Fuca region remained higher (326 tonnes) than the ten year average (153 tonnes) and increased slightly from 2017 (247 tonnes) (Table 2). Spawning in Dungeness Bay (93 tonnes in 2018) declined from 2017 (153 tonnes), but was well above the ten year average (67 tonnes) for this site. In addition, the Discovery Bay stock increased dramatically in 2018 (232 tonnes), up 60% from 2017 (93 tonnes) and was also well above the 10 year average (87 tonnes).

Spawning activity was observed in Willapa Bay at one site in 2018; no spawn was detected at the other coastal site, Grays Harbor, although the number of surveys was again restricted by poor weather. In general, herring spawning biomass for these areas is relatively small compared to Puget Sound.

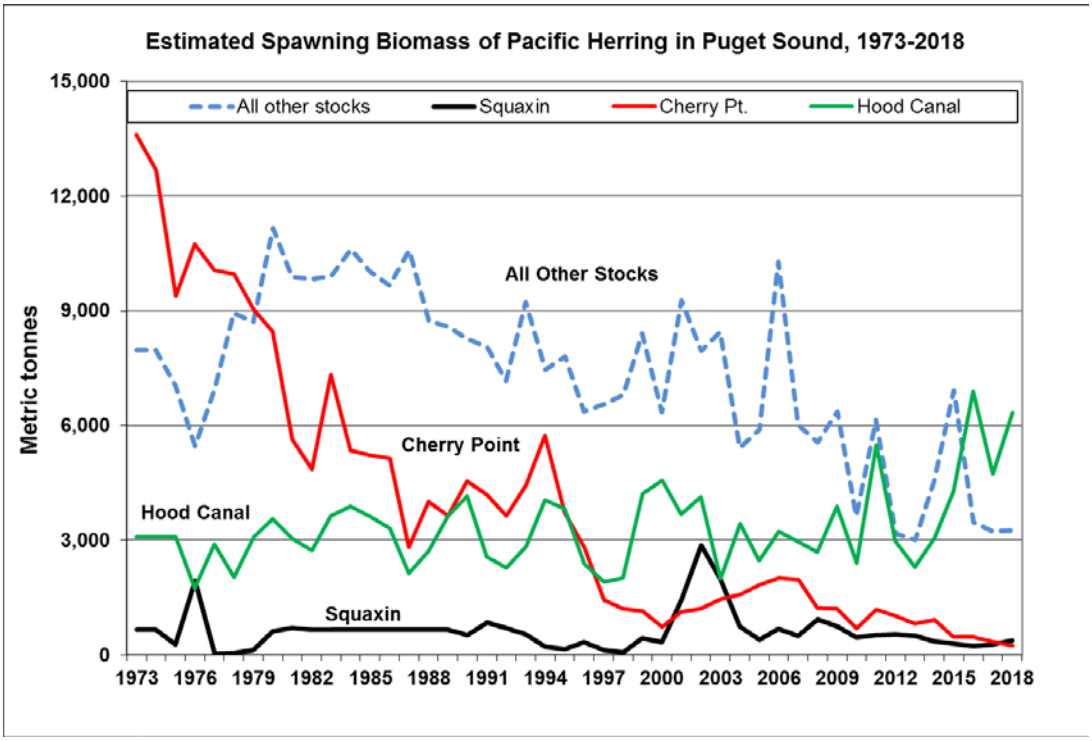


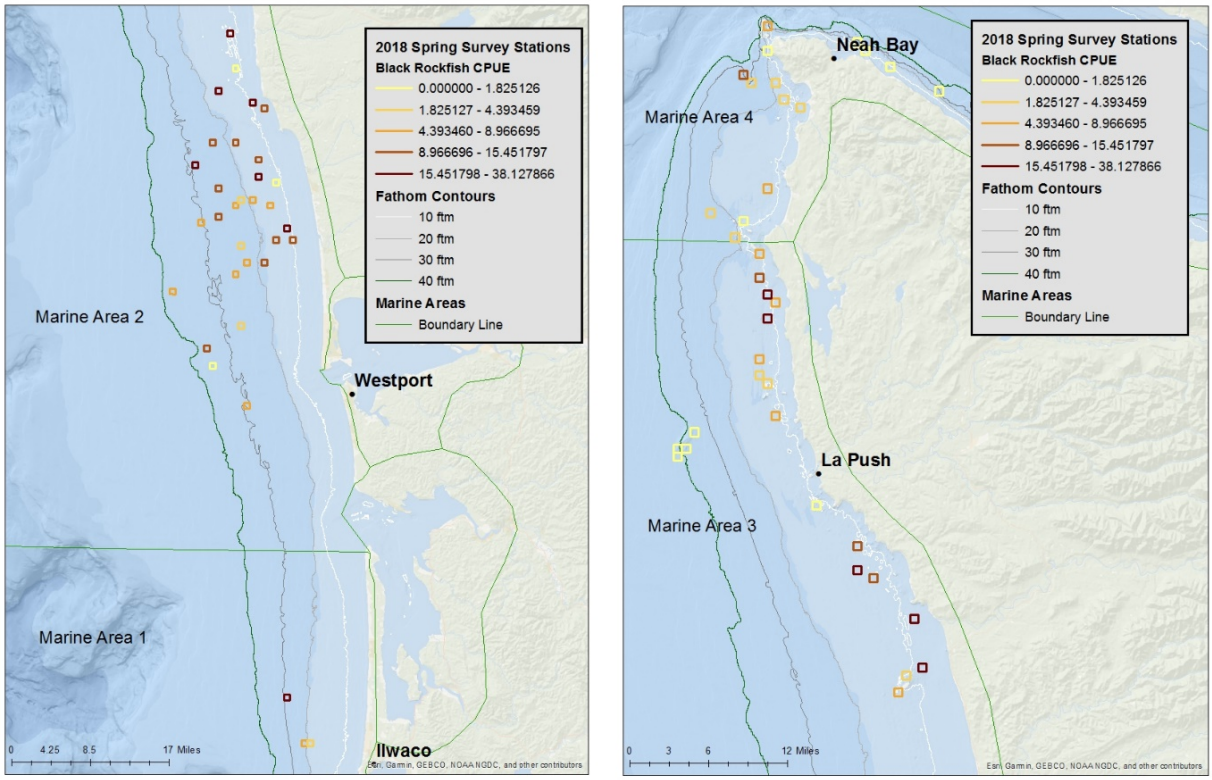
Figure 5: A comparison of Pacific Herring spawning biomass estimates for notable stocks in Puget Sound (note that only Squaxin Pass and Cherry Point are genetically distinct from the "Other stocks" complex)

Coastal Black Rockfish Rod and Reel Survey − The WDFW has conducted fishery independent rockfish surveys on the Washington coast since the 1980s. Historically, these surveys have primarily focused on Black Rockfish due to the predominance of this species in recreational fishery landings. Concerns over population sizes of other less dominant, but highly sought after, nearshore groundfish species has recently motivated survey design changes to address this data need. From 2014 through 2017, the WDFW conducted a series of experimental rod and reel surveys devoted to the development of a multispecies nearshore rockfish survey by evaluating nearshore rockfish distribution, life history, and fishing gear selectivity. This effort indicated that due to variable behaviors and terminal tackle selectivity among species, Washington's nearshore groundfish species would be best described with two separate coastal surveys: one targeting rockfish that typically school above rock piles and another targeting demersal groundfish species.

The primary focus of the 2018 rod and reel surveys was to implement standardized rod and reel surveys that can describe relative changes in population abundances of nearshore rockfish species and other associated groundfish species along the entire Washington Coast over time. Specifically, a "Black Rockfish Survey" was conducted in the spring to describe nearshore schooling species and a "Demersal Groundfish Survey" focusing on nearshore demersal rockfish and other associated groundfish species including Kelp Greenling and Cabezon was implemented in the fall.

The Black Rockfish rod and reel survey was conducted in the spring due to unsuitable ocean weather conditions in the winter, low charter vessel availability in the summer, and higher Black Rockfish catch rates in the spring when compared to fall WDFW rod and reel surveys. The survey began the day after the Washington coastal recreational groundfish season opened on March 10 to avoid any possible differences in catch rates due to varying recreational fishing pressure before and after the season opener.

Spring survey locations spanned the entire Washington Coast from the mouth of the Columbia River to the confluence of the Sekiu River with the Strait of Juan de Fuca and included all coastal marine areas. Location depths were limited to under 40 fathoms, which includes the typical depth range of Black Rockfish and all locations where the WDFW rod and reel surveys have encountered Black Rockfish in the past. Survey fishing effort was spatially distributed within the confines of the Washington Coast survey grid scheme developed by WDFW for the 2015 spring rod and reel survey. This grid is composed of 1-km squared cells superimposed over the entire Washington coast. Grid cells (stations) were chosen from this grid design for survey operations (Figure 6).



A) South Coast B) North Coast

Figure 6: 2018 spring selected survey stations (1 km grid cells) in Marine Area 1 and 2(A) and Marine Area 3 and 4 (B). Catch per unit effort (CPUE) is reported as the total number of Black Rockfish captured per rod hour (aggregated individual angler fishing time) at each station.

Targeted stations were chosen based on known rockfish habitat and observed catch rates of Black Rockfish from previous WDFW surveys. The presence of rockfish habitat within each grid cell was confirmed with rod and reel survey data spanning from 1998 to 2017. A grid cell was determined to have known rockfish habitat when at least one rockfish, Lingcod, Cabezon, or Kelp Greenling had been captured in it in a previous survey. Stations were then chosen along the Washington Coast roughly relative to the amount of known rockfish habitat by Marine Area and depth. Stations were selected to include both marginal and superior habitat locations based on catch rates from previous WDFW rod and reel surveys. All chosen cells had produced at least one groundfish in a previous hook and line survey and some effort was taken to evenly distribute stations spatially within each marine area and by depth.

Four recreational charter vessels were used to complete the 2018 spring survey. Each cruise was staffed with five hired anglers and three to four WDFW scientific staff. All contracted skippers had at least seven years of professional captain experience fishing for rockfish on the Washington Coast and each angler deployed had over 10 years of experience fishing for rockfish on the Washington Coast.

Fishing rods, reels, and terminal tackle were kept consistent across all stations surveyed. Terminal tackle consisted of two shrimp flies tied on a leader above a dropper weight and leaders were pre-tied at specified lengths before the charter day to ensure consistency. The weight of

sinkers used for each drift was chosen by the vessel's captain after taking into consideration depth and weather conditions, but were kept consistent among anglers for each drift.

Stations were generally fished in a south to north order when ocean conditions allowed. Stations to be visited on any given charter day were chosen before leaving port by the lead biologist after consultation with the vessel's captain and taking into account ocean conditions. Two to four stations were surveyed each day dependent on their distance from port. Specific fishing locations within each station that would most likely provide high rockfish catch were determined by the vessel's captain. Before setting up each fishing event, captains took time to scout for fish aggregations or high relief areas, and to consider previous survey and personally known catch locations within each cell. The distance of each drift and number of drifts per station were determined by the captain to allow for repositioning on schools of fish or habitat, to remain within the cell, or to target other areas of potentially higher catch located within the station's boundaries. All fishing effort was conducted within each station's cell boundaries. Anchoring of the vessel was only permitted when drift speed was too fast to effectively fish while drifting (approximately 1.6 knots). For record and timekeeping purposes, each anchored fishing event was recorded as a drift.

All fishing effort was conducted during daylight hours and charter days ranged from 8-12 hours. Initially, 80 minutes of total fishing time was devoted to each station. However, after the first day, total fishing time per station was reduced to 60 minutes to allow for more stations to be fished in a single charter day. Total fishing time at each station was calculated as the total aggregated time of each drift within a station's cell. Total fishing time for each drift began when the first angler's hook entered the water and ended when the last angler's hook left the water for any reason.

Five anglers fished for the total fishing time in each station surveyed, and the same five anglers fished all stations each charter day. Individual anglers were randomly assigned a specific position on the vessel to fish for all drifts at a single station. Due to space limitations on one of our chartered vessels, the F/V Topnotch in Marine Area 3, the captain was used as an angler for all drifts. Because he needed access to a specific fishing position in order to set up drifts and fish effectively, we were not able to randomize his fishing position.

For each drift, anglers started and ended fishing at the same time but were allowed to retrieve their gear as many times as necessary during the drift to land catch or maintain gear. Individual angler fishing times per drift were recorded as total time each angler's hooks were in the water, which excludes any time that fishing gear was out of the water either to land a fish or work on the gear. Anglers were allowed to fish anywhere in the water column that they expected to catch the most fish and captains were encouraged to describe the depths of fish aggregations to them.

Catch and effort information collection included station number, GPS location of the start and end of each set, depth, disposition of vessel (anchored or drifting), drift speed and direction, number of anglers, total fishing time per station, and terminal tackle gear type. Individual angler's fishing time, catch by species, gear loss, and fishing depth (benthic or pelagic) were recorded for each angler. The intensity and direction of weather conditions including tide, wind,

and swell were also recorded, and benthic habitat observations inferred from the vessel's sonar and captain's descriptions were noted for each station visited.

Catch was identified to species, measured (fork length), and scanned for previously implanted tags. Fish that were not chosen for age structure sampling were released at capture location with a descending device when needed. Released Yelloweye Rockfish were tagged with both an internal PIT tag and an external Floy tag. Released Cabezon, Kelp Greenling, China, Copper, Deacon, Quillback, Tiger, and Vermilion rockfish were tagged with a Floy tag and released.

Sixty-seven stations were successfully surveyed over 20 days in March, April and May. Aggregated individual angler rod hours at successfully surveyed stations ranged from 4.2 to 5.3, excluding the 80-minute total fishing time stations fished on the first survey day in Marine Area 1 (Figure 7). Unsuccessful survey stations included one station in Marine Area 4 where efforts were abandoned after a master time of only 46 minutes due to dramatic increase in drift speed and three stations in Marne Area 2 that were not sampled due to poor weather. Of the 67 stations surveyed, three were fished while at anchor and one had a mix of drift and anchor fishing due to an increase of current while fishing the station.

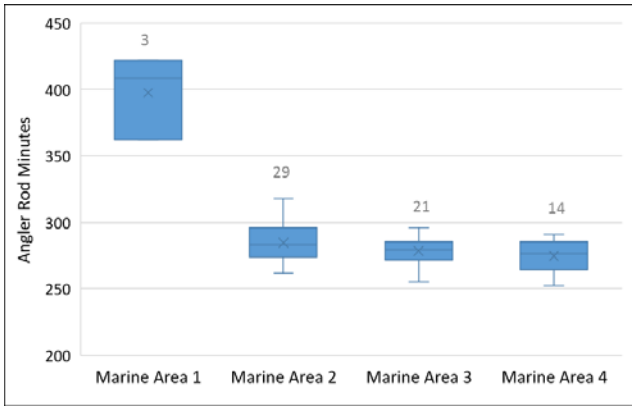


Figure 7: Box-whisker plot representing median, IQR, and minimum/maximum values of aggregated angler rod minutes spent at each station per Marine Area. Sample size (number of stations) is shown above the upper whisker.

Black Rockfish was by far the most dominant species captured across all marine areas and depth bins with the exception of 31-40 fathoms in Marine Area 3 (Table 3). Other high-catch species included Yellowtail Rockfish, Canary Rockfish, and to a lesser extent Lingcod and Deacon Rockfish. In general, species diversity was low; less than 17 individuals of all other species encountered were captured.

Table 3: Catch by number of all species per Marine Area and depth bin in the 2018 spring survey.

Species	Marine Area 1	Marine Area 2					Marine Area 3				Marine Area 4				Grand Total
	21-30 fathom	0-10 fathom	11-20 fathom	21-30 fathom	31-40 fathom	Total	0-10 fathom	11-20 fathom	31-40 fathom	Total	0-10 fathom	11-20 fathom	21-30 fathom	Total	
Black Rockfish	317	259	650	493	137	1539	492	374	2	868	30	106	89	225	2949
Buffalo Sculpin			1			1									1
Cabezon								2		2		1		1	3
Canary Rockfish			1	112	27	140	1		35	36	8	6	27	41	217
China Rockfish											1	3		4	4
Chinook Salmon									1	1		1	1	2	3
Coho Salmon									1	1					1
Copper Rockfish				1		1					1		3	4	5
Deacon Rockfish			1	5		6	32	8	15	55		9	1	10	71
Kelp Greenling							3	3		6		3		3	9
Lingcod		4	17	32	5	58	3	5	10	18	4	9	9	22	98
Pacific Halibut			1			1									1
Pacific Herring													1	1	1
Pacific Sandab					1	1									1
Quillback Rockfish				3	2	5			4	4	1	4	2	7	16
Tiger Rockfish									1	1					1
Unspecified flat fish												1		1	1
Vermilion Rockfish								1	1	2		1		1	3
Widow Rockfish									6	6					6
Yelloweye Rockfish				1	2	3			1	1					4
Yellowtail Rockfish	5			34	4	38	3	21	151	175	2	30	10	42	260
Grand Total	322	263	671	681	178	1793	534	414	228	1176	47	174	143	364	3655

The 2019 Black Rockfish Survey is currently in progress with minor method adjustments to reduce station size and further standardize survey effort.

Coastal Nearshore Demersal Groundfish Rod and Reel Survey – As part of the 2018 WDFW multispecies coastal nearshore rockfish survey efforts, a demersal rockfish rod and reel survey was implemented in the fall of 2018. The primary objective of fall survey efforts was to develop standardized gear, effort, and methods that could be utilized to describe relative changes in population abundances of a variety of nearshore demersal groundfish species along the entire Washington Coast over time. The species of interest included China, Copper, Quillback, Tiger, Vermilion, and Yelloweye rockfish, as well as Kelp Greenling and Cabezon. Survey methods in the fall of 2018 were identical to the methods described in the spring Black Rockfish Survey, with a few key changes to target demersal species.

The demersal survey was conducted in the fall due to unsuitable ocean weather conditions in the winter, low charter vessel availability in the summer, and limited staff and vessel time in the spring due to other survey priorities. Study locations spanned the Washington Coast Marine Areas 3 and 4, where most known target species' habitat exists, and depths from subtidal to 40 fathoms (Figure 8). While target species are marginally distributed in Marine Area 2, logistical issues prohibited the survey of this area in 2018. Marine Area 1 has little known habitat containing demersal species and was not included in the survey. Due to the smaller study area, only two recreational charter vessels were used to complete the 2018 fall survey over eight fishing days.

As with the spring survey, fishing effort was spatially distributed within the confines of the Washington Coast survey grid scheme developed by WDFW for the 2015 spring rod and reel survey. Within this schema, one kilometer squared grid cells (stations) were chosen for survey operations (Figure 8). Targeted stations in the fall survey were chosen based on known habitat of demersal rockfish species.

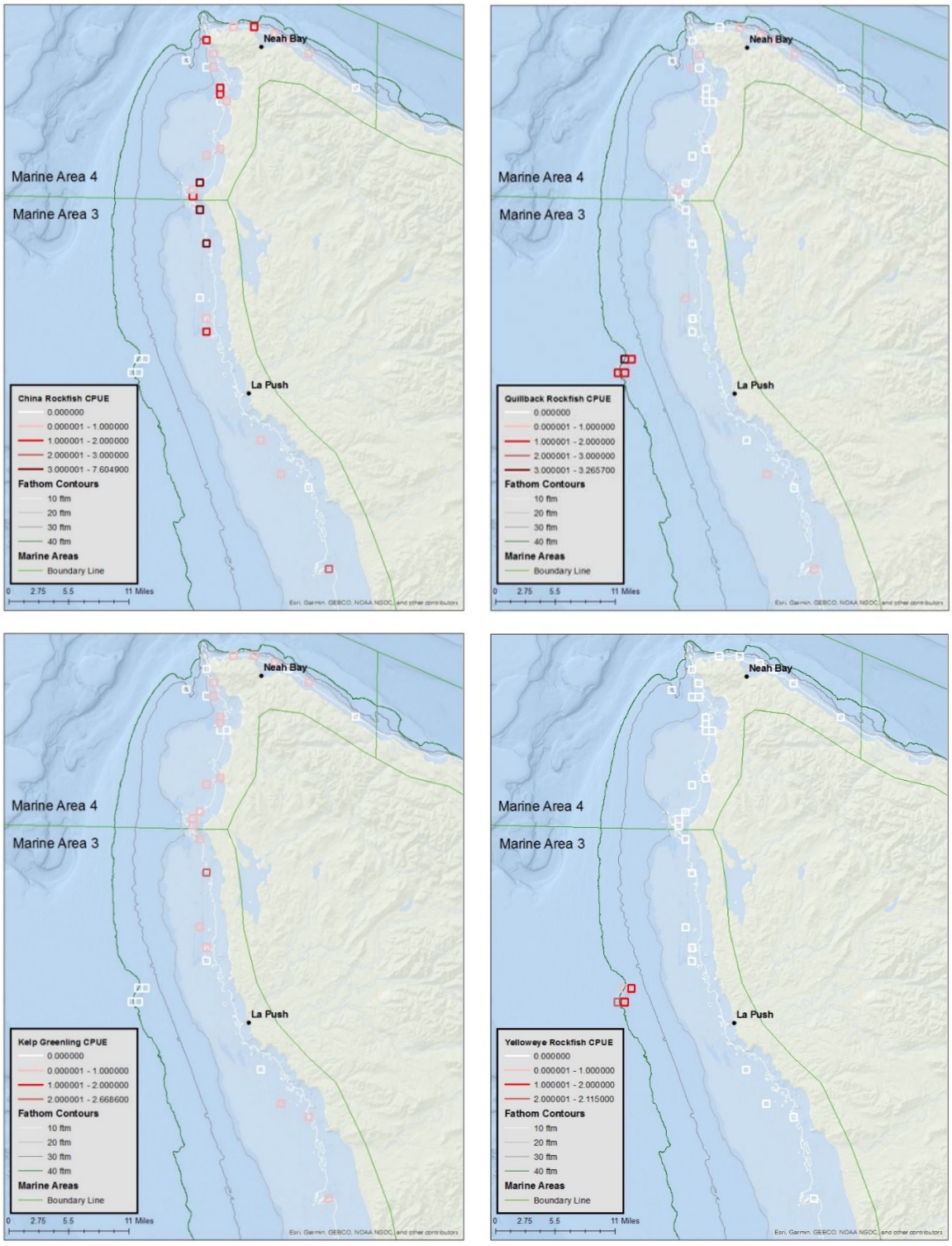


Figure 8: 2018 fall selected survey stations (1 km grid cells) and catch per unit effort (CPUE) of select target species. CPUE is reported as the total number of individuals captured per rod hour (aggregated individual angler fishing time) at each station.

Rod and reel survey data spanning from 1998 to the spring of 2018 was used to confirm the presence of demersal rockfish habitat within a grid cell. For each target species, a grid cell was determined to have known habitat when at least one target species individual had been captured in

the cell in a previous survey. Stations were then chosen along the Washington Coast roughly relative to the amount of known habitat for each target species by Marine Area and depth. Care was taken to evenly distribute chosen stations spatially within each marine area and depth bin. Stations were selected to include both marginal and superior habitat locations for each target species based on catch rates from previous WDFW rod and reel surveys.

Other method changes from the 2018 Black Rockfish Survey included a terminal tackle change to a salmon mooching rig baited with a white worm and all angler fishing effort was done on or near the bottom; schools of fish in the water column were not targeted. Also, in order to address data gaps in age structure collections from the coastal recreational fishery, any rockfish, Kelp Greenling, Lingcod, or Cabezon on the extremes of the known size distribution was sacrificed and a length, sex, and age structure (otolith or Lingcod fin) were collected. All other data collection and fishing effort methods were kept consistent with the spring survey described above.

Thirty-two stations in Marine Area 3 and 4 were successfully surveyed in September. Sixty minutes of total fishing time was spent at all successful stations allowing for the completion of 4-5 stations per charter day. All fishing effort was conducted unanchored and drift speeds ranged from 0.1 to 1.1 knots. Total angler rod hours at surveyed stations ranged from 4.2 to 4.9 rod hours (Figure 9).

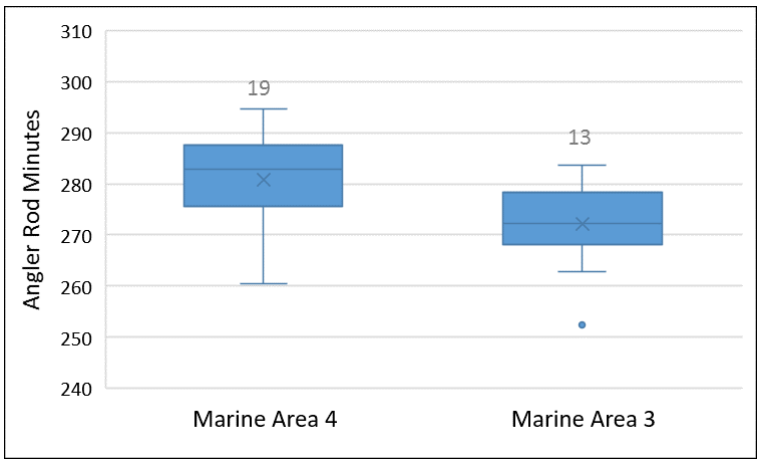


Figure 9: Box-whisker plot representing median, IQR, and minimum/maximum values of aggregated angler rod minutes spent at each station per Marine Area. Sample size (number of stations) is shown above the upper whisker.

China Rockfish was the predominant target species captured in less than 20 fathoms and in the survey overall, while Quillback Rockfish was the predominant target species captured in waters over 20 fathoms (Table 4). Catch was diverse, with eleven different rockfish species, Cabezon, Lingcod, and Kelp Greenling represented.

Table 4: Catch (number) of all species per Marine Area and depth bin in the 2018 fall survey.

Species	Marine Area 3				Marine Area 4				Grand Total
	0-10 fathom	11-20 fathom	31-40 fathom	Total	0-10 fathom	11-20 fathom	21-30 fathom	Total	
Black Rockfish	131	95		226	77	54	28	159	385
Cabezon	7	9		16	9	7		16	32
Canary Rockfish			29	29		15	36	51	80
China Rockfish	58	12		70	27	34	6	67	137
Chinook Salmon						1		1	1
Copper Rockfish	3	4		7	5	10	1	16	23
Deacon Rockfish	15	16	2	33	6	3	3	12	45
Kelp Greenling	18	9		27	12	13		25	52
Lingcod	7	5	1	13	2	10	2	14	27
Quillback Rockfish	1	2	38	41	1	11	2	14	55
Red Irish Lord					1	2		3	3
Tiger Rockfish	1	1	1	3					3
Rock Sole						3		3	3
Yellow Irish Lord			1	1					1
Vermilion Rockfish						2	1	3	3
Widow Rockfish			3	3					3
Yelloweye Rockfish			25	25					25
Yellowtail Rockfish	14	12	54	80		7	9	16	96
Grand Total	255	165	154	574	140	172	88	400	974

The 2019 Demersal Groundfish Survey is scheduled to occur in September and October. Marine Area 2 will be added and minor method adjustments to reduce station size and further standardize survey effort will be implemented.

Toward a Synoptic Reconstruction of West Coast Groundfish Historical Removals – Understanding and quantifying the historic fishery removals from a stock is essential to generating a time series of these data, which is, in turn, a crucial input to a variety of stock assessment methods and catch-based management approaches. Estimating population-specific removals is exceptionally hard, though, especially for periods with limited record keeping, aggregation of species into market categories, and aggregation of catch by outdated or poorly described geographic area. Sampling protocols, fishery diversity, catch versus landing location, dead discards, and species identification are significant additional complications that vary across time and space, and for which the level of reporting detail can vary widely.

Given that many groundfish stocks are distributed coast-wide and a complete time series of removals is needed, there is a need to coordinate approaches across the states of Washington, Oregon, and California to confront removal reconstruction challenges and establish common practices. Both California and Oregon have attempted historical removal reconstructions and continue making necessary revisions. Washington's first attempt in reconstructing commercial landings for Lingcod and rockfish market categories was completed to support 2017 PFMC groundfish stock assessments. Efforts are continuing to reconstruct flatfish catch histories. At least one report detailing data sources and analytical assumptions, and one report providing details on the history of fishery technology and prosecution, are expected to be completed in the next two years. Additionally, significant progress has been made on a report documenting the history of the fishery, fishing technology, and harvest patterns for groundfish in Puget Sound. A definitive compendium on the topic is anticipated to be complete by 2020.

Port Sampling/Creel Surveys of Recreational Fisheries – Estimates are made for recreational harvest of bottomfish, Pacific Halibut, salmonids, and other fishes caught in marine waters on an annual basis in Washington waters. Catch composition is estimated in two-month "waves" throughout the year via angler intercept surveys (i.e., creel sampling). Effort is estimated via a phone survey, which also samples two-month waves. Staffing for angler intercept surveys, contracting of the phone surveys, and all estimation procedures are the responsibility of the Fish Management Division's Coastal and Puget Sound Sampling Units, respectively. Details on the methods and results can be obtained by contacting Wendy Beeghley (coastal; Wendy.beeghley@dfw.wa.gov), Anne Stephenson (Puget Sound; Ann.stephenson@dfw.wa.gov), or Eric Kraig (estimation; Eric.kraig@dfw.wa.gov).

III. Reserves

Marine Reserve Monitoring and Evaluation – Due to changes in program priorities and staffing limitations brought on by intensive ROV survey work since 2011, very little directed monitoring of marine protected areas and reserves has occurred in Puget Sound in recent years and no monitoring activities were conducted in 2018.

A systematic evaluation of data from SCUBA-based surveys collected between 1995 and 2010 at six sites for which sufficient data are available has been performed to evaluate reserve efficacy. When only results from short-term monitoring programs are available it can be difficult for resource managers to gauge the effects of regulatory actions aimed at long-term resource conservation. This is particularly true for species that are long-lived, slow-growing, and late to mature. For these species, demographic changes in response to management actions may be slow to manifest and difficult, or impossible, to detect over time spans of fewer than two generations. Data obtained from long-term monitoring is more likely to capture changes over time in fish communities composed of a wide variety of life spans and other life history attributes. Members of the Puget Sound MFS Unit examined a sixteen year series of dive data for long-term changes or trends in abundance, size, and distribution of several key bottomfish species. Further, they made comparisons among and between those sites surveyed that fall within marine protected areas (MPAs) and those that do not. In order to gain added perspective, data were compared to those acquired from four different scuba-based studies conducted prior to the commencement of surveys at four of the sites (Figure 10).

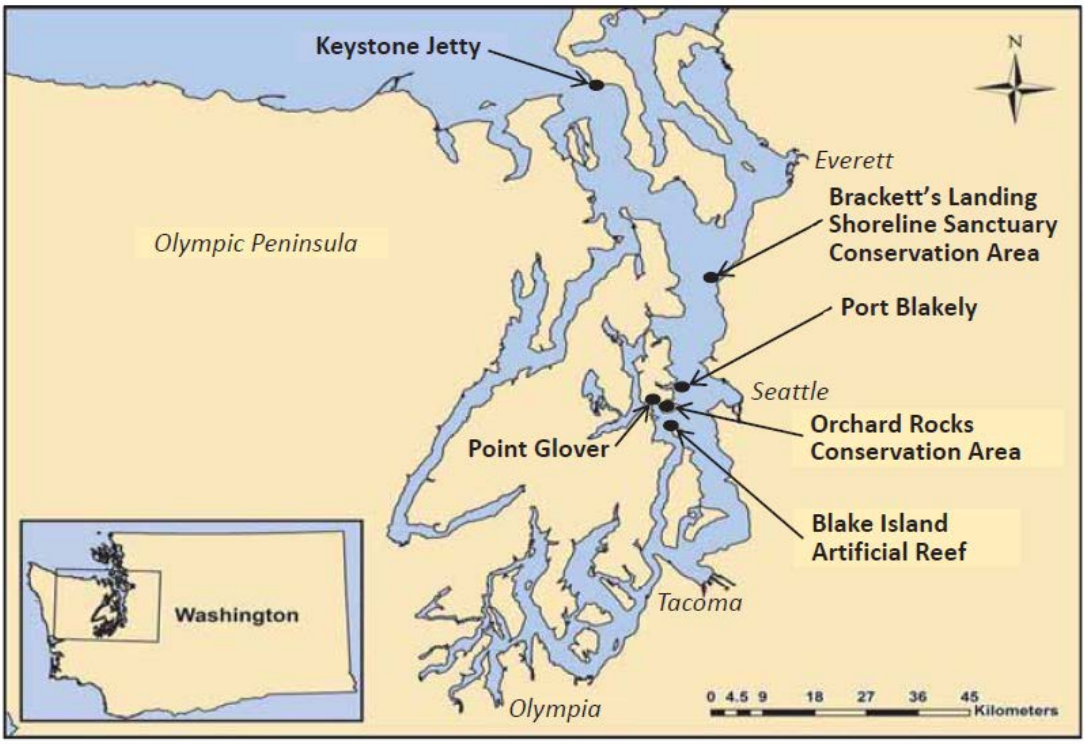


Figure 10: Locations systematically surveyed via scuba from 1995 through 2010.

At all six sites, species composition was dominated by just three taxonomic groups: rockfishes, surf perches, and greenlings, though the relative proportions of those groups varied among sites. Species richness also varied within and among groups, and within and among sties. Curiously, the greatest number of species observed was at the most heavily fished site, while the fewest number observed was at the most protected MPA. In pairwise comparisons of species composition by season (spring and fall), nearly all were significantly different both within and between sites. Though not confirmed, the data suggest that differences in species composition may occur along a latitudinal gradient. The species that contributed most to the differences between sites were Striped Seaperch, Puget Sound Rockfish, and Brown Rockfish.

At most sites, there was evidence of strong juvenile rockfish recruitment in 2006/07 for one or more of the following species: Black Rockfish, Quillback Rockfish, and Copper Rockfish. This event was made apparent by relatively high density "pulses" in length classes over time, whereby, unusually high numbers of juvenile fish enter a population and, with growth, sequentially moved from smaller to larger length-classes over time (i.e., a detectable "pulse" in length-class frequency was detected over time.)

Some have suggested that Lingcod, a high trophic-level feeder, may exert predatory top-down control over some rockfish species. We examined our data from the site where overall rockfish and Lingcod density was greatest, and where the highest density of Puget Sound Rockfish occurred. Puget Sound Rockfish rarely exceed 20 cm in length and bear fewer and less robust spines than many other rockfish species, thus they are more vulnerable to predation than larger rockfishes. We searched for inverse relationships between Lingcod and rockfish density and biomass (e.g., increasing trends in Lingcod density accompanied by decreasing trends in rockfish density). Such relationships could provide evidence that Lingcod predation is a factor in limiting rockfish

population growth. A strong relationship between Lingcod and rockfish density and biomass was not apparent.

The frequencies of occurrence of Lingcod and rockfish in the largest length-classes were greatest at the Bracket's Landing Shoreline Conservation Area, the most longstanding MPA in Puget Sound (established in 1970). However, a substantial downward trend in the density of Copper and Quillback Rockfish in the largest length classes was apparent during the first seven years of the survey period. Several potential hypotheses were considered and it appears that senescence is the most likely explanation, though poaching may be a contributing factor. Some rockfish populations are known to be dominated by a small number of year classes. Given the age and long-term protection status of fish at Bracket's Landing, it is hypothesized that a strong cohort of Copper and Quillback Rockfish reached terminal age and perished over the course of several years. The occasional occurrence of large dead Lingcod and rockfish at Bracket's Landing lends some support to this hypothesis. No dead Lingcod or rockfish were encountered at any of the other surveyed sites.

Findings were compared to studies that were conducted at four of the surveyed sites during years prior to 1995. One of the most striking contrasts was the complete absence of Lingcod noted at Bracket's Landing during surveys conducted in 1975/76. From 1995-2010, Lingcod frequency of occurrence at Bracket's Landing was 100%. Furthermore, the annual mean lengths for Lingcod were greater at Bracket's Landing than at any other site surveyed. All four of the comparable studies indicate changes over time in rockfish species composition.

The informative perspective on the recent status of several key bottomfish species at six nearshore sites in central Puget Sound in this report will serve as an important benchmark for future surveys. However, the ability to identify and interpret trends over time, particularly for rockfishes, was confounded by factors such as high interannual variability in juvenile recruitment, poorly understood post recruitment inter- and intraspecific interactions, and, at some sites, discontinuous sampling and changes in protection statuses. *In comparing MPA sites to non-MPA sites, we were not able to discern any trends that could be unequivocally linked to harvest management actions, though at least two observations suggest evidence of a protection response.* First, at the Orchard Rocks Conservation Area, subsequent to the year (1998) that it was afforded MPA status, a persistent increase in rockfish density and biomass occurred. Second, the mean length, density, and biomass of Lingcod at the Keystone Conservation Area increased after the year (2002) that it was afforded MPA protection. Unlike rockfishes, which typically grow at substantially slower rates in Puget Sound, Lingcod grow rapidly, particularly during the first several years of their life. The rapid growth, and accompanying rapid increase in fecundity, of Lingcod makes it a potentially valuable first-response species for detecting positive effects of conservation efforts.

Based on the findings of this evaluation, the Puget Sound MFS Unit recommends that surveys be resumed at an interval coinciding approximately with two elapsed generations for key species and, this recommendation is currently under review by management.

IV. Review of Agency Groundfish Research, Assessment, and Management

A. Hagfish

The Washington Hagfish Commercial Fishery – Opened in 2005 under developmental regulations, the Washington hagfish fishery is small in scale, exporting hagfish for both frozen and live-fish food markets in Korea. Management of the Washington hagfish fishery is challenged by a

lack of life history information, partial fishery controls, and high participant turnover. Active fishery monitoring and sampling began in 2009. Due to limited agency resources, only fishery dependent data programs have been developed to inform management, including logbooks, fish receiving tickets, and biological sampling of catch. Efforts have been undertaken to refine and improve these programs, including improving systematic sampling, developing species composition protocols, and shifting to use the maturity scale developed by Martini (2013). The time series using this scale now supports evaluation. Interest remains in conducting a study similar to research conducted in California to evaluate escapement relative to barrel dewatering-hole size but funding sources have not been identified.

The Washington hagfish fishery operates by rule only in offshore waters deeper than 50 fathoms and is open access. Figure 11 presents annual landings since 2000, but no update was available in 2018. Landings do not necessarily represent where fishing occurred. Washington licensed fishers can fish federal waters off Oregon and land catch into Washington. Live hagfish vessels typically fish grounds closer to their home ports, while at-sea freezing allows some vessels to fish further afield. The fishery catches predominantly Pacific Hagfish. Occasionally, Black Hagfish are landed incidentally. A few trips attempting to target Black Hagfish were successful but the market was not receptive. Landings data cannot distinguish between species as only one code exists. Hagfish are caught in long-lined barrels constructed from olive oil or pickle barrels modified with an entrance tunnel and dewatering holes (Figure 12).

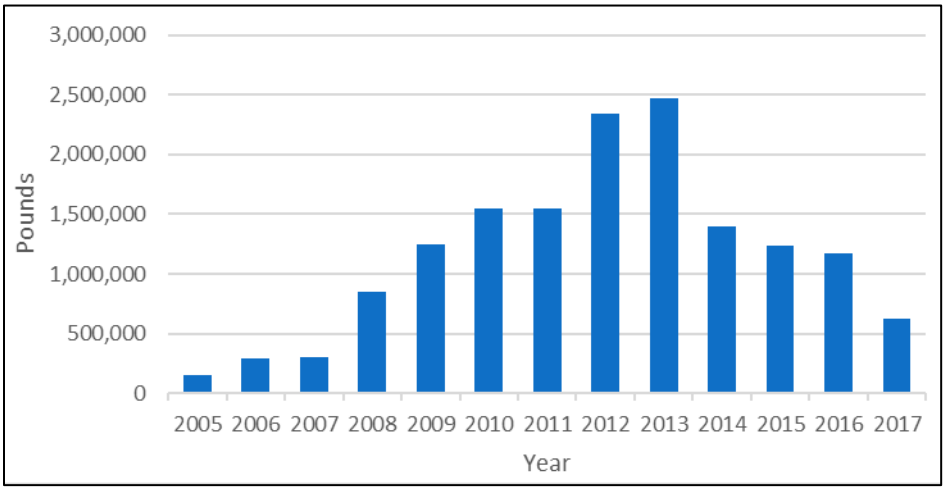


Figure 11: Hagfish Landings in pounds by Washington 2005-2017

Fishing occurs on soft, muddy habitat along the entire outer coast of Washington and northern Oregon (Figure 13). Pacific Hagfish predominate from 50-80 fa. Deeper sets, up to 300 fa, have been made to target Black Hagfish. Pacific and Black Hagfish ranges appear to overlap between 80 and 100 fathoms. Median CPUE is about 4.5 pounds. Instances of high CPUE are evident, as evidenced by reports of “plugged” barrels.

Length, weight, and maturity data have been collected from Pacific and Black Hagfish; however, only Pacific Hagfish data are reported here. Male and female hagfish present similar size distributions (Figure 14). The in-sample largest specimen was a 72 cm male, the smallest 19 cm of unknown sex. An evaluation of maturity suggests year-round spawning. Fecundity is low, with the number of mature eggs rarely exceeding 12. Few females with developed eggs have been sampled.

Figure 12: Barrels used in the WA commercial hagfish fishery.

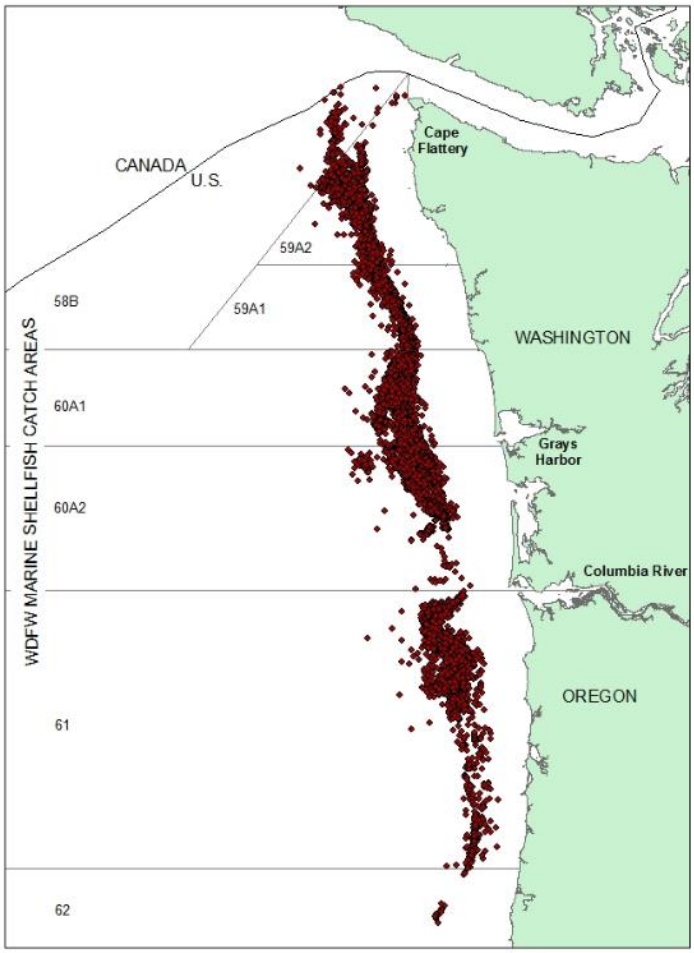


Figure 13: Distribution of Hagfish fishing trips off WA and OR, from Washington logbooks, 2005-2017.

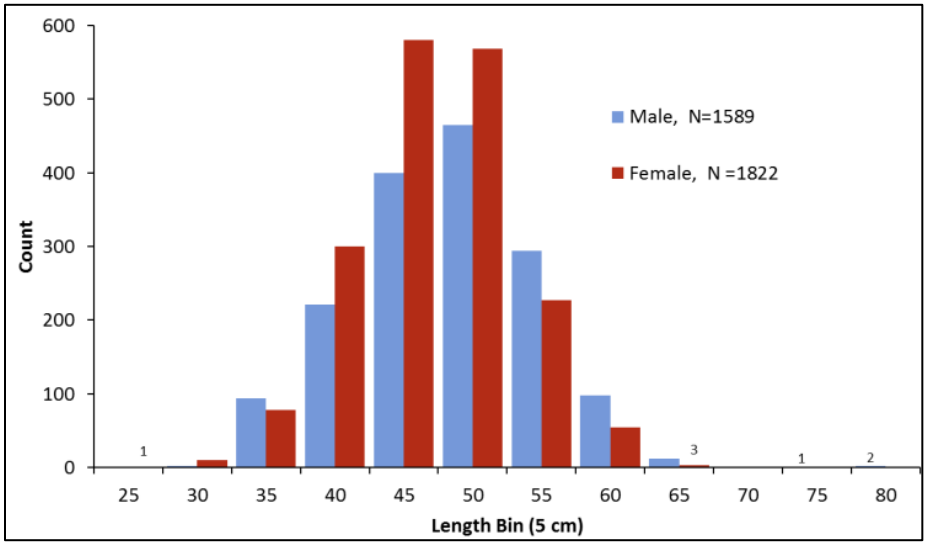


Figure 14: Length (cm), male and female Pacific Hagfish only, 2005-2014.

B. North Pacific Spiny Dogfish and other sharks

Lummi Nation Dogfish Fishery in Northern Puget Sound – Directed commercial fishing for North Pacific Spiny Dogfish was formally closed in Puget Sound in 2010 to protect ESA-listed rockfishes (Canary Rockfish, Yelloweye Rockfish, and Bocaccio) and their habitats. This included both State-sponsored and Tribal commercial fisheries. Prior to this closure, annual Sound-wide State harvest was below 500k lbs since 1997, though harvests as large as ~8.6M lbs once occurred (1979). By contrast, dogfish harvest in Puget Sound by Native American tribes peaked in 1996 at 159k lbs.

In 2014 the Lummi Nation initiated a directed drift- and set-gillnet fishery for dogfish in their Usual and Accustom Fishing Ground in northern Puget Sound (predominantly Birch Bay and Lummi Bay), which continue until 2017. The annual harvest quota for this fishery was set at 250k lbs for the entire period of operation, and harvest occurred predominantly from May-August, involved little to no reported bycatch, and closed each season as fishers transition to targeting salmon in the fall. Landings since 2014 are shown below (Table 5) and are typical of a short-term, opportunistic fishery. The fishery did not occur in 2018 as "catchers were having trouble finding markets," however a fishery may occur in 2019 again as product testing and marketing of a smoked fillet product is currently underway.

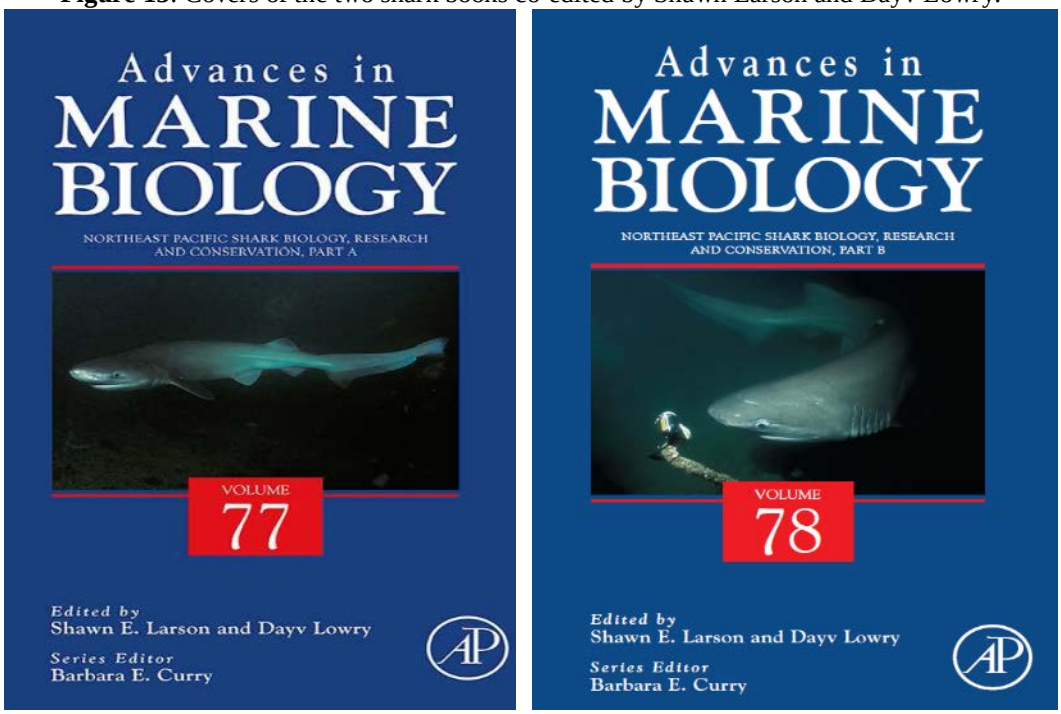
Table 5: Landings of Spiny Dogfish by the Lummi Nation since 2014.

Year	Landings (thousands of lbs)
2014	160
2015	219
2016	263
2017	87

Books Entitled <u>North Pacific Shark Biology, Research, and Conservation</u> – Together with Dr. Shawn Larson of The Seattle Aquarium, Dayv Lowry co-edited a pair of books entitled <u>Northeast Pacific Shark Biology, Research, and Conservation, Part A and Part B</u> (Figure 15), which were published in late 2018. In addition to co-editing the books Dayv also co-authored the introduction to

each volume and was the sole author of the conclusions chapter in Volume 78. The concept for the books grew out of a biennial meeting on cowshark research and management that began in 2004 and eventually morphed into the Northeast Pacific Shark Symposium (NEPSS). This two-day conference, the fourth of which will be held in La Paz, MX in March of 2020, is now the second largest international gathering of elasmophiles in North America, behind only the American Elasmobranch Society's annual meeting.

Figure 15: Covers of the two shark books co-edited by Shawn Larson and Dayv Lowry.



To date, chapters in the two volumes have been cited 42 times and downloaded over 2,500 times (Table 6). This citation rate is slightly low, but the download rate is well above normal and chapters have also been featured in blog postings and other social media.

Table 6: Details for chapters in both volumes of Northeast Pacific Shark Biology, Research, and Conservation.

Authors	Title (abbreviated)	Volume	Citations	Downloads
Lowry+Larson	Introduction to Volume 77	77		121
Ebert, et al.	Biodiversity, Life History, and Conservation	77	3	287
Bizzarro, et al.	Diet Composition and Trophic Ecology	77	4	320
Reum, et al.	Stable Isotope Applications for Understanding Sharks	77	2	256
Matta, et al.	Age and Growth of Elasmobranchs	77	5	109
Larson, et al.	Review of Current Conservation Genetic Analyses	77	4	288
Larson+Lowry	Introduction to Volume 78	78	1	93
Kacev et al.	Modeling Abundance and Life History Parameters	78	3	99
Grassman et al.	Sharks is Captivity: Husbandry, Breeding, Education	78	6	279
King, et al.	Shark Interactions With Directed and Incidental Fisheries	78	7	242
Mieras et al.	Economy of Shark Tourism: Ecotourism and Citizen Science	78	4	327
Lowry	Conclusion: Future of Management and Conservation	78	3	111

At the third NEPSS in March of 2018 an agreement was reached with several researchers and resource managers in Mexico to produce a third volume that will deal specifically with the biology, research, and conservation of sharks in waters of the Pacific Ocean off Mexico. Chapters for this volume are now complete and editorial review is underway. The volume will be finalized in June of 2019 and publication is expected by the end of the year.

C. Skates

West Coast Skate Stock Assessment Work – Stock assessments for Big and Longnose Skate will be completed in 2019 to support PFMC management. Three main challenges for this work are estimating historical catches by species, estimating historical discards, and establishing ageing techniques. The earliest coastal commercial skate landings in Washington were recorded in 1949, but landings were not recorded at the species level and landing conditions (wings or round) were not well documented either. Mandatory sorting requirements were not established until 2004 for Longnose Skate, and in 2009 for Big Skate. Dockside sampling for skates started in 2004. A large portion of skate caught were discarded or used for vitamin A production. However, we were not able to locate reports that can provide estimates of discards or prevalence of skates in the vitamin A fishery. Ageing for elasmobranchs can be challenging, with spines, vertebrae, and tag-based estimates often providing conflicting results. The NWFSC is investigating traditional methods vs. machine ageing in an effort to provide the necessary age data. WDFW staff are coordinating with NWFSC staff on data compilation and population modeling in Stock Synthesis.

D. Pacific Cod

No specific, directed research or management to report.

E. Walleye Pollock

No specific, directed research or management to report.

F. Pacific Whiting (Hake)

No specific, directed research or management to report.

G. Grenadiers

No specific, directed research or management to report.

H. Rockfishes

i. Research

Developing an Index of Abundance for Yelloweye Rockfish Off the Washington Coast – Yelloweye Rockfish was declared overfished by the PFMC in 2002 and since has been a "choke species" limiting groundfish fishing opportunities along the U.S. west coast. One of the many challenges in monitoring and managing this stock is the lack of adequate fisheries-independent surveys. The conventional bottom trawl survey does not consistently sample Yelloweye Rockfish habitat; and the only survey used in the past assessments was the International Pacific Halibut Commission's fixed-station setline survey. For Yelloweye Rockfish caught by the IPHC survey off the Washington coast, more than 90% were from one single station off Cape Alava and the minimum size was 40 cm (older than 10 years old). The abundance trend derived from the IPHC survey is uninformative for the population in Washington waters, thus the need for another survey.

Since 2006, the Washington Department of Fish and Wildlife has been conducting pilot projects to identify the best location, season, and hook-size for constructing a representative Yelloweye Rockfish abundance index trend. Working together with Jason Cope from NOAA's FRAM Division, the CMFS Unit has conducted pilot projects, compared abundance trends, and is working toward future research recommendations. Surveys continued in 2018 as noted above in the Surveys section (due to captures of more than just Yelloweye Rockfish).

ROV Studies of Yelloweye Rockfish in the greater Puget Sound/Georgia Basin DPS – The PSMFS Unit completed a two-year survey of the U.S. portion of the Yelloweye Rockfish and Bocaccio DPSs in January 2017 (see previous TSC reports for preliminary results). Survey stations where Yelloweye Rockfish were observed were prioritized to enable a population estimate for the species to be made as soon as possible. No Bocaccio were encountered at any survey station, though four fish were noted during "exploratory" deployments. Video review of these transects is on-going, with the majority of the remaining videos containing few or no fish of interest.

In March and April of 2018, the WDFW conducted a three-week survey in a portion of the Yelloweye Rockfish and Bocaccio DPSs lying in Canadian waters of the Gulf Islands within the southern Strait of Georgia. The goals of this survey were to: 1) estimate the population size of Yelloweye Rockfish (and Bocaccio as possible) within the survey area; and 2) utilize a stereo-camera system to collect accurate length information of Yelloweye Rockfish, which is needed for the length-based spawner-per-recruit (SPR) model that will be used as a basis for tracking recovery of the species per the conditions of the federal Recovery Plan. The survey was designed using the same Maximum Entropy (MaxEnt) modelling approach as the 2015-16 Puget Sound survey. The model was developed by Bob Pacunski with data provided by Dana Haggarty (DFO Canada). Funding for the survey was provided by NOAA (Dan Tonnes). A total of 64 transects were completed over 13 sampling days. Yelloweye rockfish were scarce in the southern portion of the survey area, but encounters increased as sampling moved northward. Preliminary review of the video identified at least 49 Yelloweye rockfish, but additional fish may be detected during the full video review process. No Bocaccio were observed during the survey. Initial review of the video transects is nearly complete but will require secondary reviews prior to data analysis.

In August 2018, the WDFW conducted a three-week survey of the San Juan Islands, which lies within the US portion of the DPSs for Bocaccio and Yelloweye Rockfish, with a total of 60 transects completed over 13 sampling days. This survey had the same goals and sampling design as the survey of the Canadian Gulf Islands and was meant to facilitate cross-border comparison of rockfish prevalence and size distribution. Consistent with previous ROV surveys of the San Juan Islands in 2008 and 2010, Yelloweye Rockfish were seldom encountered, with only 11 fish observed on eight transects. Canary rockfish were rarely encountered in the 2008 and 2010 surveys, but 33 fish were seen on eight transects in the most recent survey. No Bocaccio were seen in this survey. Initial review of the video transects is nearly complete but will require secondary reviews prior to data analysis.

In October 2018, the WDFW partnered with DFO Canada to conduct a 14-day survey of the southern and central Strait of Georgia. This survey utilized the WDFW-owned ROV deployed from the 40-m long Canadian Coast Guard Ship Vector. The primary goals of this survey were to 1) evaluate densities of "inshore rockfish", as defined by DFO, inside and outside established Rockfish Conservation Areas; and 2) use a stereo camera system to obtain length measurements of Yelloweye Rockfish that will be used in population recovery models. This survey was also designed

based on the results of a MaxEnt habitat suitability model. The majority of stations were randomly assigned to High probability polygons inside and outside of selected RCAs, but is some cases it was necessary to hand-place stations due to a lack of matching habitat outside of an RCA. A total of 85 transects were completed in 14 survey days. The habitat in this survey was characterized by high densities of sponges, which provided a highly-complex and crevice-rich environment utilized by several rockfish species. In contrast to the previous two surveys, Yelloweye Rockfish were commonly encountered, with over 200 fish of all sizes observed during the survey. No Bocaccio were seen in this survey. Reviews of the transect videos have just started are being conducted jointly by WDFW and DFO, with the bulk of the effort provided by DFO.

ii. Management

Participation in the Federal Rockfish Technical Recovery Team – Since 2012 Dayv Lowry and Bob Pacunski have served on NOAA's Rockfish Technical Recovery Team, which was charged with developing a detailed recovery plan for the three ESA-listed species (Canary Rockfish, Yelloweye Rockfish, and Bocaccio) in Puget Sound and the Strait of Georgia. The team held its last official meeting on February 27th, 2017 and then dedicated itself solely to finalization of a recovery plan. On March 24th, 2017 NOAA Fisheries finalized the removal of Canary Rockfish from the Federal List of Threatened and Endangered Species, (82 FR 7711) and the draft plan was revised to recognize these significant changes. The final recovery plan was released by NOAA's Office of Protected Resources on October 13th, 2017 and implementation is now underway. Research and educational outreach elements of this plan are presented elsewhere in this report.

As various kelp species may serve as habitat for ESA-listed rockfishes, NMFS, the Northwest Straits Initiative, the Puget Sound Restoration Fund, the WDFW, the Washington State Department of Natural Resources, and various other regional partners have embarked on development of a kelp assessment and recovery plan for the Southern Salish Sea as a complement to the rockfish recovery plan. Information on historic and current kelp distribution and abundance have been compiled, stressors and threats identified, and an initial draft plan is under review. Completion of the plan is anticipated in 2019 and Puget Sound MFS Unit staff (Lowry, Pacunski) are serving on a research advisory committee to help with prioritization of proposed research to fill critical management gaps.

Completion of Report to Washington State Legislature Regarding Research Funded by the Rockfish Research Fund – In 2007 the Washington State Legislature approved House Bill 1476, creating a Rockfish Research Account (RRA) to increase monitoring of rockfish abundance and distribution in state waters. This bill was needed as a result of the significant decline in the past half century of many rockfish species residing in Washington marine waters. Progressively from 1999, seven rockfish species were federally designated as "overfished" on the West Coast, followed in 2010 by the listing of three species in Puget Sound and the southern Strait of Georgia under the federal Endangered Species Act (ESA).

Funded by surcharges on commercial and recreational fishing licenses, revenues from the Rockfish Research account have helped the WDFW to greatly expand its understanding of these vulnerable marine fish. The Department, in collaboration with diverse partners, has realized significant achievements that otherwise could not have been accomplished. These achievements include rebuilding of six federally declared overfished rockfish species on the coast, and delisting of an ESA listed species, Canary Rockfish, in Puget Sound.

Since 2008, WDFW has reported to the Legislature every other year on the status of rockfish stock assessment research and fishery management efforts. In March of 2019 the latest report in that series was finalized, providing an update on the current status of rockfish stock assessment capabilities, research projects conducted in FY 2016 - 2018, and future plans for research by the Department. Most of these projects and advancements have been included in past TSC reports. The periodic report was delivered to the Legislature and an offer was made to further discuss details of the report with any and all interested parties. Due to larger budget concerns and scheduling conflicts no briefing have yet been scheduled, but it is hoped that several one-on-one meetings with legislators will occur in the summer of 2019 once the Legislature adjourns. The full citation for the report is provided below and it is available digitally upon request from Theresa Tsou, Lisa Hillier, Dayv Lowry, and/or Lorna Wargo.

Education, Outreach, and Rule Changes Pertinent to Use of Descending Devices – From 2012 through 2017 the WDFW advocated the voluntary use of descending devices to return rockfish and other groundfish to the depth of capture, thus reducing deleterious effects of barotrauma. As a result of proposals solicited during the triennial fishing rule modification cycle in March 2016, the WDFW instituted a regulation that became effective on July 1, 2017 requiring that anglers fishing for bottomfish (and Pacific Halibut) from a vessel in Washington's State Waters have a descending device onboard, rigged, and ready for use. The Puget Sound Anglers and staff from NOAA's Northwest Fishery Science Center were strong partners in education and outreach efforts leading up to this rule change – providing funding to purchase devices, engaging in promotional/educational efforts to inform the public about their use, and offering up manpower to distribute thousands of descenders and educational pamphlets. In total, over 9,500 descending devices (Shelton Fish Descenders and SeaQualizers), 55,000 laminated rockfish species identification cards, and 9,000 pocket rockfish identification keychain card sets have been distributed to charter boat captains and members of the public. A set of 4'x3' signs about rockfish conservation were also posted at prominent fishing ports in 2017. Members of the MFS have also presented at over three dozen meetings of regional fishing and conservation clubs regarding the fundamentals of rockfish management and the roll that descending devices and other conservative fishing tools/practices can play.

To continue to promote the responsible use of descending devices, the WDFW is always on the lookout for novel methods to reinforce messages about their conservation benefits. In February of 2019 the Department (Lowry and Hall) worked with PSMFC (Steve Williams) to design a L'il Sucker drink holder/stabilizer to keep messages about descending device use close at hand (Figure 16). In total, 2,500 units were ordered and are currently be distributed to anglers and users of marine waters at boat shows, sportsman's' shows, and elsewhere.

Figure 16: Design of L'il Sucker promoting descending device use to reduce the effects of barotrauma on rockfishes.

I. Thornyheads

No specific, directed research or management to report.

J. Sablefish

No specific, directed research or management to report.

K. Lingcod

Preparing for a Formal Stock Assessment in Puget Sound – Over the past 2-3 years concerns have been raised by the public about Lingcod populations within Puget Sound, especially in the San Juan Archipelago and Central Puget Sound off Edmonds. Specifically, some constituents are concerned that the current management regime is not protective enough, as legal-sized fish (26-36") are hard to find after only a few weeks into the six-week season (May 1 – June 15). Though declining trends in CPUE are apparent in some regions, the issue seems largely to be a result of increased fishing pressure/effort, especially near urban centers, since 2010. In addition to the slot limit and short season noted above, the daily bag limit is one fish per angler and fishing is not allowed deeper than 120' to reduce barotrauma impacts on rockfish. The WDFW considers this a highly conservative management regime.

The WDFW is taking steps to evaluate Lingcod populations using a Stock Synthesis model, which is a size and age-structured population assessment tool. This type of model is commonly used for coastal fisheries and is data intensive. The model structure for Puget Sound Lingcod utilizes commercial and recreational landings, length frequency data, age data, and catch-per-unit-effort data to evaluate historic and current trends in the population. When complete, managers will be able to use the output from the Stock Synthesis model to inform management decisions for Lingcod in

Puget Sound. The recreational rule change cycle in Washington considers changes to marine fisheries only every third year, with 2019 being the next applicable annum.

L. Atka mackerel

No specific, directed research or management to report.

M. Flatfishes

No specific, directed research or management to report.

N. Pacific halibut & IPHC activities

Disagreement Regarding Permitted Activities has been Resolved – In 2010 the Puget Sound/Georgia Basin distinct population segments of three species of rockfish were listed under the federal Endangered Species Act. As a result, action immediately began to: 1) close several commercial fisheries with the potential to bycatch these species; and 2) ensure all remaining State-level fishery activities in the region were appropriately permitted. In 2012 a five-year Section 10(a)1(A) permit was issued to cover recreational bottomfish hook-and-line and shrimp beam trawl fisheries in Washington waters affected by the listing. In 2017 this permit was up for reassessment and renewal. After consultation with NOAA Fisheries, MFS Unit staff revised the Incidental Take Permit Application and Fishery Conservation Plan associated with this permit to include recreational and commercial shrimp pot fisheries, for which recent research had demonstrated a very small risk of bycatch for listed rockfish species. All documentation for permit renewal was submitted to NOAA well in advance of the October 2017 renewal deadline.

Unfortunately, during the term of the initial permit, a regulation change had been made regarding the prosecution of recreational Pacific Halibut fisheries in Puget Sound. Specifically, on halibut fishing days in Marine Catch Area 6 (the eastern Strait of Juan de Fuca, from Low Point to Port Townsend) it was made permissible to retain Lingcod and Pacific Cod from waters deeper than 120'. The 120' depth restriction was put in place for all bottomfish fisheries in 2010 (Pacific Halibut are not bottomfish as defined by Washington Administrative Code), and was a conservation measure considered when evaluating bycatch levels associated with recreational fishing for the original Section 10 permit. NOAA Fisheries viewed any and all harvest of Lingcod and Pacific Cod during this fishery as a potential violation of the Section 10 permit, while the WDFW's Intergovernmental Ocean Policy Unit contended that such harvest was being duly reported on the permit covering Pacific Halibut fisheries, thus all potential risks to ESA-listed rockfish were being adequately accounted for.

In March of 2019 the WDFW agreed to eliminate Lingcod retention in the Pacific Halibut fishery in Marine Catch Area 6, removing the threat of targeted fishing over rocky habitat. This decision was arrived at after considering the increased Pacific Halibut quota for 2019, and thus the potential for increased exposure duration of deep-water rockfish to fishing pressure during the targeted halibut fishery. A final decision regarding renewal of the Section 10 permit has not been reached, but recreational bottomfish fisheries, shrimp beam trawl fisheries, and recreational/commercial shrimp pot fisheries occurred as scheduled in 2018 and 2019. The process of permit renewal is now back on track and moving forward in a timely manner.

Participation in Puget Sound Leg of Annual IPHC Survey – Each year the IPHC performs a coast-wide, extensive longline survey of Pacific Halibut abundance. In most years, fishing is focused on the outer coast of Washington and does not occur east of the Bonilla-Tatoosh line. In

some recent years, however, the IPHC, NOAA, and the WDFW have coordinated to sample stations inside Puget Sound, as far south as the waters off Tacoma.

In August of 2018 Dayv Lowry participated in the IPHC survey for four days as they fished stations from Port Townsend to Tacoma. Details on catch are provided in the IPHC report, with numerous halibut but zero rockfish caught. An event worth noting was the encounter of several dozen 200+ cm Sixgill Sharks at a station south of Maury Island, off Tacoma. This represented more sharks than observed by all other methods (trawl, scuba, public reports) over the last 8 years in Puget Sound. As a result of this high encounter rate, the WDFW is currently coordinating with the Monterey Bay Aquarium to put pop-up satellite archival tags on Sixgills Sharks in 2020. This is a fine example of inter-agency coordination prompting academic research that will enhance knowledge about fundamental aspects of marine fish biology and behavior.

O. Other groundfish (and forage fish) species

Pacific Sand Lance Genetic Research – Together with partners at the NWFSC, Shoreline Community College, Sea Doc Society, Washington State DNR, North Pacific Research Board, and UW's Friday Harbor Labs members of the PSMFS Unit and MFF unit are working to investigate regional variation in population structure of Pacific Sand Lance. Samples have been collected from the San Juan Archipelago, Eagle Harbor (Bainbridge Island), and Nisqually River delta thus far, and additional collections are planned. Fish have been obtained via beach seining and digging on mud flats during low tide. Thus far, amplification of the DNA has gone well, and is being overseen by the Shoreline Community College molecular genetics lab. Preliminary results are expected by early 2020.

Other species – No addition directed research or management to report. Various species of groundfish are counted, and density and abundance estimates are derived for them, during ROV, scuba, and trawl surveys described above and below.

V. Ecosystem Studies

Puget Sound Ecosystem Monitoring Program (PSEMP) update – The Toxics-focused Biological Observation System (TBiOS) team at WDFW has been conducting regular status and trends (S&T) monitoring of toxic contaminants in a wide range of indicator species in Puget Sound, including assessments of health effects on biota, since 1989. TBiOS' most recent regular S&T monitoring includes assessments of English sole (a benthic indicator) in 2015, 2017, and 2019, and Pacific herring (a pelagic indicator) in 2014, 2016, and 2018. In addition, TBiOS recently conducted a large-scale assessment of contaminants in winter adult Chinook salmon (i.e. Blackmouth) from sport fisheries in seven marine areas of Puget Sound (winter 2016/17). Data from the Blackmouth study was used by the Washington Department of Health to set fish consumption advisories for this species in Puget Sound. Data from the English sole, Pacific herring, and Blackmouth studies are summarized online at the Puget Sound Partnership's Toxics in Fish Vital Sign website. The Toxics in Fish Vital Sign is a communication tool that helps distill TBiOS' complex contaminant monitoring information into usable metrics for ecosystem recovery managers.

In addition to benthic and pelagic indicator species, TBiOS has recently adopted two new indicators for assessment of contamination in the *nearshore* environments of Puget Sound. To ascertain the effects of contaminants on early the life-stages of salmon, TBiOS conducted two assessments (2016 and 2018) of juvenile Chinook salmon from 12 major rivers and deltas of Puget Sound. In addition,

TBiOS recently adopted mussels as a nearshore indicator and has conducted three, Puget Sound-wide, assessments of contaminants using transplanted (i.e. caged) mussels over the winters of 2012/13, 2015/16, and 2017/18. TBiOS has secured long-term funding to conduct regular nearshore contaminant surveys with these species into the future.

TBiOS has also conducted a number of special studies in recent years. For instance, in 2012 they conducted a large-scale assessment of contaminants in Dungeness crab and spot prawn from nine marine areas and three urbanized bays of Puget Sound. This data was used by the Department of Health to set shellfish consumption advisories for these species. In addition, TBiOS has conducted several recent studies to track the effectiveness of large-scale removals of creosote-treated wooden pilings (Port Gamble Bay 2014 and 2015, and Quilcene Bay 2012-2015). In these studies, TBiOS used Pacific herring embryos, a particularly sensitive life-stage, to test for ecological impacts of chemicals leaching out of the pilings. Publications and reports for a number of these studies are available at the TBiOS list of publications website, as well as at the aforementioned Toxics in Fish Vital Sign website. For additional details on TBiOS research regarding toxic contaminants in Puget Sound biota contact Jim West at james.west@dfw.wa.gov or 360-902-2842.

Derelict gear reporting, response, and removal grant funding – Marine fish mortality associated with derelict fishing gear has been identified as a threat to diverse species around the world. In Puget Sound, removal of derelict fishing nets has been the focus of a concerted effort by the Northwest Straits Foundations since 2002. In late 2013 the Washington State Legislature granted $3.5 million to the Foundation to "complete" removal of all known legacy fishing nets in waters shallower than 105 ft and this effort was finalized in 2015. In August of 2015 a celebration ceremony was held to recognize these extensive efforts to remove 5,660 fishing nets from the Sound and restore 813 acres of benthic habitat. The Northwest Straits Foundation and the PSMFS Unit then moved on to pilot methods to remove several deep-water nets using an ROV instead of scuba divers. A manual was developed detailing the pros and cons of various approaches to retrieve these nets and funding is now being sought to aggressively go after these remaining nets.

In 2012 a reporting hotline was developed, and a rapid response and removal team was formed, to prevent the accumulation of additional fishing nets due to loss during ongoing and future fisheries. Because these nets are a direct threat to ESA-listed rockfish, in 2014 WDFW and the Foundation were able to obtain Section 6 funding to continue hotline service and ensure support for the response team through 2017, followed by a one-year grant from the Puget Sound Restoration Fund to continue the work through 2018. Combined with the legislative grant money mentioned above, these funding sources allow the WDFW and Foundation to remove old nets, stay informed about newly lost nets, and remove new nets to minimize/eliminate this threat to rockfish, and the ecosystem at large. To date reports for several dozen nets have been responded to, resulting in the removal of 27 free-floating nets, 31 sunken/entangled nets, and ample opportunity for public outreach regarding when nets are derelict and when they are legally fishing. Funding has now been secured through the Puget Sound Marine and Nearshore Grant Program administered by the WDFW to continue this work through at least June of 2019, at which time funding from the National Fish and Wildlife Foundation will provide support through 2021.

VI. Publications

Andrews, KS, Nichols, KM, Elz, A, Tolimieri, N, Harvey, CJ, Pacunski, R, Lowry, D, Yamanaka, KL, and DM Tonnes. (2018). Cooperative research sheds light on the listing status of threatened and endangered rockfish species. Cons Genetics. Online.

Drinan, DP, Gruenthal, KM, Canino, MF, Lowry, D, Fisher, MC, and L Hauser. (2018). Population assignment and local adaptation along an isolation-by-distance gradient in Pacific cod (Gadus macrocephalus). Evol Applications. 11(8): 1-17. https://doi.org/10.1111/eva.12639.

Duguid, WDP, Boldt, JL, Chalifour, L, Greene, CM, Galbraith, M, Hay, D, Lowry, D, McKinnell, S, Qualley, J, Neville, C, Sandell, T, Thompson, M, Trudel, M, Young, K, and F Juanes. (2018). Historical fluctuations and recent observations of Northern Anchovy Engraulis mordax in the Salish Sea. Deep Sea Research II. Online.

LeClair, L, Pacunski, R, Hillier, L, Blaine, J, and D Lowry. (2018). Summary of findings from periodic scuba surveys of bottomfish conducted over a sixteen-year period at six nearshore sites in central Puget Sound. Washington Department of Fish and Wildlife Technical Report. Olympia, WA. FPT 18-04. 189 pp.

The Salish Sea Pacific Herring Assessment and Management Strategy Team. (2018). Assessment and Management of Pacific Herring in the Salish Sea: Conserving and Recovering a Culturally Significant and Ecologically Critical Component of the Food Web. The SeaDoc Society, Orcas Island, WA. 74 pp.

Sandell, T, Lindquist, A., Biondo P, Lowry, D, Dionne, P, Louden, A, Seamons, TR, Brown, S, Small, M, and S Young. (2019) Cherry Point herring age composition study (2016-2017). Washington Department of Fish and Wildlife. Prepared for Washington Department of Natural Resources. 38 pp.

Washington Department of Fish and Wildlife. (2019). 2015-2018 report to the Legislature: status of rockfish research and conservation programs: July 2015 through June 2018. Washington Department of Fish and Wildlife. Olympia, WA. 28 pp.

VII. Conferences and Workshops

In 2018-19 staff of the MFS Unit presented at, participated in research presented at, and/or arranged symposia at, several regional scientific meetings, and education/outreach events, as indicated below.

Data Limited Stock Assessment Symposium and Class. Seattle, WA, May 2018. Seven MFS Unit staff attended.

Salish Sea Fish Assemblage Workshop. Seattle, WA, September 2018. MFS Unit staff were coauthors on eight talks over two days, and were the presenters of six of these talks.

South Sound Science Symposium. Shelton, WA, October 2018. Dayv Lowry served on the Steering Committee and presented results of regional ROV survey work in Puget Sound.

Seattle Aquarium Discover Science Days. Seattle, WA, November 2018. Bob Pacunski, Jen Blaine, Lisa Hillier, Andrea Hennings, and Amanda Phillips attended and presented.

VIII. Complete Staff Contact Information

WDFW permanent marine fish management and research staff include (updated 8/2018):

Headquarters and State-wide Staff

Statewide Marine Fish Lead Theresa Tsou 1111 Washington St SE, 6th Floor Olympia, WA 98504-3150 tien-shui.tsou@dfw.wa.gov 360-902-2855	Statewide Marine Forage Fish Lead Phill Dionne 1111 Washington St SE, 6th Floor Olympia, WA 98504-3150 phillip.dionne@dfw.wa.gov 360-902-2641	Senior Forage Fish Biologist Todd Sandell 16018 Mill Creek Blvd. Mill Creek, WA 98012 todd.sandell@dfw.wa.gov 425-379-2310
Forage Fish Biologist Adam Lindquist 1111 Washington St SE, 6th Floor Olympia, WA 98504-3150 adam.lindquist@dfw.wa.gov 360-902-2704	Forage Fish Biologist Patrick Biondo 1111 Washington St SE, 6th Floor Olympia, WA 98504-3150 patrick.biondo@dfw.wa.gov 360-902-2672	Forage Fish Technician Kate Olson 1111 Washington St SE, 6th Floor Olympia, WA 98504-3150 katie.olson@dfw.wa.gov 253-569-9442
Marine Fish Biologist Lisa Hillier 1111 Washington St SE, 6th Floor Olympia, WA 98504-3150 lisa.hillier@dfw.wa.gov 253-250-9753	NPFMC Member Bill Tweit 1111 Washington St SE, 6th Floor Olympia, WA 98504-3150 william.tweit@dfw.wa.gov 360-902-2723	

Puget Sound Staff

Puget Sound Marine Fish Lead Dayv Lowry 1111 Washington St SE, 6th Floor Olympia, WA 98504-3150 dayv.lowry@dfw.wa.gov 360-902-2558	Marine Fish Research Scientist Bob Pacunski 16018 Mill Creek Blvd. Mill Creek, WA 98012 robert.pacunski@dfw.wa.gov 425-775-1311 Ext 314	Senior Marine Fish Biologist Larry LeClair 1111 Washington St SE, 6th Floor Olympia, WA 98504-3150 larry.leclair@dfw.wa.gov 360-902-2767
Marine Fish Biologist Jen Blaine 16018 Mill Creek Blvd. Mill Creek, WA 98012 jennifer.blaine@dfw.wa.gov 425-379-2313	Marine Fish Biologist Andrea Hennings 16018 Mill Creek Blvd. Mill Creek, WA 98012 andrea.hennings@dfw.wa.gov 245-379-2321	Senior Technician, Captain Mark Millard 16018 Mill Creek Blvd. Mill Creek, WA 98012 mark.millard@dfw.wa.gov 360-301-4256
Scientific Technician Amanda Phillips 16018 Mill Creek Blvd. Mill Creek, WA 98012 amanda.phillips@dfw.wa.gov 425-379-2315	TBiOS Lead Jim West 1111 Washington St SE, 6th Floor Olympia, WA 98504-3150 james.west@dfw.wa.gov 360-902-2842	Toxics Research Scientist Sandy O'Neil 1111 Washington St SE, 6th Floor Olympia, WA 98504-3150 sandra.oneill@dfw.wa.gov 360-902-2666
Toxics Biologist Rob Fisk 1111 Washington St SE, 6th Floor Olympia, WA 98504-3150 robert.fisk@dfw.wa.gov 360-902-2816	Toxics Biologist Mariko Langness 1111 Washington St SE, 6th Floor Olympia, WA 98504-3150 mariko.langness@dfw.wa.gov 360-902-8308	

Coastal Staff

Coastal Marine Fish Lead Lorna Wargo 48 Devonshire Rd Montesano, WA 98563 lorna.wargo@dfw.wa.gov 360-249-4628	Marine Fish Biologist Rob Davis 48 Devonshire Rd Montesano, WA 98563 robert.davis@dfw.wa.gov 206-605-5785	Marine Fish Biologist Donna Downs 48 Devonshire Rd Montesano, WA 98563 donna.downs@dfw.wa.gov 360-249-4628
Senior Scientific Technician Jamie Fuller 48 Devonshire Rd Montesano, WA 98563 jamie.fuller@dfw.wa.gov 360-249-1297	Senior Scientific Technician Tim Zepplin 48 Devonshire Rd Montesano, WA 98563 timothy.zepplin@dfw.wa.gov 360-580-6286	Marine Fish Biologist Kristen Hinton 48 Devonshire Rd Montesano, WA 98563 kristen.hinton@dfw.wa.gov 360-249-4628
Scientific Technician Michael Sinclair 48 Devonshire Rd Montesano, WA 98563 michael.sinclair@dfw.wa.gov 360-249-4628		
Intergovernmental Coastal Policy Manager Michele Culver 1111 Washington St SE, 6th Floor Olympia, WA 98504-3150 michele.culver@dfw.wa.gov 360-902-2182	Coastal Marine Policy Lead Corey Niles 1111 Washington St SE, 6th Floor Olympia, WA 98504-3150 corey.niles@dfw.wa.gov 360-902-2733	Coastal Shellfish and Halibut Lead Heather Reed 1111 Washington St SE, 6th Floor Olympia, WA 98504-3150 heather.reed@dfw.wa.gov 360-902-2487
Coastal Marine Policy Analyst Jessi Doerpinghaus 1111 Washington St SE, 6th Floor Olympia, WA 98504-3150 jessi.doerpinghaus@dfw.wa.gov 360-902-2675		