Washington Department of Fish and Wildlife Contribution to the 2020 Meeting of the Technical Sub-Committee (TSC) of the Canada-U.S. Groundfish Committee: Reporting for the period from May 2019-April 2020

April 23rd-24th, 2020
(CANCELLED due to COVID-19 pandemic)

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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. Lisa Hillier oversees the Unit budget, participates in various fieldwork projects, oversees the Washington Conservation Corps (WCC) survey group, and models 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, Kate Olson, Eric Bruestle, Aidan Coyle, and Stephanie Lewis. 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, Ian Craick, and Katie Kennedy. 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, Louisa Harding, 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. 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. In 2018 Lisa Hillier was added to the NPFMC Groundfish Plan Teams for both the Bering Sea and Gulf of Alaska. Bill Tweit, who reports straight to the Director of the Department, serves as a member of the NPFMC.

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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, Kristen Hinton, Jamie Fuller, Michael Sinclair, and Tim Zepplin. 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 a currently vacant lead (previously Michele Culver), Corey Niles, Heather Hall, Whitney Roberts, and Victoria Knorr. Heather serves on the PFMC's Groundfish Management Team (GMT).

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For complete staff contact information see section VIII of this report.

II. Surveys

Puget Sound Bottom Trawl

BRIEF SURVEY HISTORY, DESIGN, METHODOLOGY – 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 the mouth of the Sekiu River in the Strait of Juan de Fuca – that have provided invaluable long-term, fisheries-independent indicators of population abundance for benthic organisms 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; Blaine et al. 2020). Surveys in 1987, 1989, and 1991 were semi-stratified random surveys of the majority of Puget Sound. From 1994-97 and 2000-07, surveys were annual, stratified-random surveys focusing on individual sub-basins (WDFW unpublished data; Palsson et al. 1998; Blaine et al. 2020). 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 key species, size distribution data and various biological samples are collected from a subset of individuals from each sampling location. 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). A total of 51 fixed index stations throughout the study area are sampled each spring (late April-early June) (Figure 1).

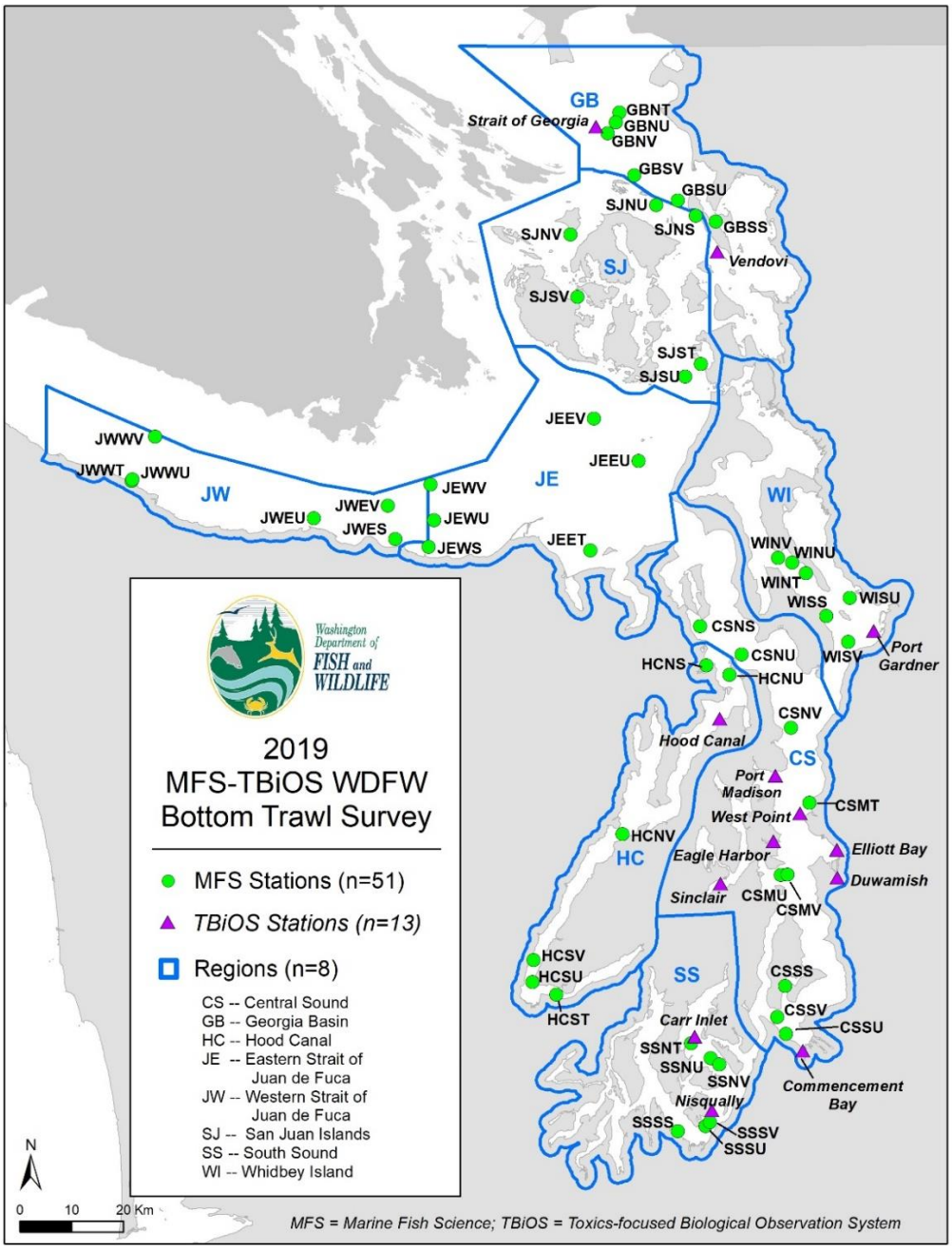


Figure 1. Trawl site locations for the index survey, sampled 2008-19. Stations CSNV and JEWU were moved several hundred yards in 2014/15 to reduce the potential for interactions of trawl gear with previously unknown submarine cables. Vessel time in 2019 was split between the Marine Fish Science (MFS) Unit and the Toxics-focused Biological Observation System (TBiOS) team, which conducts their bottom trawl survey biennially and samples 13 independent stations.

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 were moved slightly to accommodate concerns raised by fiber-optic cable companies.

The trawling procedure of the survey has remained largely consistent throughout the historical survey period 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.

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 a live data feed regarding the net's depth, proximity to the bottom, and opening height.

2019 SURVEY RESULTS – The WDFW conducted the 12th annual index trawl survey from April 22 through June 3, 2019. Vessel time was split between the PSMFS Unit and the TBiOS group, which conducts their bottom trawl survey biennially and samples separate stations. During the 15 survey days allocated to the PSMFS Unit, all 51 index stations were occupied, and a total of 53 index bottom trawls were conducted, as 2 stations required a second tow.

All Fish

An estimated 49,918 individual fish belonging to 84 species or taxa and weighing 10.2 mt were caught during the survey. Overall, the total estimated bottomfish biomass and abundance for Puget Sound was 125,670 mt and 550.6 million individuals, respectively. Compared to the estimates from the 2018 survey (96,967 mt; 582.2 million individuals), the biomass increased but the abundance decreased slightly (Figure 2). Among the regions, Central Sound (CS) again supported the highest densities of bottomfish at 571 kg/ha and 1,984 fish/ha, substantially greater than those from any other region (Figure 3). The Eastern Strait of Juan de Fuca (JE) had the second highest biomass and population densities, which were both higher than the 2018 estimates by 131% and 40%, respectively. The largest increases from 2018, though, occurred in the Western Strait of Juan de Fuca (JW), in which biomass estimates jumped 216% and abundance estimates increased 81%, primarily due to higher catches of Spotted Ratfish, but also in part due to higher numbers of several flatfish species. Other than JE and JW, the San Juan Islands (SJ) was the only other region whose biomass and abundance estimates both increased (27% and 11%, respectively), while both estimates in the Georgia Basin (GB), Hood Canal (HC), and Whidbey Island (WI) decreased.

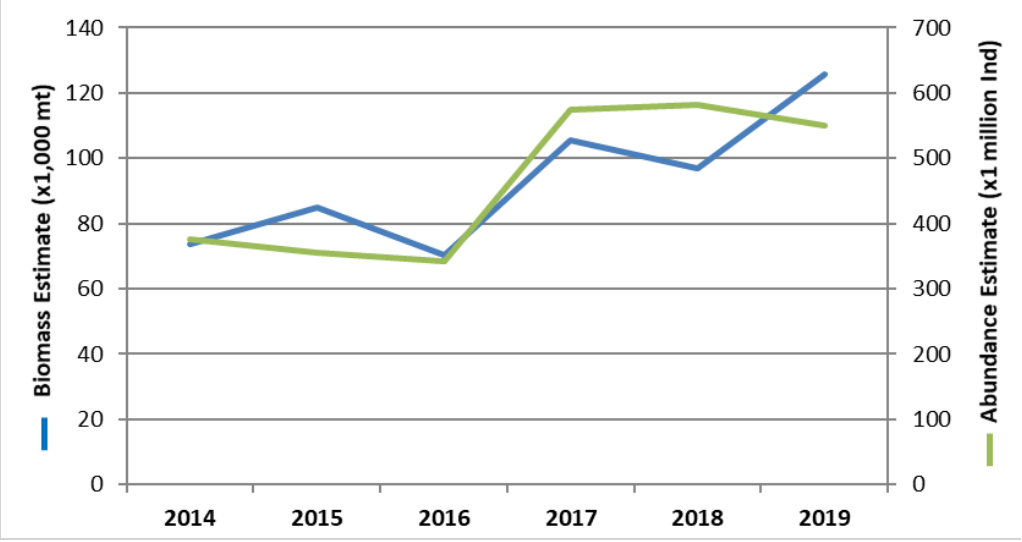


Figure 2. Estimates of bottomfish biomass (x 1,000 mt) and abundance (x 1 million individuals) throughout Puget Sound from the annual bottom trawl surveys since 2014.

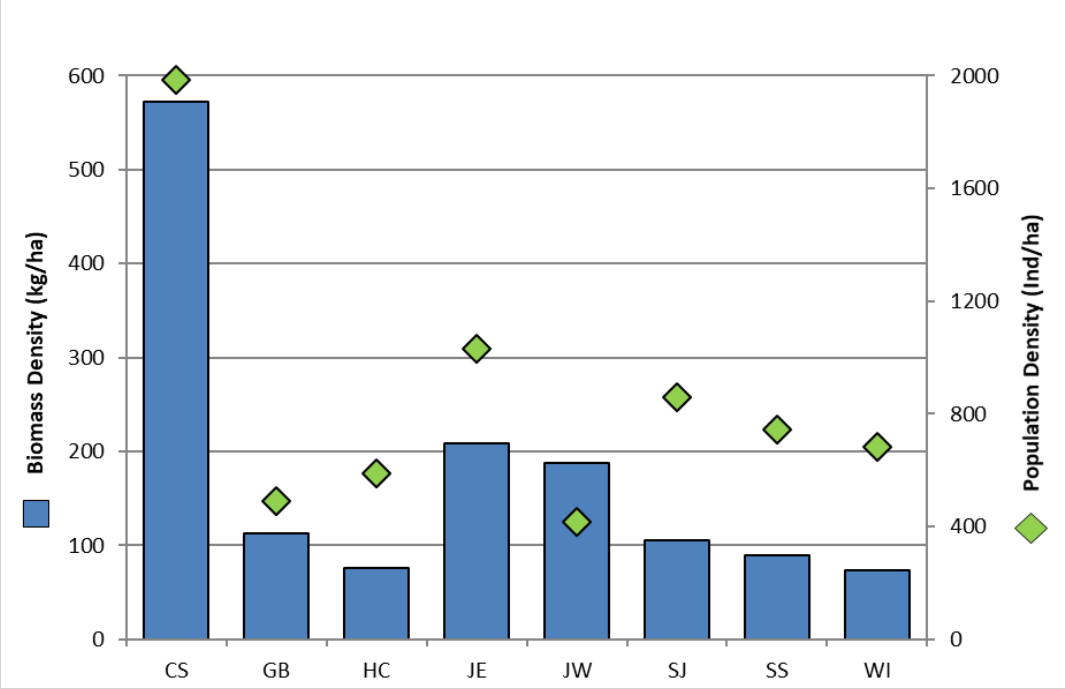


Figure 3. Estimates of bottomfish biomass density (kg/ha) and population density (ind/ha) in each of the eight regions of Puget Sound.

Similar to previous years, Spotted Ratfish dominated the catch, constituting 64% of the total fish catch by weight and 36% of the total number of individual fish, followed by English Sole at 10% and 16%, respectively. These catch rates equate to a biomass estimate of 80,798 mt for Spotted Ratfish and 11,520 mt for English Sole, and abundance estimates of 213 million and 92.8 million individuals, respectively (Figure 4). The remaining fish species contributed 4% or less to the total fish catch weight and 5% or less to the total number of individual fish (other than Walleye Pollock at 12%), and were categorized into the following species groups for comparisons: Other Flatfishes, Sharks & Skates (Elasmobranchs), Sculpins (Cottoidea), Codfishes (Gadiformes), and Other Fishes (e.g., forage fish, eelpouts). Other Flatfishes and Sharks & Skates actually had very similar biomass estimates (12,027 mt and 11,600 mt, respectively) to that of English Sole. After Ratfish and English Sole, Other Flatfishes and Codfishes had the highest abundance estimates (86.3 million and 83.7 million individuals, respectively) among the species groups. The 'Other Fish' category includes most species that the bottom trawl was not designed to target due to their size and/or behavior (including habitat preference), the most abundant of which were Blackbelly Eelpouts and Shiner Perch.

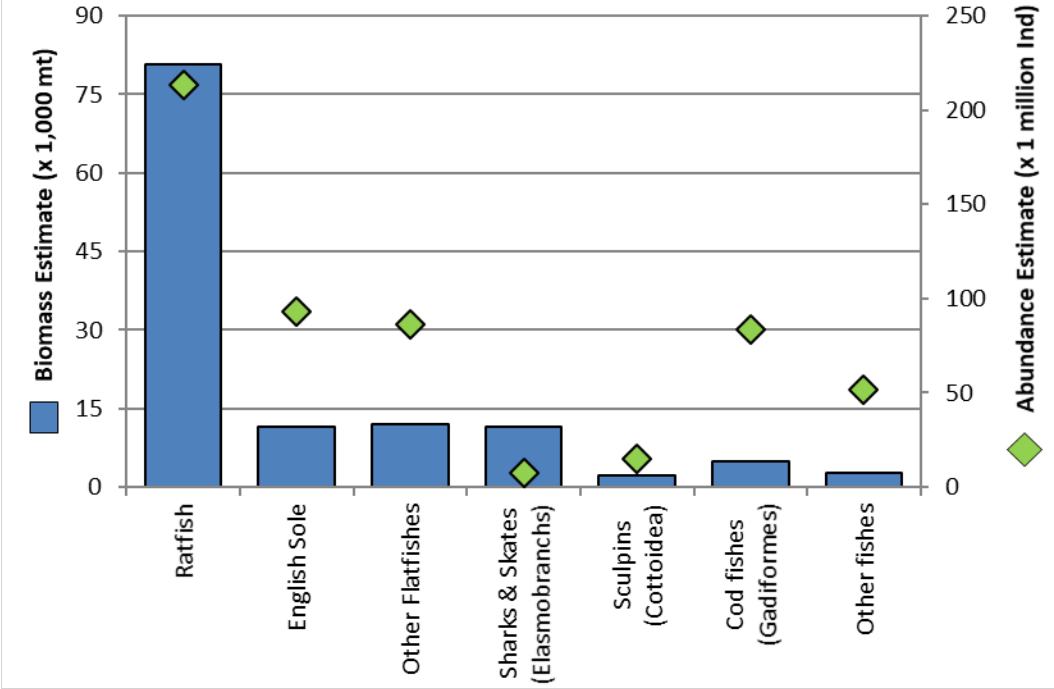


Figure 4. Estimates of bottomfish biomass (x 1,000 metric tons) and abundance (x 1 million individuals). Species were combined into groups by taxa, other than Spotted Ratfish and English Sole, the two most prominent species.

Flatfish

English Sole, as previously mentioned, were the most prevalent species of flatfish, with estimates of 11,520 mt and 92.8 million individuals (Figure 4); these estimates are over 25% lower than those in 2018. Among regions, CS supported the highest densities of English Sole at 40 kg/ha and 276 fish/ha; the smallest population was found in JW at 2.8 kg/ha and 19 fish/ha. In terms of other flatfish species, Rock Sole (3,785 mt & 24.2 million individuals), Starry Flounder (3,106 mt & 8 million individuals), and Pacific Sanddab (1,742 mt & 31.7 million individuals) were the most dominant by both weight and abundance after English Sole.

While these estimates are for all of Puget Sound, each region supported its own composition of flatfish species, although English Sole dominated the flatfish biomass in 5 of the 8 regions. Rock Sole, albeit closely followed by English Sole, comprised the largest proportion (47%) of flatfish biomass in GB; Dover Sole comprised the largest proportion (34%) in JW, and Starry Flounder (51%) did so in SS. Rock Sole also contributed 24% and 37% to SS and WI flatfish biomass, respectively, while Arrowtooth Flounder made up 25% in JW and Starry Flounder 27% in HC. Otherwise, all other flatfish species comprised 16% or less of a region's flatfish biomass. Among the regions, South Sound supported the highest biomass density of non-English Sole flatfish species at 50 kg/ha, while WI supported the highest population density at 199 individuals/ha.

Sharks and Skates (Elasmobranchs)

Compared to 2018, the 2019 North Pacific Spiny Dogfish catch was higher both in terms of individuals, with 170 dogfish caught versus 87 in 2018, and in terms of weight, with 181 kg caught versus 142 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 all eight regions, with 33% of the weight being caught in GB and 31% of the individuals caught in JE.

Brown catsharks were again caught in the survey after being caught last year for the first time since 2014. Four females ranging from 45-48 cm total length were caught; one was found in GB, one in HC, and two in WI. Genetic samples (tissue plugs) were taken, and all were kept for researchers at the WDFW and Moss Landing Marine Labs for further analysis.

Bluntnose Sixgill Sharks were caught for the first time since 2013 and were found at station SSSU, where the species had been previously caught in 2010, 2011, and 2013. Not just one Sixgill, but three, were brought up in the net. The largest shark was a female, 2.46 m long (total length); another female was 1.42 m long. The third shark was a male and 1.89 m. Decaying bits of a seal carcass also came up in the catch, so it was predicted that the three Sixgills were feeding on the carcass at depth. Fork and total lengths were taken on the sharks, as well as tissue plugs for genetics, but the sharks were too big to be weighed safely. Instead, weights were estimated based on measured total lengths using the growth rates from Williams et al. (2010).

Big Skate biomass and abundance estimates increased from the 2018 survey 168% and 73%, respectively, to 6,008 mt and 2.5 million individuals. Encounter rates of Big Skates were highest in SJ, which accounted for over 40% of the abundance, but those caught in JE comprised over 50% of the Big Skate biomass. Longnose Skate biomass estimates also increased 77% to 2,222 mt, while abundance estimates increased 58% to 2 million individuals; estimates were highest in CS and WI. Lastly, 18 Sandpaper Skates were caught in 2019, which is on par with last year's catch rate of 19. Sandpaper Skates were primarily caught in JE, but were also found in GB and SJ.

Codfishes (Gadiformes)

Pacific Cod catch increased again from last year's catch of 17 fish; 21 were caught in this year's survey, weighing a total of 20 kg. This catch rate resulted in an estimated population density of 1.7 ind/ha in JW, 1.9 ind/ha in GB, 0.18 ind/ha in CS, and 0.08 ind/ha in SJ (Figure 5). While the density in JW was similar to that from the 2018 estimates, the density in GB doubled, and it was also the first year that Pacific Cod were caught in CS since 2015. Pacific Cod caught this year ranged in size from 30 cm to 63 cm, with an average length of 43 cm and a median of 38 cm.

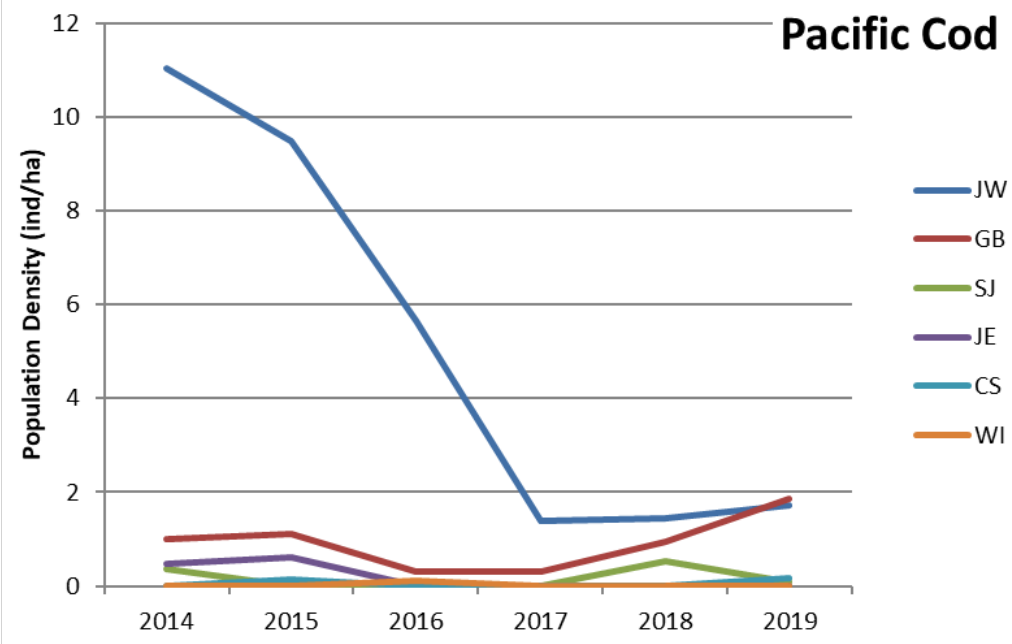


Figure 5. Population density (individuals/hectare) of Pacific Cod caught in the 2014-2019 bottom trawl surveys, by region.

Pacific Hake biomass and abundance estimates both decreased 64% from the 2018 survey to 1,152 mt and 14.6 million individuals, making this year's estimates more similar to those from 2016-2017; hake were found in all eight of the regions. Walleye Pollock also were found in all regions but saw growth in both estimates; biomass and abundance estimates increased 18% and 17%, respectively, from 2018 to 3,206 mt and 65.4 million individuals.

ESA-Listed Species

Pacific Eulachon was the only ESA-listed species encountered during the 2019 survey; 62 individuals were caught (19 in 2018, 29 in 2017) in regions GB, JE, JW, and SJ. While this was a smaller regional distribution compared to previous years, this was the most Eulachon caught in the bottom trawl survey, despite sampling design and effort reductions, since 2004. All Eulachon were kept and sent to the WDFW Forage Fish lab for further analysis.

No other ESA-listed species were caught, including Bocaccio, which had been caught in each of the past three years in northern portions of the survey area (JW, JE, SJ, and GB).

Other Fishes/Notable Finds

Because rockfish tend to exhibit preferences for rocky, untrawlable habitats, the bottom trawl survey serves as a poor indicator of rockfish populations. With this in mind, however, there was a noticeably higher catch of rockfish in the 2018 survey compared to the previous years, but the catch in the 2019 survey was closer to that of the 2017 survey, and less than half of what was caught in 2018 (Table 1). Nine different species were caught, including Shortspine Thornyhead, which were seen in 2018 for the first time since 2010. Quillback Rockfish were, as usual, the

most abundant species, followed by Brown Rockfish, and very few Copper and Yellowtail Rockfishes were caught this year compared to last.

Table 1. Rockfish species counts caught in the bottom trawl survey from 2014-19.

Species	2014	2015	2016	2017	2018	2019
Black Rockfish	1	-	-	-	-	-
Bocaccio	-	-	11	7	3	-
Brown Rockfish	2	13	15	16	42	14
Canary Rockfish	-	1	-	2	3	3
Copper Rockfish	27	7	4	4	123	9
Greenstriped Rockfish	2	5	2	8	5	1
Puget Sound Rockfish	9	2	-	-	1	-
Quillback Rockfish	41	34	117	235	344	207
Redbanded Rockfish	-	-	1	-	-	-
Redstripe Rockfish	5	4	6	8	4	9
Shortspine Thornyhead	-	-	-	-	1	1
Splitnose Rockfish	-	-	2	-	3	1
Yellowtail Rockfish	-	7	-	13	59	5
Total	**87**	**73**	**158**	**293**	**588**	**250**

Like rockfish, Lingcod exhibit a preference for untrawlable habitats, and therefore the bottom trawl is a poor survey method for assessing their populations; however, in the 2019 survey, 14 Lingcod were caught, which is the highest catch rate since 2013. Individuals ranged in size from 28 cm to 87 cm, with a median length of 48 cm; before this survey, only 3 Lingcod less than 35 cm had been caught since 2013. The majority of individuals were caught in JW, but one each was caught in CS, GB, and SJ. All but two small Lingcod, which were retained for WDFW and NOAA biologists, were released alive.

Sablefish (aka "Black Cod"), which have been caught in the survey the previous two years, were again found in the survey this year. Eight Sablefish were caught, all in JW; this is 6 more than were caught in 2018, and the same number as 2017. Lengths ranged from 39 cm to 52 cm, with an average of 48 cm. Fin clips were taken for genetic analysis, and all individuals were released alive. A few other less-frequently caught species found in the 2019 survey include a Wolf-eel, a Red Brotula, and two Pacific Spiny Lumpsuckers.

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 WDFW's Shellfish Team uses the estimates of Dungeness Crab and Spot Prawns to better inform fishery management decisions; a researcher and her students at Mount Holyoke College are researching the reproductive development of Spotted Ratfish; NOAA is building a collection of fish genetics; and three University of Washington researchers are furthering their studies on Longnose Skates, Spotted Ratfish, and poachers, all of which are possible thanks to data and samples from the trawl survey. 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 2019 bottom trawl survey, please contact Jen Blaine (Jennifer.blaine@dfw.wa.gov). Unless cancelled due to COVID-related restrictions, the 2020 Index bottom trawl survey will occur from May 4 – June 5 and may include exploratory stations in South Sound to continue the effort that began in 2018 to test the representativeness of the Index stations.

Annual Pacific Herring Assessment in Puget Sound – Annual herring spawning biomass was estimated in Washington in 2019 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 genetically distinguishable groupings within Puget Sound (Cherry Point, Squaxin Pass, and the "other stocks" complex). PSMFS Unit and MFF 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 2019 are shown in Figure 6. Stock biomass assessment activities for the 2020 spawning season were underway when statewide response to the COVID-19 pandemic forced the suspension of field surveys. Unfortunately, anecdotal observations from citizen scientists and house-bound MFF staff indicate that spawning in 2020 is occurring at extraordinary, possibly record setting, levels in some locales.

The herring spawning biomass estimate for all Puget Sound stocks combined in 2019 was 7,891 metric tons, a 23% decrease from 2018 (10,280 tonnes) (Table 2). The 2019 total is a 19% increase from the recent 2013 low point of 6,651 tonnes and is 84% of the ten-year average (9,366 tonnes).

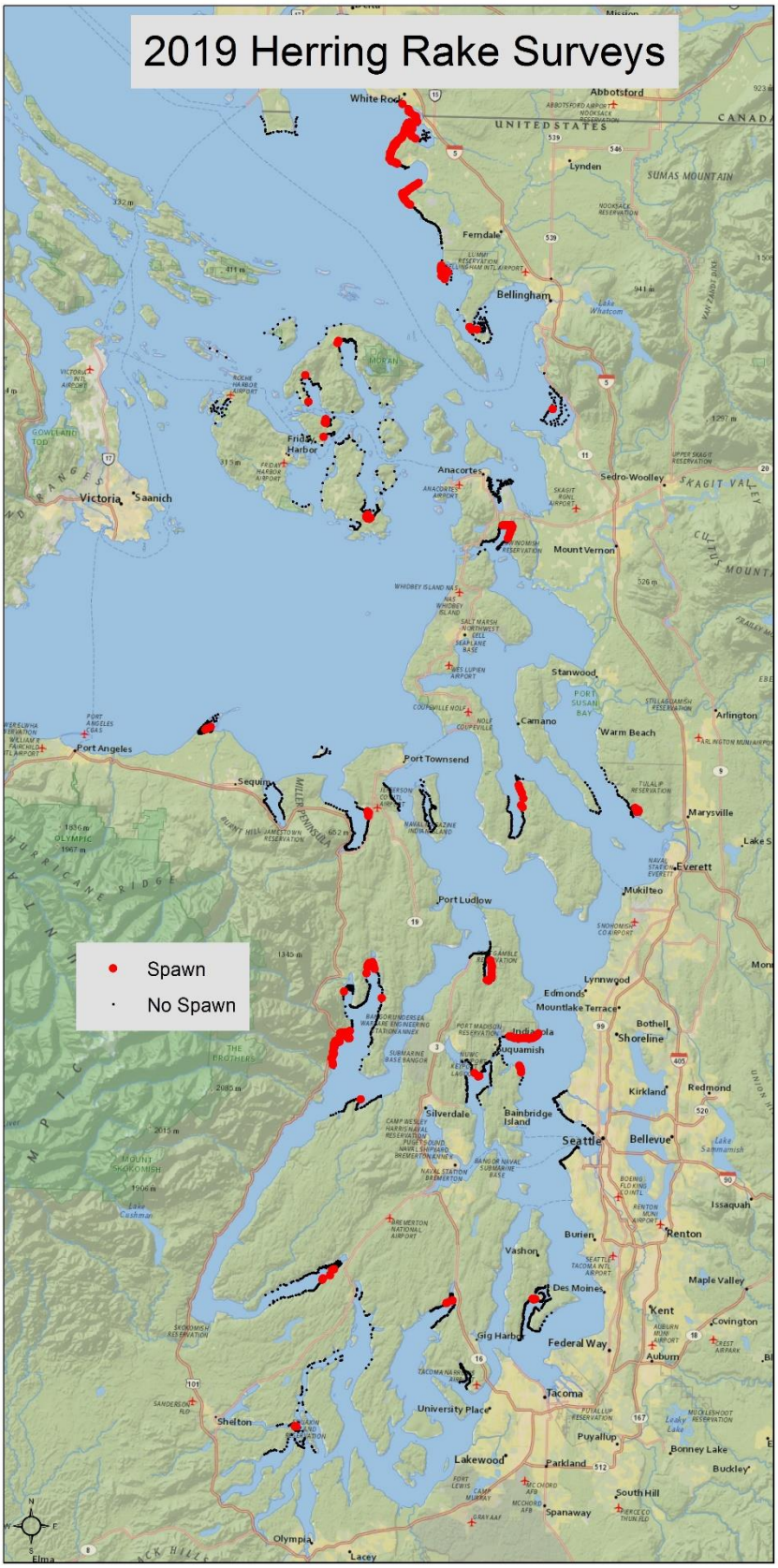


Figure 6: Locations of all rake surveys conducted in 2019, with red dots indicating detection of eggs.

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

Stock and Region (Unique genetic groups *italic*)	**PUGET SOUND HERRING SPAWNING BIOMASS ESTIMATES (Metric Tons), 2010-2019**									
South Puget Sound	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Squaxin Pass	463	513	534	503	357	294	236	271	381	14
Purdy	454	645	122	236	75	29	0	20	15	110
Wollochet Bay	10	19	28	9	35	0	0	5	0	0
South Puget Sound Total	926	1,177	685	748	468	323	236	297	396	124
Central Puget Sound										
Quartermaster Harbor	130	87	98	142	40	50	0	0	11	22
Elliott Bay			263	194	26	122	99	68	199	0
Port Orchard-Port Madison	318	112	197	167	82	83	0	0	13	1,867
Central Puget Sound Total	447	199	558	503	148	256	99	68	222	1,889
Hood Canal										
South Hood Canal	194	142	239	181	102	256	226	90	58	38
Quilcene Bay	1,825	4,031	2,382	1,880	2,810	3,717	6,496	4,482	5,816	2,960
Port Gamble	393	1,328	367	248	154	313	163	164	451	207
Hood Canal Total	2,412	5,500	2,988	2,308	3,065	4,286	6,884	4,736	6,325	3,205
Whidbey Basin										
Port Susan	138	125	55	26	62	64	55	103	67	64
Holmes Harbor	611	2,724	615	531	416	414	448	70	341	385
Skagit Bay	365	425	402	412	267	259	44	176	310	208
Whidbey Basin Total	1,113	3,275	1,072	969	745	736	547	349	718	657
North Puget Sound										
Fidalgo Bay	93	108	81	91	200	73	5	5	0	0
Samish/Portage Bay	589	351	390	629	706	507	929	451	379	204
Semiahmoo Bay	825	1,456	797	516	2,566	5,309	1,631	2,097	1,603	1,175
Cherry Point	702	1,180	1,016	824	910	475	468	337	249	290
Interior San Juan Islands	22	0	5	0	5	34	0	0	61	167
NW San Juan Islands	0	0	0	0	0	0	0	0	0	0
North Puget Sound Total	2,231	3,095	2,289	2,059	4,386	6,398	3,033	2,890	2,292	1,836
Strait of Juan de Fuca										
Discovery Bay	24	0	95	0	5	11	221	93	232	102
Dungeness/Sequim Bay	68	94	39	64	65	7	40	153	93	78
Kilisut Harbor	0	0	0	0	5	0	0	0	0	0
Strait of Juan de Fuca Total	92	94	134	64	74	18	261	247	326	180
Other Stocks total *(*excludes Cherry Pt. and Squaxin*)*	6,056	11,647	6,176	5,325	7,620	11,247	10,356	7,979	9,649	7,587
Puget Sound Total	**7,221**	**13,340**	**7,726**	**6,651**	**8,887**	**12,017**	**11,060**	**8,587**	**10,280**	**7,891**

Decreased spawning biomass was observed in every region of Puget Sound from 2018 to 2019 except for Central Puget Sound; and the Central Puget Sound and Strait of Juan de Fuca regions are the only regions that remained above the 10-year average. The Squaxin Pass stock in South Puget Sound decreased to only 14 tonnes in 2019, about 340 tonnes below its 10-year average. This decrease was partially mitigated in South Puget Sound by a 95 metric ton increase of the Purdy stock, but Purdy too is below its 10-year average of 171 tonnes. The Central Puget Sound increased 750%; driven mostly by the increase of the Port Orchard/Port Madison stock from 13 tonnes to 1,867 tonnes. Quartermaster Harbor doubled from 2018 to 22 tonnes but remained below half of its 10-year average of 58 tonnes.

Hood Canal, which accounted for over 60% of the spawning biomass in 2018, decreased by nearly 50% in 2019, and was below the 4,171 metric ton 10-year average. This decrease was driven by the 2,856 decrease of the Quilcene Bay stock, but both the South Hood Canal and Port Gamble stocks decreased as well. Despite continuing to decline and remain below the 10-year average of 1,018 tonnes, the Whidbey Basin stocks remained relatively stable from 2018 to 2019, with less than a 10% difference between the annual estimates.

In North Puget Sound, a minor increase (16%) was observed at Cherry Point, and the Interior San Juan Islands also increased and surpassed its 29 metric ton 10-year average. However, this

increase may be attributed to improved survey coverage of the Interior San Juan stock in 2019 thanks to collaboration with the UW Friday Harbor Marine Lab and San Juan Co. Resource Conservation Organization. The Dungeness/Sequim Bay, and Discovery Bay stocks in the Strait of Juan de Fuca both decreased from 2018 but remained above their respective 10-year averages of 70 and 78 tonnes.

A number of stocks in the region that were previously abundant continue to hold at low levels (Figure 7), and several stocks again had no spawn detected in 2019. The NW San Juan Islands stock is considered a disappearance with no spawn documented in the past decade, and the Kilisut Harbor stock is also now considered a disappearance, with only one year of spawn detected in the past decade. The Wollochet Bay stock in South Puget Sound has only had spawn documented once in the past 4 years, and for the second year in a row, no spawn was documented at Fidalgo Bay. Also, for the first time since it was documented in 2012, no spawning was documented at Elliott Bay.

In the coastal estuaries, Willapa Bay and Grays Harbor, while spawning activity was observed in Willapa Bay at one site in 2018, no spawn was detected in Willapa Bay or Grays Harbor in 2019. The number of surveys in these estuaries were again restricted due to weather and logistical challenges in 2019.

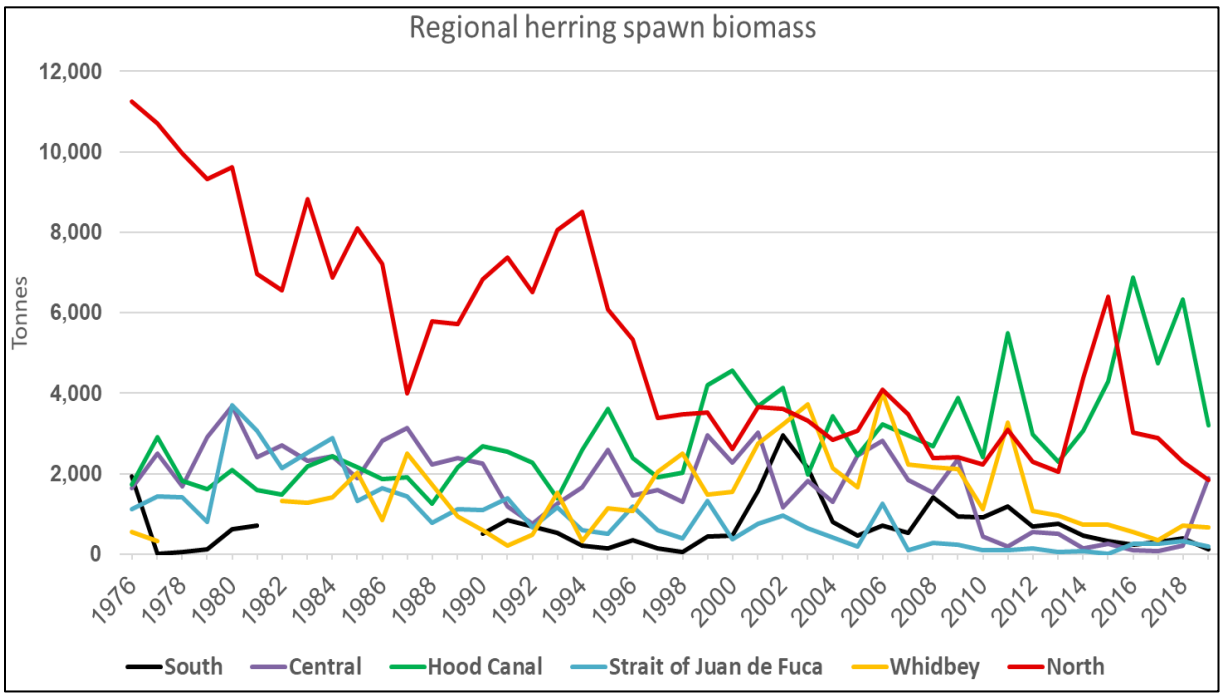


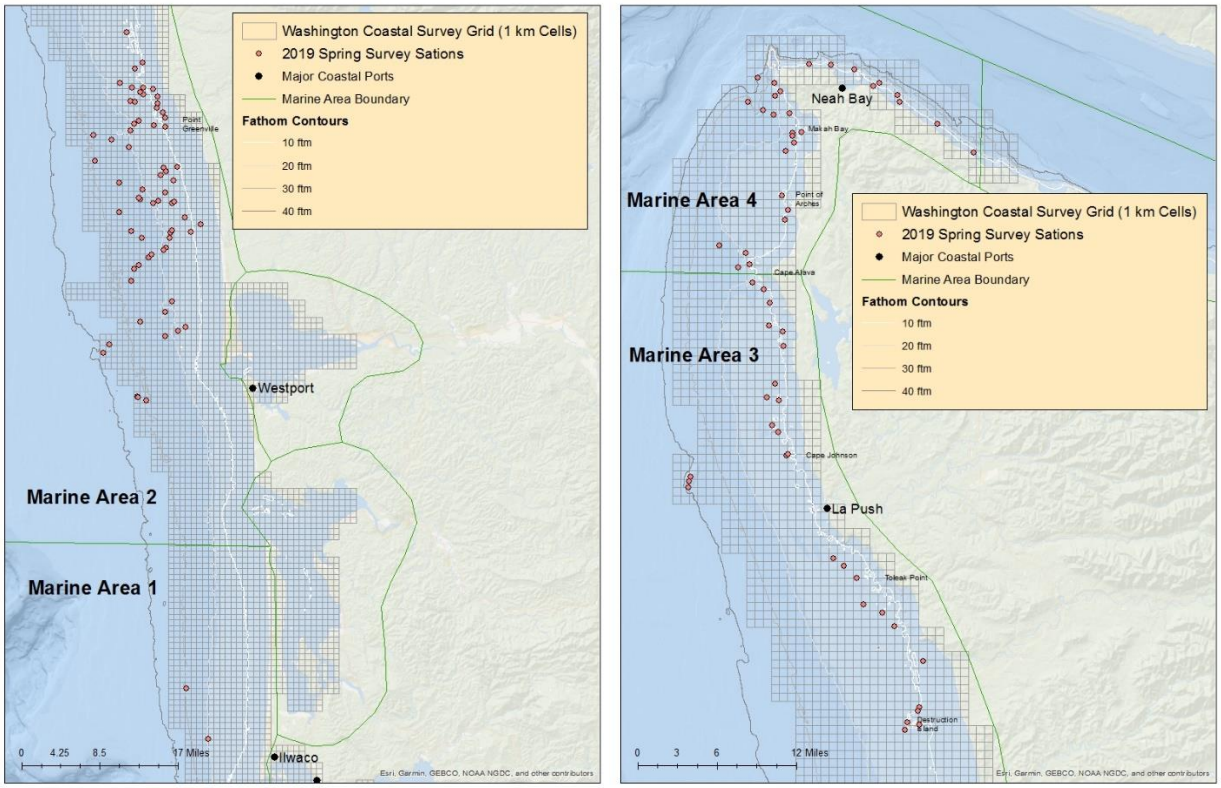
Figure 7. A comparison of Pacific Herring spawning biomass estimates for notable stocks in Puget Sound (note that only Squaxin Pass and Cherry Point are genetically distinct from the "Other stocks" complex)

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.

A standardized rod and reel survey designed to describe relative changes in population abundances of nearshore rockfish species and other associated groundfish species along the entire Washington Coast over time was implemented in 2018. 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. This effort was continued in 2019 with adjustments to survey methods addressing some standardization concerns.

The 2019 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 9 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 (Figure 8). Location depths were limited to under 40 fathoms, which includes the typical depth range of Black Rockfish, and all locations where 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 the WDFW for the 2015 spring rod and reel survey. This grid is composed of one-kilometer squared cells superimposed over the entire Washington coast. Within this schema, one-kilometer squared grid cells were chosen for survey operations (Figure 8).



A) South Coast B) North Coast

Figure 8. The Washington coast survey grid scheme (1 km grid cells) and survey station (single GPS locations) selected for the 2019 spring Black Rockfish Survey in Marine Area 1 and 2 (A) and Marine Area 3 and 4 (B).

Targeted cells 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. One hundred and fourteen cells were then random-systematically chosen from cells with known habitat. Of these selected locations, seven were removed prior to the start of the survey due to known hazards, location issues or uncertainties in historic location data accuracy. Eighteen additional cells were chosen purposefully to more effectively distribute survey locations relative to the amount of known rockfish habitat by Marine Area and depth, and to include both marginal and superior habitat locations based on catch rates from previous WDFW rod and reel surveys.

Each Station was defined as a single GPS position located within each selected grid cell (Figure 8). Fishing effort consisted of four drifts that began within 50 yards of the single GPS position and 32 minutes of total fishing time. This was the most significant adjustment to methodology from the 2018 studies where 60 minutes of total fishing time was devoted to each selected grid cell and effort could be deployed anywhere within the one kilometer squared cell. This further standardized our survey efforts, reducing the effect of inconsistent skipper fishing techniques.

Additionally, the decrease in station size reduced time spent searching for schools of fish and allowed for more stations to be surveyed in a single charter day.

Three recreational charter vessels were used to complete the 2019 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.

All fishing effort was conducted during daylight hours and charter days ranged from 8-11 hours. All stations in Marine Area 1 and 2 were fished before moving survey operations to the northern coast. Cells 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 considering ocean conditions.

At each chosen one-kilometer squared grid cell, captains took time to scout for fish aggregations and hard bottom/high relief areas, and to consider previous survey and personally known catch locations within each cell. Survey "stations" were then chosen as a single GPS position within each grid cell at the center of rocky substrate that would most likely provide high rockfish catch. Fishing effort at each station consisted of four eight-minute fishing drifts that began within 50 yards of the central GPS position. A fishing "drift" is defined as any consecutive time span that is spent fishing, beginning when the first angler's hook enters the water and ending when the last angler's hook leaves the water for any reason. Depending on weather conditions, the vessel either drifted or anchored over the target area, but vessel disposition remained constant for each individual station. For recordkeeping purposes, each anchored fishing event was recorded as a drift.

Five anglers fished for the total fishing time at each station surveyed. Each charter day the same five anglers fished all stations. Individual anglers were assigned a position on the vessel to fish for all drifts at a single station. These standard angler fishing positions were established on either the port or starboard side of the vessel, depending on the captain's preference. Angler positions were evenly spread out on the chosen side of the vessel from bow to stern. Before fishing began for each survey station, anglers were randomly assigned to one of the standard fishing positions. Due to space limitations on the F/V TOPNOTCH, 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 times per drift were recorded as total time 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 drift, 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 necessary. 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.

Over 22 charter days, 125 stations were successfully surveyed along the Washington coast (Table 3). Four to eight stations were surveyed each charter day dependent on the distance of target locations from port. Drift speeds ranged from 0.2 to 1.7 knots and six stations were fished while at anchor. Total angler rod hours at successfully surveyed stations ranged from 2.4 to 2.9.

Table 3. Number of stations successfully surveyed in the 2019 spring survey by Marine Area and 10 fathom depth bins.

	0-10 fathom	11-20 fathom	21-30 fathom	31-40 fathom	All Depths
Marine Area 1			2		2
Marine Area 2	10	33	20	3	66
Marine Area 3	11	14	1	2	28
Marine Area 4	9	15	5		29
Coastwide	30	62	28	5	125

Black Rockfish was by far the most predominant specie captured across all Marine Areas in waters less than 30 fathoms (Table 4). Other high catch species included Yellowtail Rockfish, Deacon Rockfish, and to a lesser extent Lingcod and Canary Rockfish. Less than 16 individuals of all other species encountered were captured, but species diversity did increase by Marine Area up the coast.

Table 4. Catch by number of all species per Marine Area and depth bin in the 2019 spring survey.

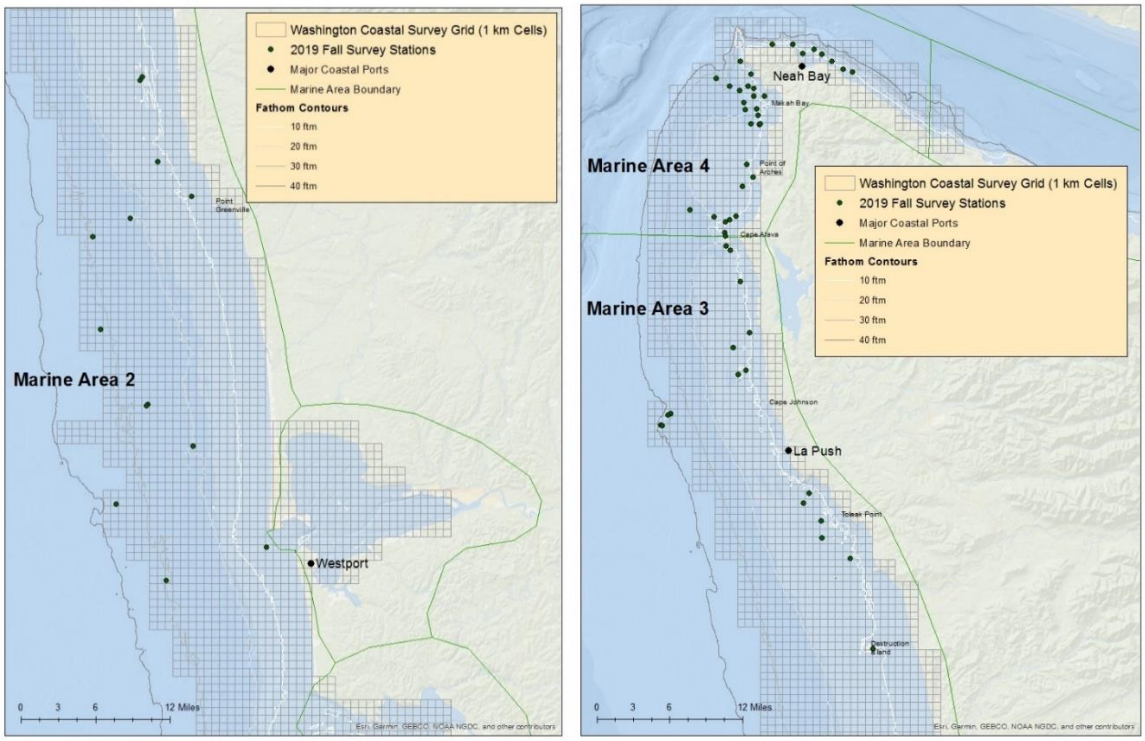
	Marine Area 1	Marine Area 2					Marine Area 3					Marine Area 4				
Species	21-30 fathom	0-10 fathom	11-20 fathom	21-30 fathom	31-40 fathom	Total	0-10 fathom	11-20 fathom	21-30 fathom	31-40 fathom	Total	0-10 fathom	11-20 fathom	21-30 fathom	Total	Grand Total
Black Rockfish	15	252	464	208	12	936	279	206	5		490	45	135	120	300	1741
Blue Rockfish							6				6	2	7		9	15
Buffalo Sculpin			2			2										2
Cabezon							1	1			2	4			4	6
Canary Rockfish			1	13	6	20		9		4	13	1	32	23	56	89
China Rockfish								4			4		4		4	8
Coho Salmon												1	1		2	2
Copper Rockfish													8	6	14	14
Deacon Rockfish			1	1	5	7	108	58	23	15	204	8	64	20	92	303
Kelp Greenling							1	1			2	1	5	1	7	9
Lingcod		6	5	6		17	3	4	3	2	12	3	17	5	25	54
Pacific Herring			1			1										1
Pacific Sandab	1												1		1	2
Quillback Rockfish				2	1	3		1		1	2		3	6	9	14
Vermilion Rockfish													1		1	1
Widow Rockfish									6	4	10			2	2	12
Yelloweye Rockfish				1		1			2	1	3			2	2	6
Yellowtail Rockfish			1	11	65	77	13	73	10	51	147	2	42	30	74	298
Grand Total	16	258	475	243	89	1064	411	357	49	78	895	67	320	215	602	2577

The 2020 Black Rockfish Survey began March 9th with no significant changes to survey methods or station locations but is currently suspended due to the COVID-19 pandemic.

Coastal Nearshore Demersal Groundfish Rod and Reel Survey – As part of the WDFW multispecies coastal nearshore rockfish rod and reel survey efforts, the Demersal Groundfish Survey was continued in the fall of 2019. The primary objective of fall survey efforts was to describe relative changes in population abundances of a variety of nearshore demersal groundfish species along the entire Washington Coast over time. These demersal focus species include China, Copper, Quillback, Tiger, Vermilion, and Yelloweye rockfish, as well as Kelp Greenling and Cabezon. Survey methods in the fall of 2019 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 2, 3 and 4, in depths from subtidal to 40 fathoms. Marine Area 1 has little known habitat containing demersal species and was not included in the survey.

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 were chosen for survey operations (Figure 9). Targeted grid cells in the fall survey were chosen based on known habitat of demersal rockfish species.



A) South Coast B) North Coast

Figure 9. The Washington coast survey grid scheme (1 km grid cells) and survey station (single GPS locations) selected for the 2019 fall Demersal Groundfish Survey in Marine Area 2 (A) and Marine Area 3 and 4 (B).

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. Sixty-four cells were then chosen for survey operations roughly relative to the amount of known habitat for each target species by Marine Area and depth. Cells 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. Similar to the 2019 spring Black Rockfish Survey, survey "stations" were chosen as a single GPS position within each grid cell (Figure 9) at the center of rocky substrate that would most likely provide high demersal groundfish catch.

Other method changes from the 2019 Black Rockfish Survey included a terminal tackle change to a salmon mooching rig baited with a white worm and a restriction of all angler fishing effort to on or near the bottom; schools of fish in the water column were not targeted. All other data collection and fishing effort methods were kept consistent with the spring survey described above.

Over 11 charter days, 64 stations were successfully surveyed along the coast (Table 5). Three to seven stations were surveyed each charter day dependent on weather conditions and the distance of target locations from port. Drift speeds ranged from 0.1 to 1.3 knots and no stations were fished at anchor. Total angler rod hours at successfully surveyed stations ranged from 2.5 to 2.9.

Table 5. Number of stations successfully surveyed in the 2019 spring survey by Marine Area and 10-fa depth bins.

	0-10 fathom	11-20 fathom	21-30 fathom	31-40 fathom	All Depths
Marine Area 2	4	1	6	2	13
Marine Area 3	5	8	2	2	17
Marine Area 4	12	17	5		34
Coastwide	21	26	13	4	64

While Black Rockfish was the most predominant specie captured across all Marine Areas, China Rockfish was encountered second most coastwide (Table 6). Other high catch demersal species included Cabezon, Kelp Greenling, and Copper Rockfish. Catch was diverse in Marine Areas 3 and 4 with 11 different rockfish species, Cabezon, Kelp Greenling, and Lingcod encountered.

Table 6. Catch (number) of all species per Marine Area and depth bin in the 2019 fall survey.

Species	Marine Area 2					Marine Area 3					Marine Area 4				Grand Total
	0-10 Fathoms	11-20 Fathoms	21-30 Fathoms	31-40 Fathoms	Total	0-10 Fathoms	11-20 Fathoms	21-30 Fathoms	31-40 Fathoms	Total	0-10 Fathoms	11-20 Fathoms	21-30 Fathoms	Total	
Black Rockfish	67	28	19	5	119	28	73			101	39	44	6	89	309
Buffalo Sculpin							2			2					2
Cabezon		1			1	2	14			16	14	16	1	31	48
Canary Rockfish			5	3	8	2		9	5	16	1	10	22	33	57
China Rockfish						27	26			53	31	33	4	68	121
Coho Salmon													1	1	1
Copper Rockfish						6				6	5	26	4	35	41
Deacon Rockfish	5		1		6	8	5		2	15	10	42		52	73
Flathead Sole			1		1										1
Jack Mackerel							1			1					1
Kelp Greenling						11	19			30	12	25	1	38	68
Lingcod	5		2	1	8	3	9	2	1	15	9	12	1	22	45
Pacific Sandab			5		5										5
Pile Surf Purch			1		1										1
Quillback Rockfish				3	3			2	4	6	1	12	2	15	24
Red Irish Lord												2		2	2
Redstripe Rockfish								2		2					2
Tiger Rockfish						2	3		1	6					6
UNSP. Blue/Deacon Rockfish						1				1					1
Vermilion Rockfish						1				1			2	2	3
Yelloweye Rockfish			1		1		1	7	8	16					17
Yellowtail Rockfish			2	1	3	5	7	10	16	38		16	9	25	66
Grand Total	77	29	37	13	156	96	160	32	37	325	122	238	53	413	894

The 2020 Demersal Groundfish Survey is scheduled to occur in September and October with no significant changes to survey methods or station locations.

Summary of the 2019 Nearshore Coastal Pelagic Species Acoustic Trawl Methodology Survey of the California Current off Washington and Oregon – In 2019, the WDFW Marine Fish Science unit placed biologists onboard the F/V LISA MARIE in collaborative survey conducted by the NOAA/Southwest Fishery Science Center (SWFSC), the West Coast Pelagic Conservation Group (WCPCG) – a commercial fishery industry coalition, and the WDFW. The work accomplished in 2019 was a continuation of a "proof of concept" study initiated by industry in 2017 to extend acoustic surveying and sampling of the coastal pelagic species (CPS) assemblage to the nearshore, complementing the offshore NOAA/SWFSC California Current Ecosystem survey (CCES).

The CCES acoustic trawl methodology survey conducted annually by the NOAA Southwest Fisheries Science Center (SWFSC) is a critical tool for understanding the abundance and distribution of Coastal Pelagic Species (CPS) such as Pacific Sardine, Northern Anchovy, Pacific Herring, Pacific Mackerel, Jack Mackerel, and mesopelagic fishes. Although the survey employs the latest in technology, it has certain limitations. The NOAA R/V REUBEN LASKER does not survey nearshore, in waters shallower than 35-50 meters (m). As CPS distribution is known to extend into much shallower depths, a major point of concern – the potential bias of survey estimates of CPS biomass – has been identified in peer reviews of the survey and in Pacific sardine stock assessments, by the Pacific Fishery Management Council Scientific and Statistical Committee, and fishermen (PFMC 2018, 2018a). The second limitation relates to gear and sample timing. Species and size composition sampling are conducted with trawl gear at night after the daytime acoustic portion of the survey. Fishermen's experience suggests that species presence and composition in the upper water column can vary significantly from day to night. Additionally, very few fish samples are taken with trawl gear and this is also a concern noted in stock assessment reviews (PFMC 2017). In contrast to the NOAA research vessel, industry-operated seine vessels can fish in waters as shallow as six meters which, in some cases where the continental shelf is broad, may be over 10 miles closer to shore than the 35-50 m depth curve. Industry seiners can collect large numbers of samples, day or night, and release un-sampled catch with low mortality. They can also be equipped to collect acoustic data in nearshore waters.

Recognizing these limitations and opportunities, NOAA/SWFSC collaborated with the WCPCG in 2017 and 2019 to capitalize on the abilities of fishermen, the capacity of their vessels, and their specialized harvest equipment to achieve a survey methodology that could ultimately become the foundation for a more robust stock assessment. The approach – using an industry vessel to sample (acoustic and biologic) the nearshore – has been cited among preferred methods for addressing the potential bias of the CCES survey because it supports direct synoptic observation of the nearshore CPS assemblage and is most comparable (PFMC 2019). The costs of the first year were covered by industry (through the WCPCG) and by SWFSC Cooperative Research funds supplemented by the Washington Department of Fish and Wildlife in 2019. The WCPCG has applied for a federal Saltonstall-Kennedy grant to continue and expand the effort in 2020.

In 2019, The F/V LISA MARIE completed acoustic surveys of the nearshore distribution of CPS biomass off Washington and Oregon between June 17 and July 3. During this period, a total of 78 transects (27 transects off Washington and 51 off Oregon) as well as 30 purse seine sets were completed (Figure 10). Captained by a fisherman, the F/V LISA MARIE was outfitted with a Simrad EK 60 GPT echosounder, provided, installed and calibrated by NOAA scientists. The echosounder was connected to the vessel's hull-mounted 38-kHz split-beam transducer (Simrad ES38-B). WDFW biologists were onboard for the duration of the project to collect species composition and biological data, as well as monitor the acoustic equipment and maintain a log of seining operations. All project data were submitted to NOAA/SWFSC. Ageing was accomplished by the WDFW Ageing Unit.

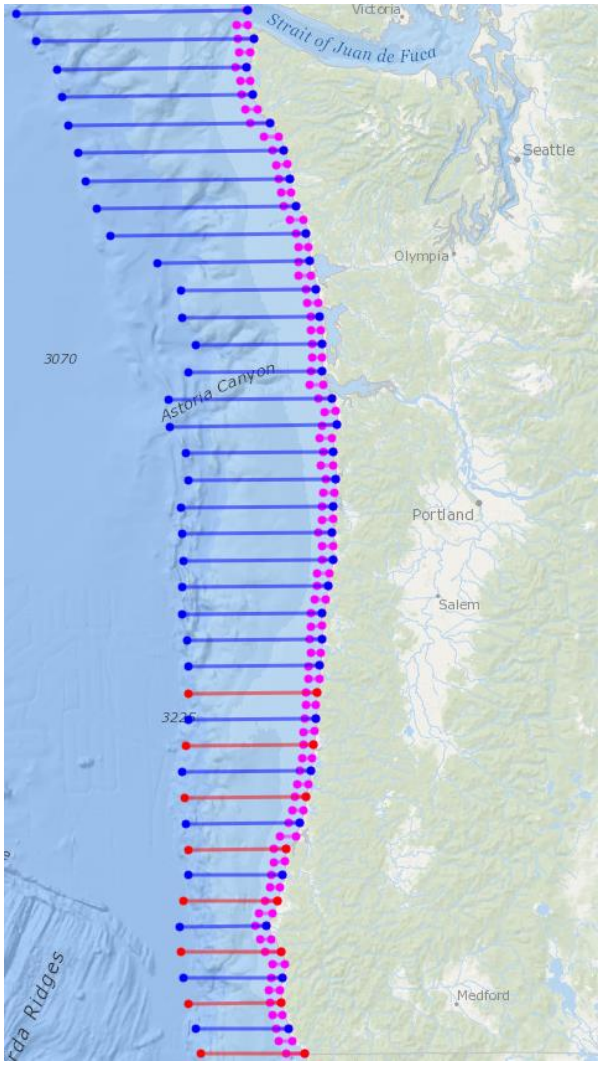


Figure 10. The R/V REUBEN LASKER's compulsory (red) and adaptive transect lines (blue) overlaid on the F/V LISA MARIE's nearshore lines (pink). Both vessels will run the transects to the east as close to shore as safely navigable.

The vessel completed transect lines moving from east to west, beginning as near to shore as safely navigable following the planned transect lines starting at the Canada-Washington border and ending at the Oregon-California border. Acoustic surveying began most mornings around 0630 PST (sunrise) and ended around 1900 PST (sunset). Sets were made after the completion of the transect and in proximity to the transect line if fish had been observed. Schools of fish observed while transiting to the next transect line were also set on. For all sets, the date, time, latitude, longitude, and general species composition were recorded. Size of schools wrapped and estimate of tonnage released were not documented. Released fish were presumed alive. Of the 30 completed sets, one was aborted due to the net getting stuck in the skiff, and four were dumped due to appearing to be all jellyfish. No sets were made on June 30 due to foul weather.

Biological data and species composition of each set was accomplished by collecting three dip net samples of approximately 4.5 kg (10 pounds) from the seine. The total weight of all species retained for sampling was 0.09 metric tons (Table 7). For each species per set, a total weight in grams and

total number were reported. For Pacific Sardine, Northern Anchovy, Pacific Mackerel, Jack Mackerel, and Pacific Herring, a 50 fish sample was randomly collected from the total combined dip netted sample and weighed. Then each of the 50 fish were sampled for length and weight, with 25 of the fish also being sampled for sex, macroscopic maturity, and age structures (Table 8).

Table 7. Total weight and number of species retained for sampling.

Species	Count	Weight (g)
American Shad	1	225
Black Rockfish	2	4340
Cabezon	1	
Chinook Salmon	9	190
Chum Salmon	1	42
Greenling	4	4
Jack Mackerel	44	52559
Lamprey	1	386
Market Squid	364	4116
Northern Anchovy	57	2017
Pacific Cod	24	249
Pacific Herring	588	22254
Pacific Sardine	148	5790
Pacific Tomcod	14	29
Pacific Whiting	2	
Pomfret	5	650
Rockfish Unid	6	2
Rockfish Unid 2	2	8
Sandlance	25	288
Starry Flounder	9	1802
Surf Smelt	29	1028
Whitebait Smelt	189	951
Grand Total	**1525**	**96930**

Complete results from the study are reported in: Stierhoff, Kevin L., Juan P. Zwolinski, and David A. Demer. 2020. Distribution, biomass, and demography of coastal pelagic fishes in the California Current Ecosystem during summer 2019 based on acoustic-trawl sampling. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-626. https://doi.org/10.25923/nghv-7c40

Table 8. Length data from select species sampled from purse seine sets.

	Count	Length_mean	Length_max	Length_min
Fork length	581	176	536	20
Black Rockfish	1	50	50	50
Jack Mackerel	44	473	536	435
Pacific Cod	24	82	185	53
Pacific Herring	496	157	196	135
Pacific Tomcod	7	59	85	48
Starry Flounder	9	106	236	20
Standard length	296	141	243	91
Northern Anchovy	57	143	165	91
Pacific Herring	91	140	160	120
Pacific Sardine	148	141	243	122
Grand Total	**877**	**164**	**536**	**20**

References cited

PFMC 2017. Pacific Sardine STAR Pane Meeting Report. April 2017 Agenda item G.5.a STAR Panel Report. Pacific Fishery Management Council, Portland, Oregon.

PFMC 2018. Methodology Review Panel Report: Acoustic Trawl Methodology Review for Use in Coastal Pelagic Species Stock Assessments. April 2018 Agenda item C.3.a Attachment 2. Pacific Fishery Management Council, Portland, Oregon.

PFMC 2018a. Scientific and Statistical Committee Report on Acoustic Trawl Methodology Review – Final Approval. April 2018 Agenda item C.3.a Supplemental SSC Report 1. Pacific Fishery Management Council, Portland, Oregon.

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 year. 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 the end of 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 2019.

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 (LeClair et al. 2018). 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.

The PSMFS 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. Comparisons were made 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 11).

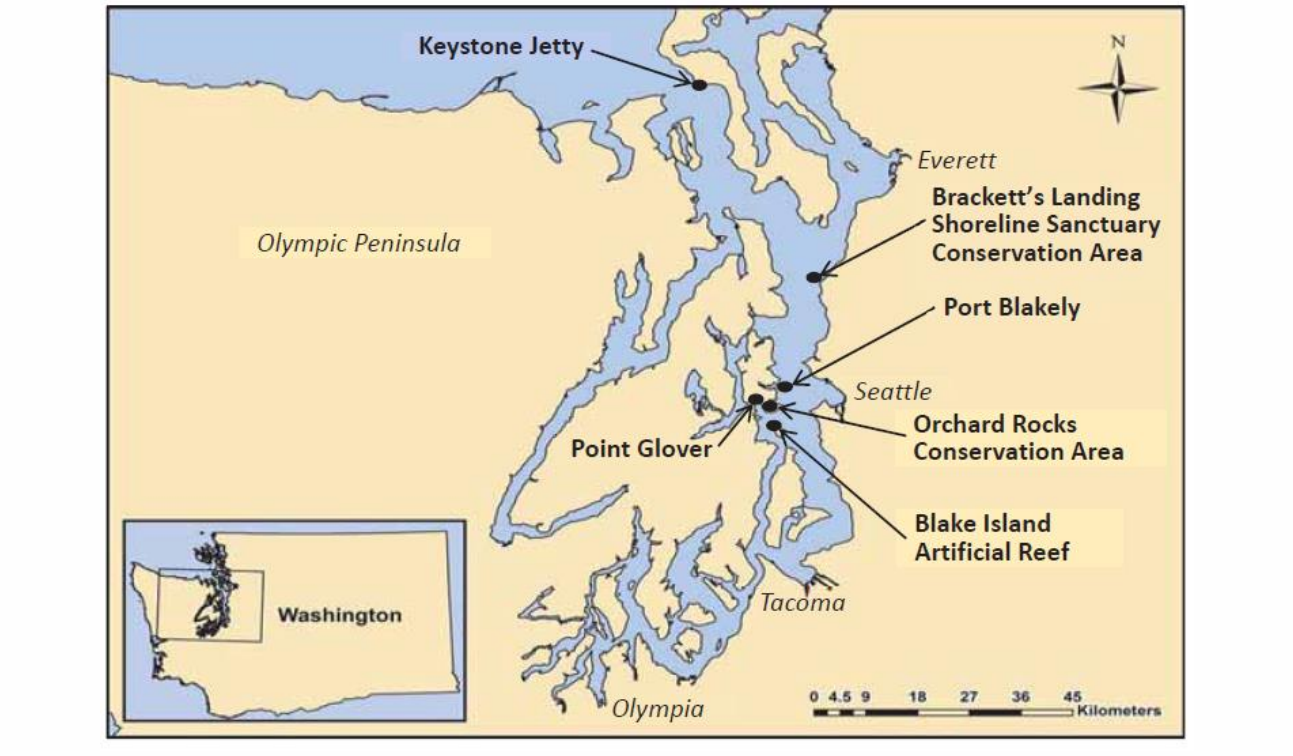


Figure 11. Locations systematically surveyed via scuba from 1995 through 2010.

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.)

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 PSMFS Unit is currently collaborating with the Seattle Aquarium and Point Defiance Zoo and Aquarium to resume surveys in 2020, coinciding with approximately two elapsed generations for key species.

References Cited

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.

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 12 presents annual landings since 2005. 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 homeports, 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. Fish ticket landing 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 13).

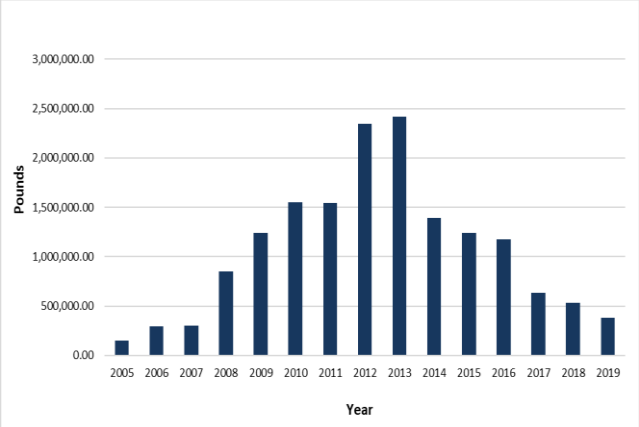


Figure 12. Hagfish Landings in pounds by Washington 2005-2019.

Figure 13. Barrels used in the WA commercial hagfish fishery.

Fishing occurs on soft, muddy habitat along the entire outer coast of Washington and northern Oregon (Figure 14). 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.

Biological sampling data is collected from Pacific and Black Hagfish and consist of length, weight, maturity, and egg counts for female maturity stage 4 through 7; however, only Pacific Hagfish data are reported here. Male and female hagfish present similar size distributions (Figure 15). The in-sample largest specimen was a 67 cm female, the smallest a 26-cm female. An evaluation of maturity suggests year-round spawning. Fecundity is low, with the number of mature eggs --stages 6 & 7 (Table 9) averaging 24 eggs per female. Few females with developed eggs have been sampled; the 2017-2019 sample contained 13% mature females.

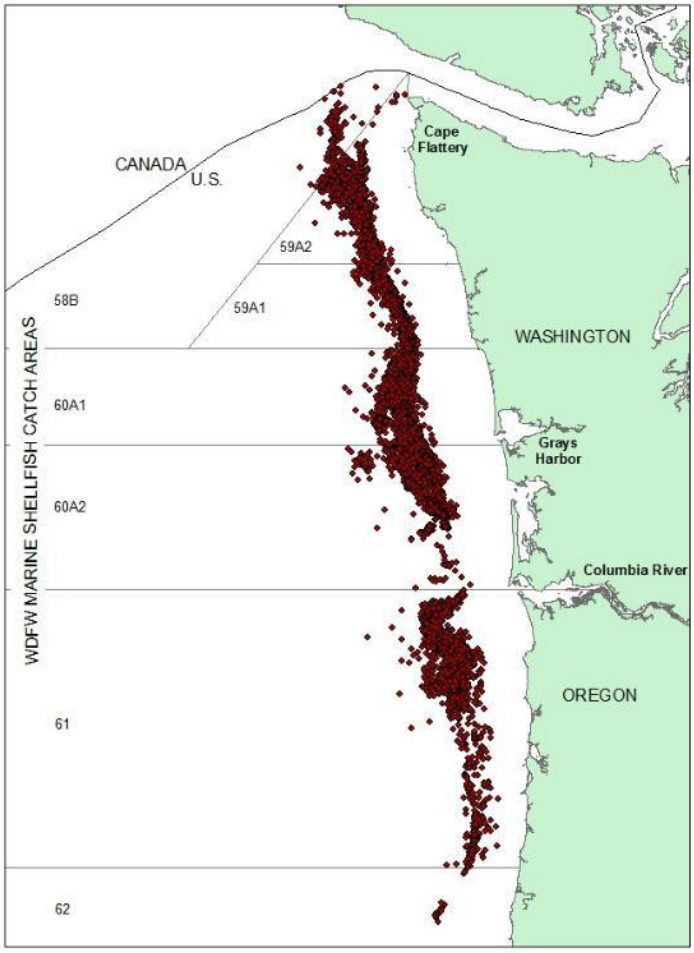


Figure 14. Distribution of Hagfish fishing trips off WA and OR, from Washington logbooks, 2005-18.

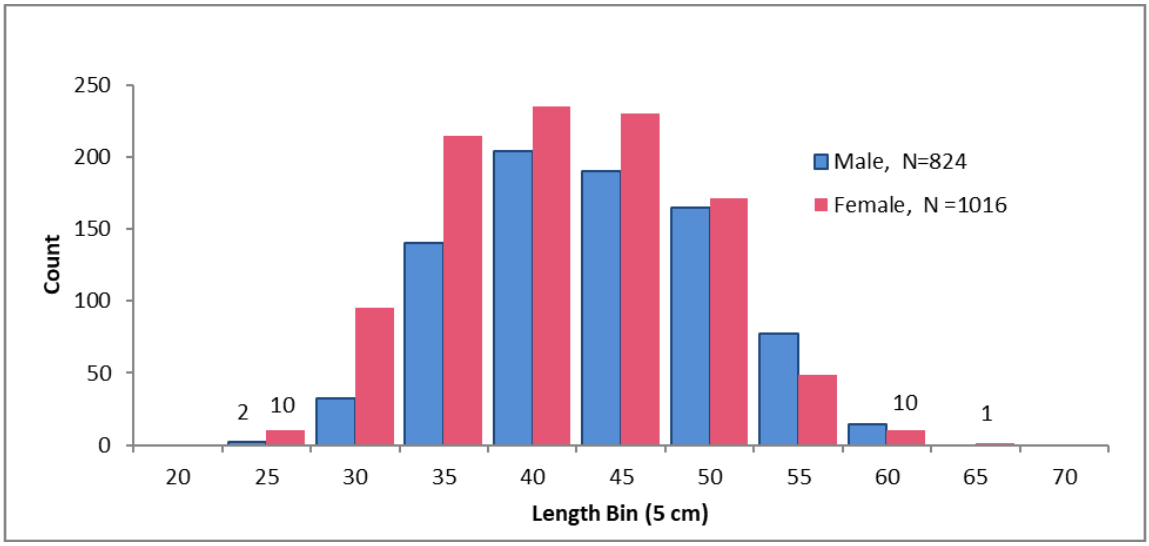


Figure 15. Length (cm), male and female Pacific Hagfish only, 2017-19.

Table 9. Average egg count per female for mature pacific hagfish collected from Washington landings during 2017-19.

Pacific Hagfish	Count_samples	Egg Count_ min	Egg Count_max	Egg Count_average
Maturity stage 6	117	9	49	25
Maturity stage 7	16	5	39	19
Total	133			24

B. North Pacific Spiny Dogfish and other sharks

Books Series on Sharks of the Northeast Pacific Ocean – Together with Dr. Shawn Larson of The Seattle Aquarium, in 2018 Dayv Lowry co-edited a pair of books entitled Northeast Pacific Shark Biology, Research, and Conservation, Part A and Part B (Figure 16). 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 conference, the fourth of which was 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.

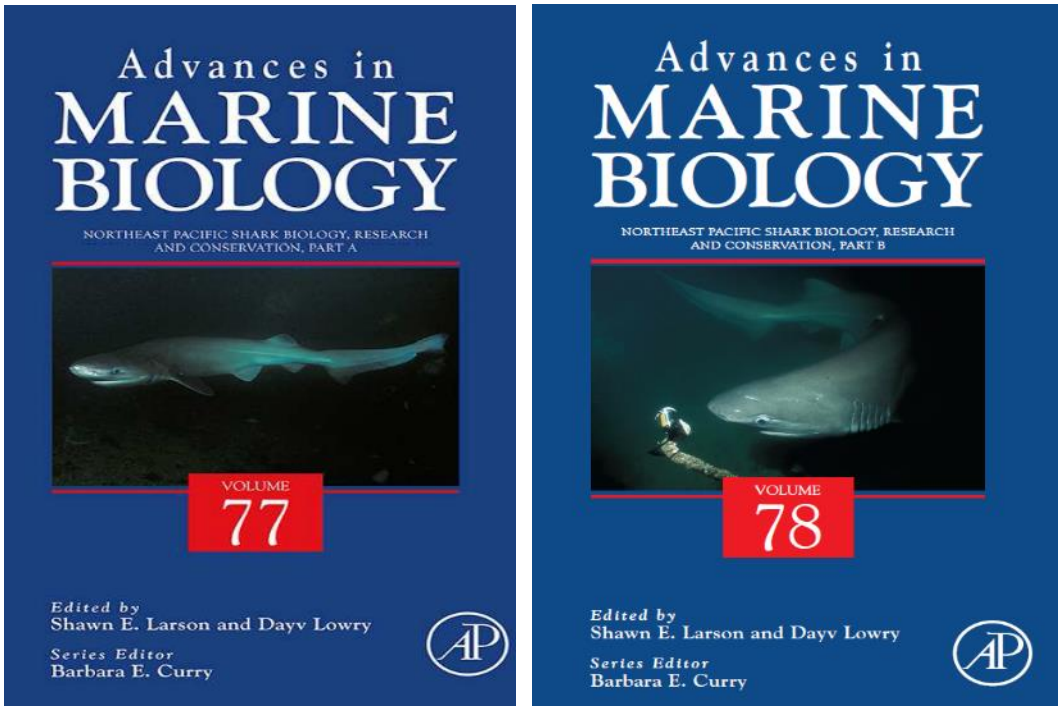


Figure 16. Covers of the two volumes on shark research and management published in 2018.

Following on the heels of the 2018 volumes, which largely dealt with research and management from Alaska to California, Mexican colleagues who had attended the 2018 NEPSS inquired about a companion volume focusing on research and management in Mexican waters. Shawn and Dayv agreed to co-edit this volume, which was subsequently broken into two volumes by the publisher, and lead authors were selected for chapters paralleling those in the 2018 volumes. In late 2019 Volume 83 was published, and in early 2020 Volume 85 followed it (Figure 17).

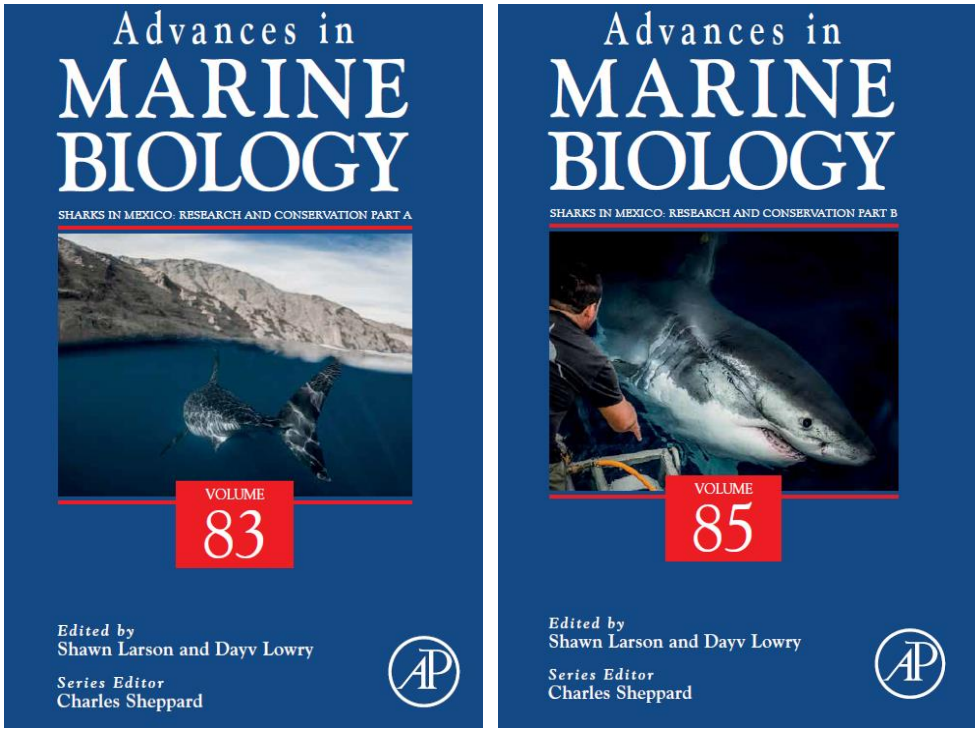


Figure 17. Covers of the two volumes on shark research and management in Mexico.

As of March 2020, chapters in the thre published volumes had been cited 59 times and purchased for direct download through the publisher over 1,300 times (Table 10). 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 almost 600 times.

Table 10. Details for chapters in both volumes of Northeast Pacific Shark Biology, Research, and Conservation.

Volume	Authors	Title (abbreviated)	Cites	Downloads	Social
77	Lowry+Larson	Introduction to Vol 77	3	49	10
77	Ebert et al.	Biodiversity, life history, and conservation	7	101	24
77	Larson et al.	Review of current conservation genetics	7	161	76
77	Bizzaro et al.	Diet composition and trophic ecology	11	109	60
77	Reum et al.	Stable isotope applications	3	144	37
77	Matta et al.	Age and growth of elasmobranchs	4	89	47
78	Larson+Lowry	Introduction to Vol 78	3	50	13
78	King et al.	Interactions with directed and incidental fisheries	5	93	10
78	Kacev et al.	Modeling abundance and life history parameters	2	44	22
78	Grassman et al.	Sharks in captivity: husbandry, breeding, education	3	151	46
78	Mieras et al.	Economy of tourism and citizen science	5	177	189
78	Lowry	Conclusion: future of management and conservation	5	91	16
83	Lowry+Larson	Introduction to Vol 83	1	9	3
83	Sladaña-Ruiz et al.	Shark biodiversity and conservation in Pac MX	0	21	18
83	Galván-Magaña et al.	Eecology, role of apex predator, and conservation	0	26	16
83	Sandoval-Castillo	Conservation genetics of elasmobranchs in Pac MX	0	11	3

Collaboration on DFO Dogfish Longline Survey – In October of 2019 Dayv Lowry joined DFO staff aboard a 6-day leg of their annual dogfish longline survey. This afforded the opportunity to observe DFO's at-sea, integrated electronic monitoring system and get hands-on experience with IT infrastructure necessary to support such a system. This will be invaluable as the WDFW moves forward with building out the data collection system on the newly acquired 56' R/V SALISH ROVER.

Several North Pacific Spiny Dogfish and Spotted Ratfish were brought back to Olympia for use in educational presentations. The first of these was at Washington State University in Pullman, where Dayv lectured on shark research, management, and conservation to the WSU Shark Conservation Club, followed by a detailed dissection of two dogfish and one ratfish. The second was to over 300 sixth grade students at Rainier Middle School in Puyallup, where Dayv dissected a shark, showcased a collection of preserved jaws and other specimens, and answered questions about general shark biology and ecology. Both presentation were well received and return engagements have been booked for 2020.

C. Skates

No specific, directed research or management to report.

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 2019 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 has identified at least 57 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 now complete and secondary reviews are ~90% complete.

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 now complete and secondary reviews are ~75% complete.

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 observed. Reviews of the transect videos have just started and are being conducted jointly by the WDFW and DFO, with the bulk of the effort provided by DFO.

In August 2019 the WDFW MFS unit initiated an ROV survey focused on benthic rockfishes, Lingcod, and Kelp Greenling within the interior marine waters of Washington using a two-stage survey design. Within the Yelloweye Rockfish and Bocaccio DPSs, the survey design was based on the results of a MaxEnt habitat suitability model. Due to a lack of reliable bathymetry coverage for the waters of the Strait of Juan de Fuca west of the western DPS boundary, the MaxEnt approach could not be implemented, and the survey design was based on an evaluation of known and suspected habitats identified during previous drop-camera and ROV surveys. After 450 stations were randomly selected (Figure 18), the survey began on August 6 but was suspended on September 26th due to an equipment failure on the support vessel R/V MOLLUSCAN. Because the WDFW was already in the process of purchasing a replacement vessel for the MOLLUSCAN, we opted not to replace the failed equipment in order to apply those funds to the purchase price of the new vessel. The new vessel, the R/V SALIH ROVER, was acquired in December 2019 and is currently undergoing final retrofitting and testing prior to resuming the survey in June 2020.

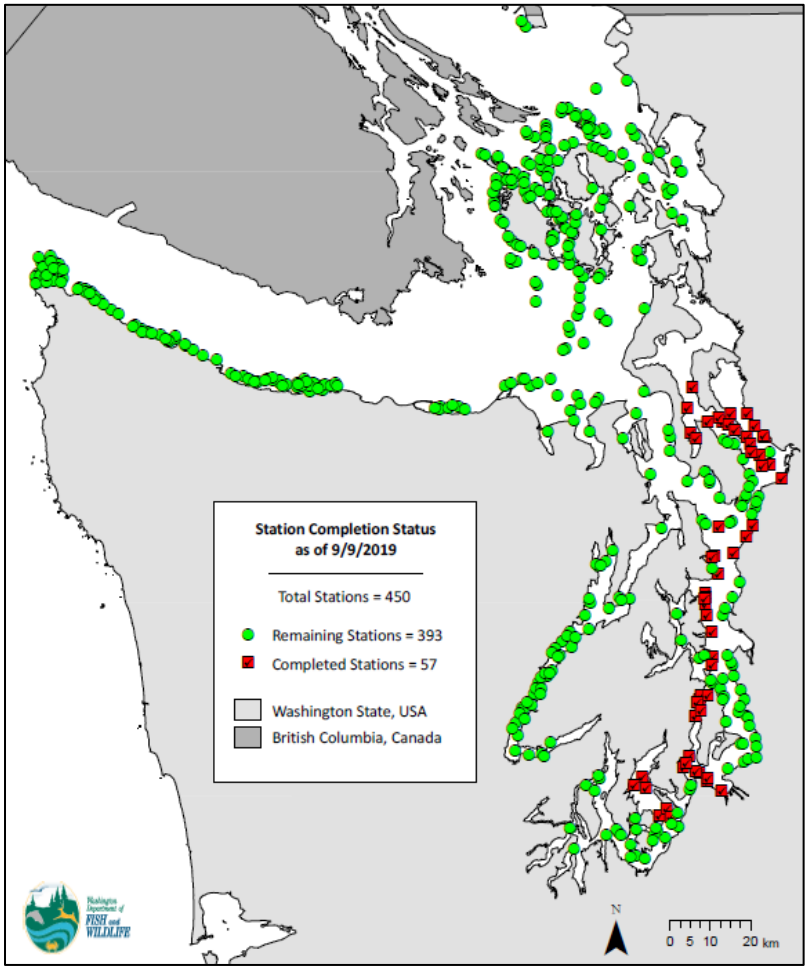


Figure 18. Randomly selected stations for the 2019-21 ROV survey. Stations all far within the highly suitable stratum predicted by the MaxEnt model based on prior ROV survey data.

ii. Management

No specific, directed management to report.

I. Thornyheads

No specific, directed research or management to report.

J. Sablefish

No specific, directed research or management to report.

K. Lingcod

Formal Stock Assessment in Puget Sound – Over the past several 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 has nearly completed an evaluation of 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. Finalization of the report is expected in late 2020.

Pre-season Lingcod Rod and Reel Test Fishing Survey to Evaluate Claim of "No More Fish" – The PSMFS Unit conducted a four-day test fishing survey targeting Lingcod in Marine Catch Area 7 (San Juan Islands) during April 2019 prior to the opening of the recreational Lingcod fishing season (Figure 19). This was a pilot study with a primary goal of obtaining basic catch per unit effort (CPUE) and length frequency data for Lingcod under simulated recreational fishery conditions for potential use in a Puget Sound Lingcod stock assessment, and to evaluate the claim made by several recreational anglers that "no more legal sized fish are around." Secondary goals included documenting bycatch and obtaining genetic samples from select fish species to inform demographic models of Puget Sound bottomfish.

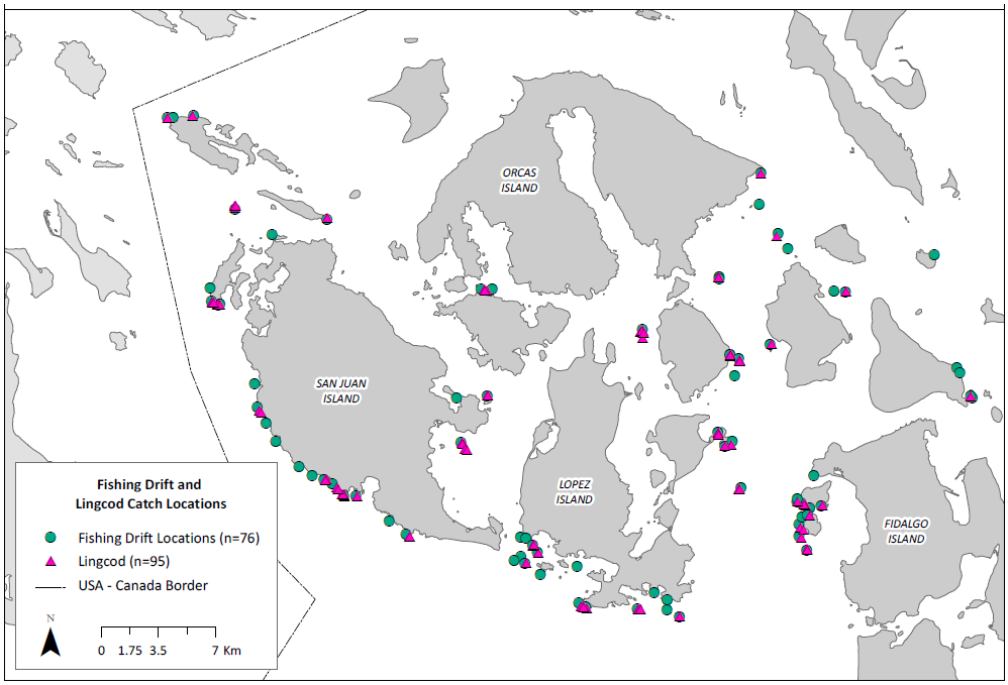


Figure 19. Fishing sites and locations of Lingcod caught during the 2019 pre-season survey.

Fishing was conducted from two WDFW Enforcement Program vessels during daylight hours on April 25-26 and 29-30, 2019. Six Unit staff, seven WDFW Police officers, and two Washington Conservation Corps (WCC) members fished during the survey.

A map of potential fishing locations was developed from prior remotely operated vehicle (ROV) surveys, SCUBA observations, and known recreational fishing locations. Fishing sites were chosen on the water as weather and currents allowed and were coordinated among vessels in an attempt to distribute effort across the broadest geographic extent possible (Figure 1). Tidal exchanges during the hours fished were less than 5 feet and were assumed to have a negligible effect on catches. One or more drifts were performed at each site and all fishing was conducted in accordance with WDFW recreational bottomfish regulations. The starting and ending times and locations of each drift were recorded when the first line went into the water and when the last line was retrieved, respectively. The number of anglers actively fishing varied and was also recorded for each drift. Terminal tackle was chosen by the individual angler and included curly tail jigs, flies, Point Wilson darts, whole squid, whole herring, and live bait.

The total fishing time over 76 drifts was 40 hours and 55 minutes resulting in a total of 174 rod-hours (Table 11). In total, 139 fish were caught with Lingcod being the most numerous (n = 95). Lingcod were caught throughout the study area, with the majority of fish ranging from 400mm to 550mm (total length) and legal-sized fish (650mm and 900 m) accounting for 14% of the lingcod catch (Figure 20). Bycatch included Cabezon (n = 8), Kelp Greenling (n = 5), Quillback Rockfish (n = 4), Red Irish Lord (n = 4), Brown Irish Lord (n = 1), and Brown Rockfish (n = 1). Genetics samples were taken from select Cabezon, Copper Rockfish, and Lingcod. All fish were released alive, except for two Kelp Greenling that were retained as live bait. Two Quillback Rockfish were released using a SeaQualizer descending device after showing signs of barotrauma post-capture. The conclusion of the survey was that Lingcod are abundant in the area and that competition due to high angler interest is the most likely reason that some anglers are unable to land a legal fish. Management options are being considered to reduce competition in this derby style fishery.

Table 11. List of fishing locations, number of rods, and fishing times during the 2019 pre-season Lingcod survey.

General Fishing Location	Number of Rods	Total Fishing Time	Fishing Start Latitude	Fishing Start Longitude	Fishing End Latitude	Fishing End Longitude
Bell Island Marker	4	00:40:00	48.594653	-122.977087	48.593793	-122.973013
Bellevue point	4	00:36:00	48.529208	-123.163414	48.525044	-123.159724
Bird Rocks	3	00:55:00	48.484478	-122.761285	48.483075	-122.762981
Black Rock	4	00:53:00	48.558348	-122.770048	48.559028	-122.769979
Black Rock	4	00:01:00	48.546774	-122.766345	48.546620	-122.766851
Blakely Island Shoal	4	01:12:00	48.572093	-122.842897	48.570897	-122.841083
Boat Harbor	4	00:29:00	48.547613	-122.578653	48.547882	-122.579612
Broken Point	5	00:09:00	48.594902	-122.968057	48.592857	-122.952450
Buckeye Shoal	3	00:24:00	48.625075	-122.729912	48.623054	-122.731761
Burrows Lighthouse	5	00:12:00	48.476818	-122.714636	48.476563	-122.714289
Burrows Lighthouse North	5	00:07:00	48.478369	-122.714358	48.479255	-122.713612
Castle Island	5	00:28:00	48.422311	-122.822879	48.422305	-122.822877
Cattle Pass	10	00:22:00	48.444364	-122.950023	48.444937	-122.948719
Cone Islands	4	00:45:00	48.593011	-122.683262	48.609457	-122.722026
Cypress Reef	4	00:13:00	48.616796	-122.721639	48.614240	-122.723502

Danger shoal	6	00:58:00	48.638724	-123.182234	48.638971	-123.183524
Davidson Rock	5	00:56:00	48.413419	-122.812572	48.422369	-122.820222
Davis Point	3	00:38:00	48.452964	-122.934680	48.452371	-122.933455
Deadman Bay	4	00:16:00	48.510106	-123.148105	48.507616	-123.143870
Deadman Island	5	00:16:00	48.457595	-122.944560	48.456940	-122.942661
Deadman Island 2	2	00:04:00	48.457024	-122.940215	48.456622	-122.939870
Dennis Shoal	4	00:32:00	48.457748	-122.713328	48.439272	-122.692606
Eagle Point	4	00:39:00	48.458894	-123.039603	48.458153	-123.038909
East Blakely, Black Rock	4	00:27:00	48.558037	-122.769991	48.552744	-122.769496
East James Island	4	01:20:00	48.510559	-122.768492	48.550349	-122.771679
East Vendovi Island	3	00:06:00	48.612852	-122.599731	48.611421	-122.598564
Fidalgo Head	3	00:21:00	48.491122	-122.700765	48.491068	-122.698376
Green Can North of Black Rock	4	00:55:00	48.555979	-122.762967	48.546822	-122.765356
Green Point, Speiden Island	4	00:43:00	48.633059	-123.105967	48.634462	-123.106311
Griffon Bay	5	01:33:00	48.509762	-122.994171	48.501778	-122.999540
Hughes Bay	5	00:23:00	48.426757	-122.833448	48.422916	-122.832773
Iceberg Point	7	00:30:00	48.418466	-122.891672	48.417421	-122.887789
Iceberg Point	7	00:32:00	48.420916	-122.896306	48.418123	-122.892464
Kanaka Bay	5	00:29:00	48.480180	-123.081182	48.479867	-123.085526
Kellett Bluff	5	00:52:00	48.585913	-123.196223	48.585885	-123.196674
Kellett south	2	00:10:00	48.586221	-123.195031	48.585891	-123.195388
Kellett Bluff	4	00:45:00	48.587793	-123.201949	48.586604	-123.200561
Long Island	5	00:10:00	48.436927	-122.927889	48.435388	-122.926003
Lydia Shoal	4	00:46:00	48.601275	-122.778796	48.602100	-122.780615
Lydia Shoal	4	01:18:00	48.600190	-122.778756	48.601931	-122.781804
McKay Harbor	5	00:20:00	48.441268	-122.897590	48.441807	-122.897876
Mummy Rocks	4	00:19:00	48.448946	-122.930481	48.448290	-122.928492
N Lime Kiln	4	00:12:00	48.520565	-123.156192	48.519994	-123.155065
N Stuart Island	4	00:21:00	48.690334	-123.217095	48.689816	-123.218828
North Allan Island	7	00:18:00	48.469021	-122.706190	48.468372	-122.711029
North Allan Island	7	00:29:00	48.468298	-122.710812	48.470047	-122.700749
North Boat Harbor	4	00:18:00	48.550343	-122.581123	48.551106	-122.582586
North of north of pile	5	00:23:00	48.491545	-123.117900	48.491069	-123.117034
North of pile	4	00:30:00	48.489407	-123.108202	48.488796	-123.106701
North Pile Point	4	00:33:00	48.486844	-123.101000	48.483750	-123.096211
North Turn Island	4	00:18:00	48.535765	-122.972161	48.535954	-122.971671
Northeast turn	5	00:09:00	48.689394	-123.234315	48.689376	-123.234340
NWR North of Eagle Point	4	00:29:00	48.466356	-123.053652	48.464754	-123.049839
Outside Roche ROV transect	4	00:15:00	48.624639	-123.151447	48.624330	-123.146068
Pea Pod Rocks	4	00:07:00	48.641081	-122.745241	48.641012	-122.744518
Pile Point	4	00:47:00	48.480127	-123.091382	48.481028	-123.092532
Point Colville	5	00:31:00	48.417195	-122.823115	48.414904	-122.818897
Smallpox Bay	3	00:14:00	48.542308	-123.165795	48.542200	-123.164363
South Brown Island	5	00:27:00	48.534473	-122.997776	48.532254	-122.997850
South Burrows Island	4	00:49:00	48.473018	-122.704210	48.475145	-122.710127
South Huckleberry	4	00:22:00	48.533955	-122.568465	48.532601	-122.567457
South Huckleberry Island	4	01:21:00	48.534792	-122.569914	48.535267	-122.566763
South James Island	3	00:29:00	48.507401	-122.774707	48.507782	-122.772073
South Point Lawrence	4	00:22:00	48.658838	-122.743757	48.658670	-122.744853
Southeast Burrows Island	5	00:26:00	48.474237	-122.694504	48.474328	-122.694352
Southwest Burrows	5	00:10:00	48.475804	-122.711478	48.475908	-122.711814
Swirl Island	4	00:33:00	48.417585	-122.847488	48.416597	-122.845533
The Cones	5	00:22:00	48.592841	-122.673922	48.592468	-122.672948
Turn point	5	00:10:00	48.689243	-123.239098	48.689599	-123.238354
West Allan Island	5	00:42:00	48.464220	-122.713151	48.456669	-122.704580
West Henry Island	1	00:07:00	48.595265	-123.202960	48.593514	-123.203389
West James Island	4	01:31:00	48.515487	-122.780168	48.511911	-122.764342
West SJI south of Deadman Bay	4	00:11:00	48.496163	-123.128662	48.495754	-123.126755
West Strawberry Island	4	00:50:00	48.563835	-122.736760	48.563807	-122.736992
Whale Rocks	5	00:12:00	48.446732	-122.944352	48.447824	-122.944199
Williamson Rock	4	00:52:00	48.450032	-122.706980	48.451208	-122.703493

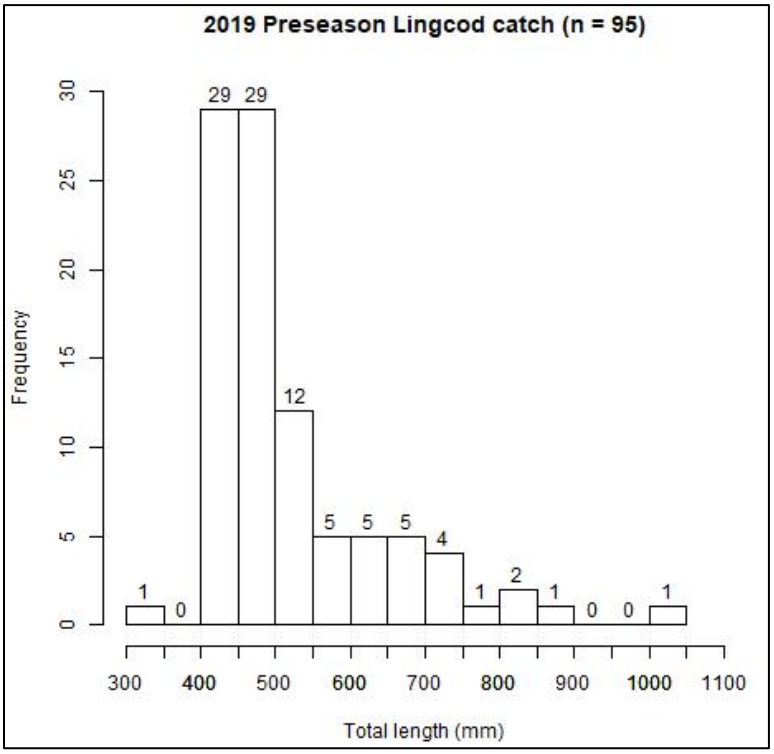


Figure 20. Length distribution of Lingcod in the 2019 pre-season survey.

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. The new Section 10 permit covering recreational bottomfish fishing, commercial shrimp trawling, and now including both recreational and commercial shrimp pot fishing, was submitted in March of 2020.

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. Results thus far show no population differentiation at any observable geographic scope. Additional funding is being sought to process samples recently acquired from three sites in British Columbia and five sites in Alaska.

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.

VI. Publications

In 2019-20 staff of the MFS Unit published the documents indicated below.

Blaine, J, Lowry, D, and R Pacunski. (2020). 2002-2007 WDFW scientific bottom trawl surveys in the southern Salish Sea: species distribution, abundance, and population trends. Fish Program Technical Report No. 20-01. Washington Department of Fish and Wildlife, Olympia, WA. 237 pp.

Burger, M, Sandell, T, Fanshier, C, Lindquist, A, Biondo, P, and D Lowry. (2020). Findings of the 2016-17 southern Salish Sea acoustic mid-water trawl survey. Fish Program Technical Report No. 20-03. Washington Department of Fish and Wildlife, Olympia, WA. 48 pp.

Hersherberger, P, MacKenzie, AH, Gregg, JL, Lindquist, A, Sandell, T, Groner, ML, and D Lowry. (2019). A geographic hot spot of *Ichthyophonus* infection in the Southern Salish Sea, USA. Diseases of Aquatic Organisms. Accepted, online.

Larson, SE, and D Lowry (eds.) (2019). *Sharks in Mexico: Research and Conservation Part A.* Advances in Marine Biology. Academic Press. Volume 83. 157 pp. ISBN: 9780081029169.

- Lowry, D and S Larson. (2019). Introduction: The sharks of Pacific Mexico and their conservation: why should we care? In: Larson, SE, and D Lowry (eds). *Sharks in Mexico: Research and Conservation Part A.* Advances in Marine Biology. Academic Press. Volume 83: 1-9.

Lowry, D, Pacunski, R, Kraig, E, Tribble, V, and T Tsou. (2020). Conservation Plan for reducing the impact of selected fisheries on ESA-listed species in Puget Sound, with an emphasis on bocaccio and yelloweye rockfish. Washington Department of Fish and Wildlife, Olympia, WA. 100 pp.

Petrou, EL, Fuentes-Pardo, AP, Rogers, LA, Orobko, M, Tarpey, C, Moss, ML, Yang, D, Pitcher, TJ, Sandell, T, Lowry, D, Russante, DE, and L Hauser. (submitted) Functional genetic diversity in an exploited marine species and its relevance to management. Nature Ecology and Evolution. Submitted Nov 2019.

Sandell, T, Lindquist, A, Dionne, P, and D Lowry. (2019). 2016 Washington State herring stock status report. Fish Program Technical Report No. 19-07. Washington Department of Fish and Wildlife. 87 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.

WKUSER Workshop on Unavoidable Survey Reduction. Seattle, WA, January 2019. Theresa Tsou, Bob Pacunski, and Jen Blaine attended.

PFMC ROV Survey and Statistical Methods Review Panel. Santa Cruz, CA, February, 2019. Theresa Tsou, Bob Pacunski, and Dayv Lowry attended.

Northeast Pacific Shark Symposium. La Paz, MX, March 2019. Dayv Lowry attended, co-organized, and presented two talks.

Three additional conferences were planned but were cancelled due to COVID-19 concerns.

VIII. Complete Staff Contact Information

WDFW permanent marine fish management and research staff include (updated 4/2020):

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