Washington Department of Fish and Wildlife Contribution to the 2024 Meeting of the Technical Sub-Committee (TSC) of the Canada-U.S. Groundfish Committee: Reporting for the period from April 2023-March 2024

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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. Two primary work units deal with marine fish research within the Fish Management Division. The Toxics-focused Biological Observation System for the Salish Sea (TBiOS) (formerly Puget Sound Ecosystem Monitoring Program or PSEMP) conducts considerable marine forage fish and groundfish research in Puget Sound but focuses on the accumulation of toxic contaminants in these species. The unit is led by Sandy O'Neill and also consists of Rob Fisk, Louisa Harding, Mariko Langness, and Molly Shuman-Goodier, Wes Flynn, Andrea Cary, Dwight Causey, Danielle Nordstrom, and Andrew Beckman. A second work unit within the Fish Management Division is the Marine Fish Science (MFS) Unit, which itself is broadly separated into three groups that deal with distinct geographic regions and/or species assemblages (Puget Sound Groundfish, Marine Forage Fish, and Coastal Marine Fish), though there is some overlap of senior staff. The entire MFS Unit is overseen by Theresa Tsou, while Lisa Hillier oversees the Unit budget, manages the Washington Conservation Corps (WCC) survey group with Kate Olson, and assists with stock assessments both on the coast and in Puget Sound. Kathryn "Kat" Meyer is the lead of the Puget Sound Groundfish Unit; Phill Dionne leads the Marine Forage Fish Unit; and as of June 1, 2023, Fabio Prior Caltabellotta leads the Coastal Marine Fish Unit.

Puget Sound Marine Fish Science (PSMFS) Unit ~ Groundfish

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 key species (and species groups) of interest. 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 Yelloweye Rockfish and Bocaccio in the Puget Sound/Georgia Basin DPS since 2010 (National Marine Fisheries Service 2010)[1].

In addition to Ms. Meyer, staff of the PSMFS Unit during the reporting period included Robert "Bob" Pacunski, Larry LeClair, Jennifer Blaine, Andrea Hennings, Mark Millard, Ian Craick, and Katie Kennedy. Ms. Meyer also serves as the Washington State representative on the Scientific and Statistical Committee (SSC) of the North Pacific Fishery Management Council (NPFMC). In 2018 Lisa Hillier was added to the NPFMC Groundfish Plan Teams for both the Bering Sea and Gulf of Alaska.

[1] Canary Rockfish were also listed in 2010 but were delisted in 2017 based on more recent genetic studies showing no difference between PSGB and coastal populations.

Marine Forage Fish (MFF) Unit

Forage fish in Washington are managed under the auspices of the Forage Fish Management Plan (Bargmann 1998) and managed by members of the statewide Marine Forage Fish (MFF) Unit, which works primarily in Puget Sound. Together with Phill Dionne, the MFF Unit is composed of Erin Jaco, Emily Seubert, Kate Olson, and Esmeralda Farias, and the six person WCC Crew. In early 2024, Ash Cameron, Henry Stier, and Sam Caviar also joined the MFF unit. 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).

Primary Contacts – Puget Sound, Forage Fish, and TBiOS:

Groundfish Monitoring, Research, and Assessment

- *Kathryn (Kat) Meyer: 360-302-6568, kathryn.meyer@dfw.wa.gov*

Forage Fish Stock Assessment and Research

- *Phill Dionne: 360-902-2641, phillip.dionne@dfw.wa.gov*

Toxics-focused Biological Observation System for the Salish Sea (TBiOS)

- *Sandie O'Neill: 360-480-3359, sandra.oneill@dfw.wa.gov*

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

Coastal Marine Fish Science (CMFS) Unit

Under the direction of Fabio Prior Caltabellotta, the staff of the CMFS Unit includes Rob Davis, Donna Downs, Hannah Christian, Kristen Hinton, Michael Sinclair, Matt Pellinger, Campbell Gunnell, Alec Cravens, Dan Lynch, Robert Weber, Walter Smith, Curtiss Robertson, Dan Wolfley, JM Swope, and Thomas Hargrove. Additionally, one technician from the PSMFS Unit, Katie Kennedy, has assumed port sampling duties for trips landed in Bellingham. CMFS Unit tasks are supported through a combination of state general and federal funds. CMFS 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, coastal rockfish research projects, and the monitoring and management of ocean pink shrimp. In the last two years, the coastal unit has expanded to also include the monitoring and management of coastal pelagic species (CPS), including finfish and squid species, through collaborative research projects with federal and industry partners.

Groundfish, highly migratory species (HMS), and CPS on the Washington coast are subject to state regulatory and policy authority as well as to federal management under the Magnuson-Stevens Fishery Conservation and Management Act and the PFMC's fishery management plans for groundfish and CPS. The Department's Forage Fish Management Plan also guides management of coastal fishery resources in state waters. The MFS Unit contributes fishery policy and scientific support for federal west coast groundfish, HMS, and CPS management via participation on the Highly Migratory Species Management Team (HMSMT, Phill Dionne), Coastal Pelagic Species Management Team (CPSMT, Lisa Hillier), and the Scientific and Statistical Committee (SSC, Theresa Tsou) of the Pacific Fishery Management Council (PFMC). Landings and fishery management descriptions for PFMC are summarized annually in the Stock Assessment and Fishery Evaluation (SAFE) documents.

Additional west coast fishery management support is provided by the Intergovernmental Ocean Policy Unit, which consists of Heather Hall (lead), Corey Niles, Lorna Wargo, Whitney Roberts, and Victoria Knorr. Whitney and Lorna also serve on the PFMC's Groundfish Management Team (GMT). Further support is provided to the PFMC by Randi Thurston, who serves on the Habitat Committee.

Primary Contacts – Coastal MFS Unit:

Groundfish Management, Monitoring, Research, and Assessment –

- *Fabio Prior Caltabellotta: 564-224-0000, fabio.priorcaltabellotta@dfw.wa.gov*
- *Heather Hall: 360-902-2487, heather.hall@dfw.wa.gov (Ocean Policy Lead)*

Coastal Pelagic Species /Forage Fish Management, Monitoring, Research, and Assessment

- *Phill Dionne: 360-902-2641, phillip.dionne@dfw.wa.gov*
- *Lisa Hillier: 253-250-9753, lisa.hillier@dfw.wa.gov*

Highly Migratory Species Management

- *Corey Niles: 360-902-2733, corey.niles@dfw.wa.gov (Coastal Marine Policy Lead)*
- *Phill Dionne: 360-902-2641, phillip.dionne@dfw.wa.gov*

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

II. SURVEYS

A. 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). Surveys in 1987, 1989, and 1991 were semi-stratified random surveys of the majority of Puget Sound. From 1994-1997 and 2000-2007, surveys were annual, stratified-random surveys focusing on individual sub-basins (WDFW unpublished data; Palsson et al. 1998; Blaine et al. 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).

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; in 2014 and 2015, stations JEWU and CSNV were moved slightly to accommodate concerns raised by fiber-optic cable companies; and in 2020, the survey was unable to be executed due to the COVID-19 pandemic.

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 ~0.40 nautical miles at a speed of 1-3 knots, with an average to duration of 11 minutes. The resulting catch is identified to the lowest taxonomic level possible, weighed, counted, and most of the catch is returned to the sea. The

density of fish at each station is determined by dividing the catch numbers or weight by the area sampled with the net, which is based on a mensuration study conducted in 1994 (WDFW unpublished data). A small portion of the catch is retained for biological sampling, either when fresh on deck or after being preserved (freezing, ethyl alcohol, or formalin) for processing in the laboratory. Samples collected may include fin clips (genetics); scales, spines, and otoliths (ageing); stomachs and intestines (gut contents); and muscle tissue (stable isotopes). When necessary, whole specimens may also be retained for positive identification or special projects being conducted by the WDFW or its collaborators.

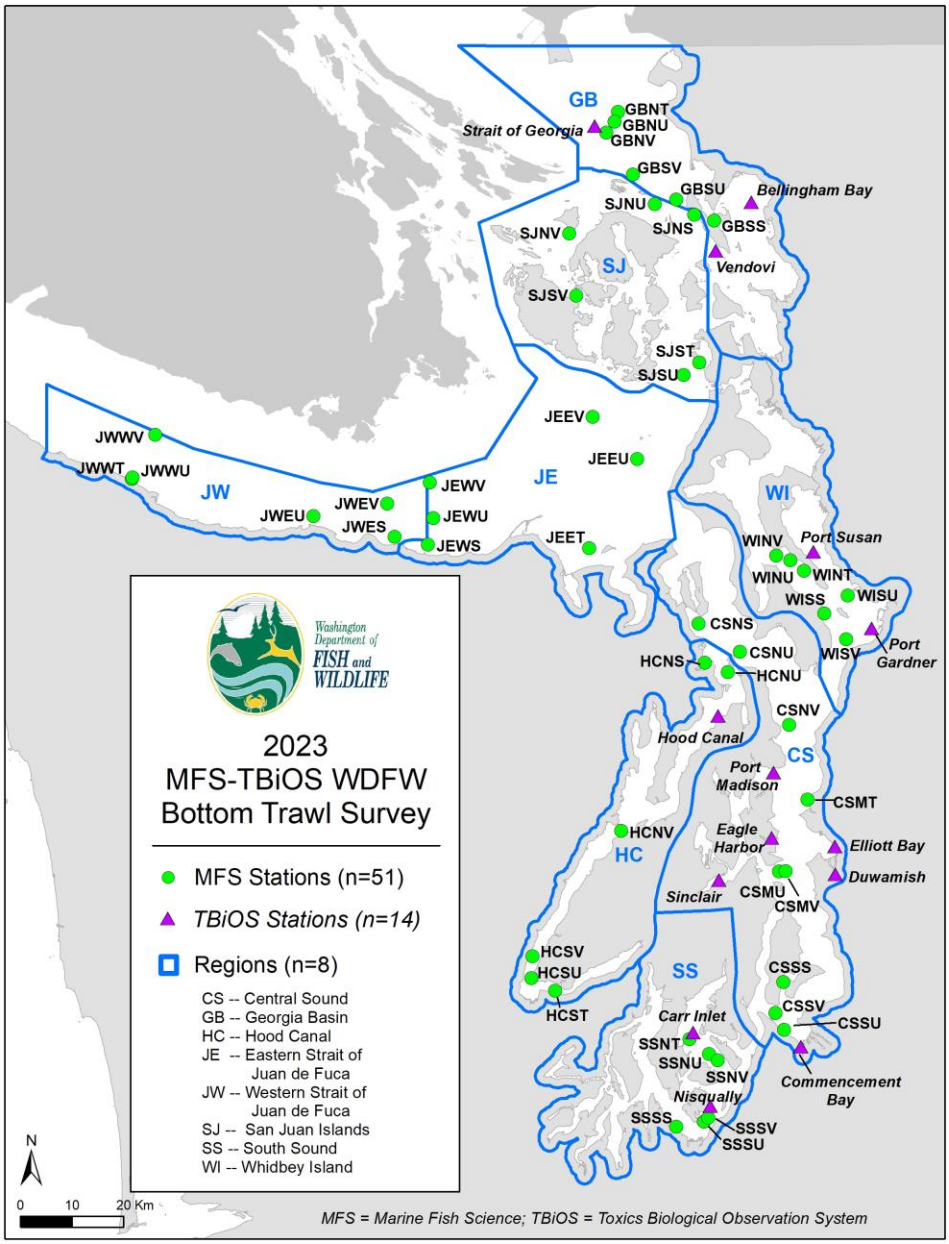

Figure 1: Survey map for the 2023 bottom trawl survey. Green dots indicate MFS Index stations, sampled each year since 2008 (with the exception of 2020). Purple triangles indicate TBiOS stations, sampled biennially.

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 (kg/ha and ind/ha per species) at that station since 2008. If the fish species comprising the majority (>75% by weight) of the catch fall within the previous years' average (+/- 1 standard deviation), no second tow is conducted at that station. If it is determined that the species composition was substantially different than expected (i.e., falls outside of the range of mean +/- 1 standard deviation), a second tow is conducted. This greatly improves the efficiency of the survey, as an average of only two stations have required a second tow each year. In 2014 HOBO accelerometers, which serve as bottom contact sensors, were added to the footrope to improve our understanding of net performance and the collected data will be used to increase the accuracy of density estimates from the trawl. A mini-CTD was deployed from 2014-2017 and 2021 on the headrope to collect water quality data at each station and provide more accurate depth readings; however, no CTD casts were made during the 2018, 2019, 2022, or 2023 surveys due to equipment failures. In 2017, a Marport Trawl Explorer was also attached to the headrope to provide a live data feed regarding the net's depth, proximity to the bottom, and opening height; this unit has been deployed on nearly every tow since its acquisition.

2023 SURVEY RESULTS

The WDFW conducted the 15th annual index bottom trawl survey of Puget Sound from May 1 through June 7, 2023. During the 15 survey days, all 51 index stations were occupied, and a total of 52 index bottom trawls were conducted, as one station required a second tow.

All Fish

An estimated 45,740 individual fish belonging to 85 species or taxa and weighing 8.6 mt were caught during the survey. Overall, the total estimated bottomfish biomass and abundance for Puget Sound was 96,758 mt and 459.6 million individuals, respectively. Compared to the estimates from the 2022 survey (94,071 mt; 561.5 million individuals), the biomass increased slightly while the abundance decreased (Figure 2). Overall fish abundance had remained relatively consistent since 2017, but the decrease in 2023 brings abundance levels to their lowest level since 2016. Among the regions, Central Sound (CS) again supported the highest densities of bottomfish at 390 kg/ha and 1,401 fish/ha, substantially greater than those from any other region (
Figure 3). This biomass estimate was 40% higher than in 2022 due primarily to an increase in Spotted Ratfish biomass, but the abundance estimate was 23% lower due to declines in English Sole abundance and catches of Shiner Perch and Quillback Rockfish (which are species not well-suited to bottom trawl estimations). The Western Strait of Juan de Fuca (JW) had the second highest biomass density (168 kg/ha), while Whidbey Island (WI) and Hood Canal (HC) supported the second and third highest population densities (1,528 fish/ha and 1,069 fish/ha, respectively). A 57% increase in abundance and a 50% increase in biomass in WI were the largest changes of both estimates among regions between 2022 and 2023, and can be attributed primarily to increases of Ratfish, English Sole, and Pacific Hake, as well as additional abundance increases of sculpins and Shiner Perch. Other substantial shifts included a 43% increase in abundance in HC, due to increases of Plainfin Midshipmen, Pacific Herring, and several species of flatfish; a 42% decrease in abundance in JW, due to decreases in Ratfish and Walleye Pollock; and the previously mentioned 40% increase in biomass in CS. Among the regions, biomass and abundance estimates both increased in only South Sound (SS)

and WI. Compared to the averages of the previous five surveys (referred to as "5-year mean"), each region's biomass density, except WI's, fell within the standard deviation of the 5-year mean; the biomass density of WI (99.75 kg/ha) was slightly higher than the 5-year mean of 79.8 +/- 10.2 kg/ha. WI was also higher in terms of population densities, as was HC, while CS, GB, and JE fell below the standard deviations of the 5-year means.

As in previous years, Spotted Ratfish dominated the catch in terms of biomass, constituting 50% of the total fish catch by weight and 25% of the total number of individual fish, followed by English Sole at 13% and 18%, respectively. These catch rates equate to a biomass estimate of 47,760 mt for Spotted Ratfish (down from 47,984 mt in 2022) and 9,172 mt for English Sole (9,565 mt in 2022), and abundance estimates of 127 million and 67 million individuals, respectively (Figure 4). Compared to 5-year mean, Spotted Ratfish fall within one standard deviation of the mean for both biomass and abundance, while English Sole fall lower. The remaining individual fish species contributed 4% or less to the total fish catch weight and 5% or less to the total number of individual fish (aside from Pacific Hake at 10% and Walleye Pollock at 9%) 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). Codfishes and Other Flatfishes had the second and third highest abundance estimates (97 and 88 million individuals, respectively) among species groups; both groups were higher than the 5-year mean +- SD in terms of biomass and within the range in terms of abundance. Other Flatfishes also had the second highest biomass estimates at 16,106 mt, which surpassed the estimate of English Sole. 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 (and tend to be each year) Blackbelly Eelpouts and Shiner Perch.

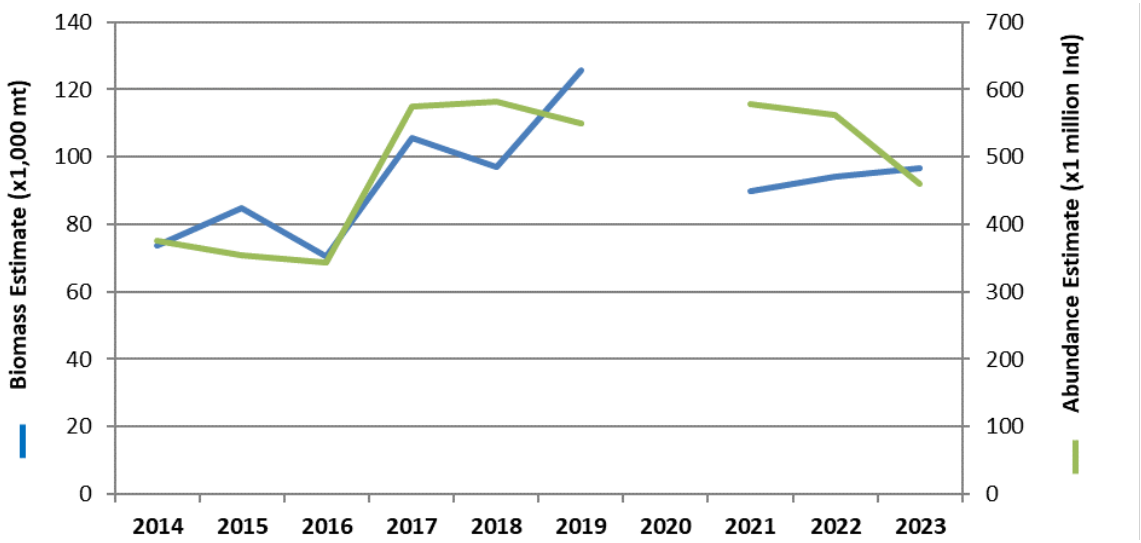

Figure 2: Estimates of bottomfish biomass (x 1,000 mt; primary axis) and abundance (x 1 million individuals; secondary axis) throughout Puget Sound from the annual bottom trawl surveys since 2014. No survey was conducted in 2020.

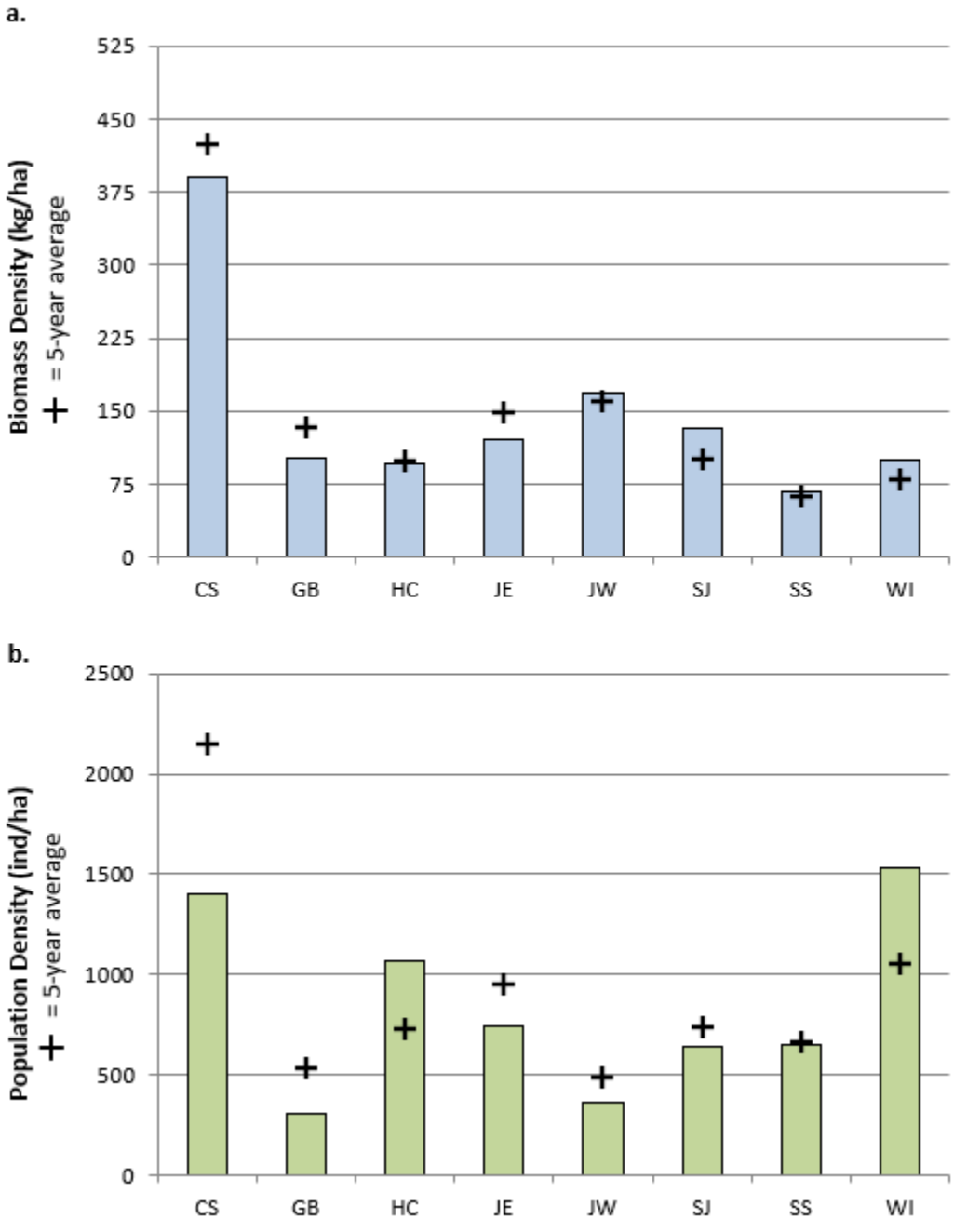

Figure 3: Estimates of bottomfish biomass density (kg/ha; graph a.) and population density (ind/ha; graph b.) in each of the eight regions of Puget Sound from the 2023 survey. Plus signs indicate the mean from 2017-2022, excluding 2020.

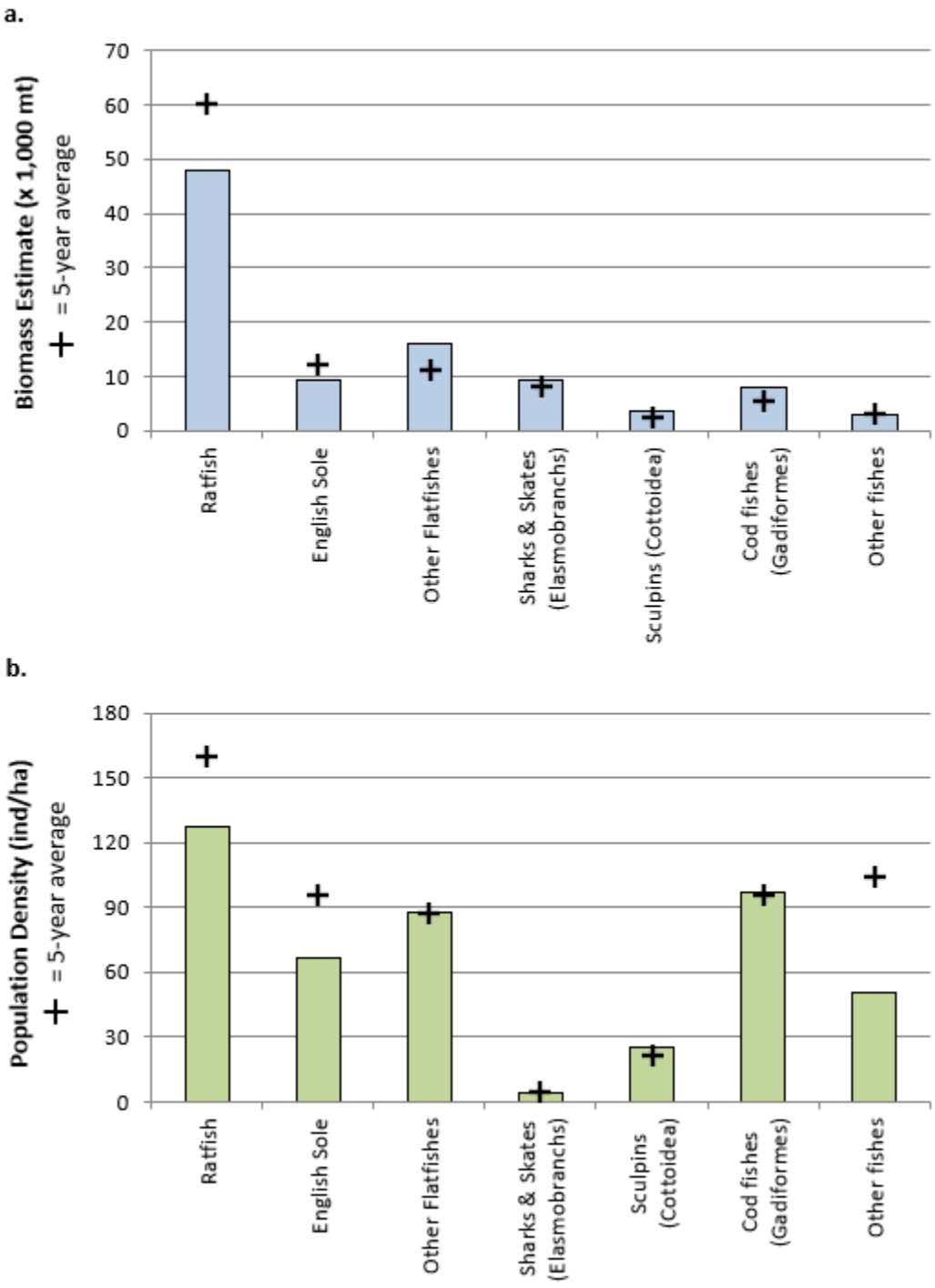

Figure 4: Estimates of bottomfish biomass (x 1,000 metric tons; graph a.) and abundance (x 1 million individuals; graph b.) from the 2023 survey. Species were combined into groups by taxa, with the exception of Spotted Ratfish and English Sole, the two most prominent species. Plus signs indicate the mean from 2017-2022, excluding 2020.

Flatfish

English Sole, as previously mentioned, were the most prevalent of the 15 species of flatfish encountered, with estimates of 9,172 mt and 67 million individuals (Figure 4); the biomass estimate was 4% lower than in 2022 while the abundance estimate was 23% lower. Among regions, HC and CS supported the highest biomass densities of English Sole at 39 kg/ha and 33 kg/ha, respectively, while WI and HC supported the highest population densities of 365 fish/ha and 364 fish/ha, respectively; the smallest densities were again found in JW at 4.6 kg/ha and 18 fish/ha. In terms of other flatfish species, Dover Sole (5,462 mt; 21.6 million individuals) and Rock Sole (4,458 mt; 22.9 million individuals) were the most dominant species by both weight and abundance after English Sole, followed by Pacific Sanddab (1,685 mt; 12.6 million individuals).

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. In JW, Dover Sole dominated the flatfish species (57% of regional flatfish biomass estimates), followed by Arrowtooth Flounder at 20%. In GB, Rock Sole were the most prominent flatfish species, comprising 52% of the region's flatfish biomass, followed by English Sole at 25%. In SS, both Rock Sole and Starry Flounder each comprised 34% of the region's flatfish biomass. Rock Sole were one of the top three flatfish species by biomass in each region except HC and JW, and Pacific Sanddab was one of the top four species in each region except JW. At least 10 species of flatfish were found in each region, with HC and WI having the fewest (10) species and JE and SJ having the most (13). Among the regions, CS supported both the highest biomass and population densities of non-English Sole flatfish species at 57 kg/ha and 330 fish/ha, respectively.

Sharks and Skates (Elasmobranchs)

Four species of elasmobranchs caught in the 2023 survey: North Pacific Spiny Dogfish, Big Skate, Longnose Skate, and Sandpaper Skate.

Compared to 2022, the catch of North Pacific Spiny Dogfish was higher both in terms of weight and number of individuals, with 154 kg and 102 fish caught in 2023 compared to 98 kg and 76 fish in 2022. 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 can be highly variable. For this reason, the trawl survey cannot be used as a reliable estimator of dogfish abundance but does allow for the collection of needed biological samples that will be used to inform a planned stock assessment for the species. Nevertheless, dogfish were found in all regions except SS, with 66% of the weight and 58% of the individuals being caught in GB. Lengths of individuals ranged from 28 cm – 105 cm, with an average of 68 cm; the largest individual was caught in GB.

The catch rate of Big Skates decreased from 411 kg and 106 individuals in 2022 to 332 kg and 86 individuals in 2023. Encounter rates of Big Skates were highest in SJ, which accounted for 54% of the biomass and 55% of the abundance, while those in GB accounted for 27% of the biomass and 10% of the abundance. Lengths of individuals ranged from 17 cm – 151 cm, with an average of 64 cm; the largest individual was caught in GB. Longnose Skate catch rates increased by weight from 2022 (152 kg) to 2023 (240 kg) but decreased by number of individuals (142 in 2022, 128 in 2023). Among the regions, SS supported the highest weight but the fewest individuals, while the most individuals were caught in WI. Lengths ranged from 16 cm – 154 cm, with an average of 56 cm; the largest individual was caught in SS. Lastly, 19 Sandpaper Skates were caught in 2023 – 13 in JE and 6 in GB. This catch

rate is tied for the highest since the beginning of the index survey design in 2008; 19 individuals were also caught in 2018 (6 in JW, 8 in JE, and 5 in GB). Lengths ranged from 31 cm – 64 cm, with an average of 49 cm; the largest individual was caught in JE.

Codfishes (Gadiformes)

Fewer Pacific Cod were caught in 2023 compared to 2022, but the fish were larger on average and thus equated to a higher total weight; 201 fish were caught in this year's survey, weighing a total of 287 kg, compared to 283 fish and 209 kg in 2022. This catch rate resulted in an estimated population density of 8.6 ind/ha in JW, 2.6 ind/ha in GB, 7.6 ind/ha in SJ, 5.6 ind/ha in JE, and 0.6 ind/ha in CS, all of which were lower than in 2022 (Figure 5). Pacific Cod caught in the 2023 survey ranged in size from 31 cm to 71 cm, with an average length of 51 cm (38 cm in 2022).

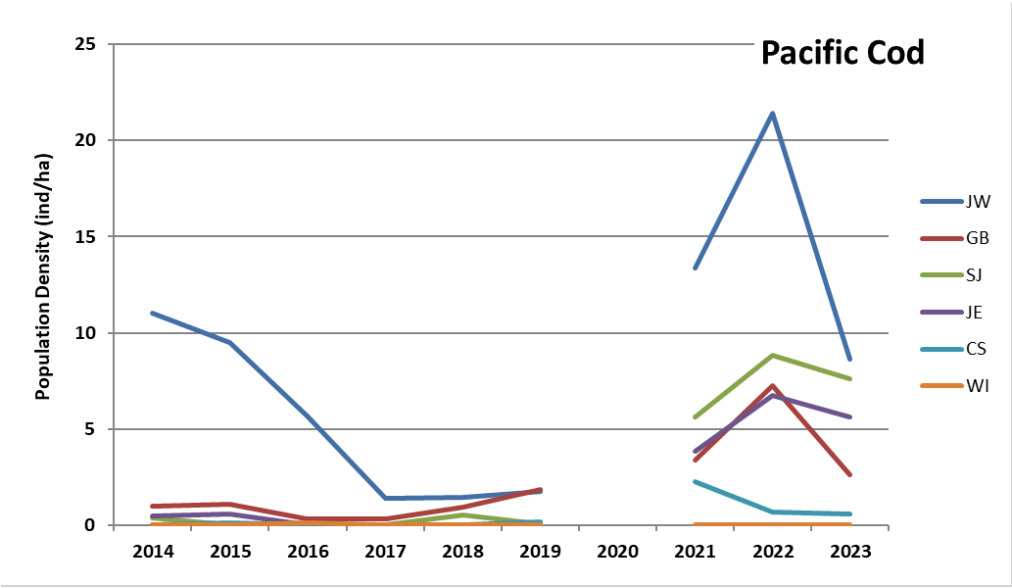

Figure 5: Population density (individuals/hectare) of Pacific Cod caught in the 2014-2023 bottom trawl surveys, by region. No survey was conducted in 2020.

The Pacific Hake biomass estimate increased to 1,172 mt from the 2021 survey estimate of 672 mt, and the abundance estimate soared to 23.7 million individuals from 7.9 million in 2022. Hake were found in each region but were most abundant in WI, which is typical; 84% of the abundance and 57% of the biomass was found in WI. Walleye Pollock were found in each region except SS, but JE and SJ supported the largest catch both in terms of abundance and biomass. Pollock biomass estimates increased from the 2022 survey to 3,074 mt from 2,615 mt while abundance estimates decreased from 83.9 million individuals in 2022 to 64.18 million in 2023.

ESA-Listed Species

Three ESA-listed species were encountered during the 2023 survey. Pacific Eulachon was (and is typically) the most common with 16 individuals caught, a drop of 61% from the catch of 41 individuals in 2022. Eulachon were encountered in GB, JE, JW, and CS, with the majority being caught in JE and JW. All Eulachon were retained and sent to the WDFW Forage Fish lab for further analysis. The other listed species encountered were two Chinook Salmon and one Yelloweye

Rockfish. Of the salmon, one was a wild-origin adult measuring 84 cm and 6.62 kg caught in JE that was released alive; the other was a hatchery/clipped smolt caught in GB and weighing 0.01 kg (length not taken). The Yelloweye Rockfish, a 27-cm-female, was also caught in GB; it had suffered significant barotrauma and was sacrificed for otolith and genetic samples.

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, the 2023 survey caught 334 rockfish – less than half the number caught in 2022 (Table 1). Thirteen species were represented in the catch, including Darkblotched Rockfish for the third year in a row. Consistent with previous surveys, Quillback Rockfish were most abundant and accounted for 81% (n = 269) of all rockfish caught, although 108 fish were caught at one station (CSNU); this was similar to 2022 where the majority were also caught at one station. Also consistent with recent surveys, Brown Rockfish were the second most abundant species with 25 individuals caught, a 73% decline from the 2021 and 2022 catches. Other notable catches include the most Greenstriped Rockfish caught since 2012; two Redbanded Rockfish, which have only been caught six times since the inception of the trawl survey in 1987; and a Yelloweye Rockfish, the first since 2013. As previously mentioned, the Yelloweye Rockfish was sacrificed for otoliths and genetics samples.

Table 1: Rockfish species counts caught in the bottom trawl survey from 2014-2023.

Species	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Black Rockfish	1	-	-	-	-	-	*N/A*	-	-	-
Bocaccio	-	-	11	7	3	-	*N/A*	-	-	-
Brown Rockfish	2	13	15	16	42	14	*N/A*	91	91	25
Canary Rockfish	-	1	-	2	3	3	*N/A*	15	5	10
Copper Rockfish	27	7	4	4	123	9	*N/A*	18	10	6
Darkblotched Rockfish	-	-	-	-	-	-	*N/A*	6	4	2
Greenstriped Rockfish	2	5	2	8	5	1	*N/A*	-	1	12
Puget Sound Rockfish	9	2	-	-	1	-	*N/A*	1	-	1
Quillback Rockfish	41	34	117	235	344	207	*N/A*	159	589	269
Redbanded Rockfish	-	-	1	-	-	-	*N/A*	-	-	2
Redstripe Rockfish	5	4	6	8	4	9	*N/A*	3	5	1
Rockfish uniden.	-	-	-	-	-	-	*N/A*	-	-	1
Shortspine Thornyhead	-	-	-	-	1	1	*N/A*	-	1	
Splitnose Rockfish	-	-	2	-	3	1	*N/A*	6	2	1
Vermilion Rockfish	-	-	-	-	-	-	*N/A*	1	-	-
Yelloweye Rockfish	-	-	-	-	-	-	*N/A*	-	-	1
Yellowtail Rockfish	-	7	-	13	59	5	*N/A*	3	3	3
Total	**87**	**73**	**158**	**293**	**588**	**250**	***N/A***	**303**	**711**	**334**

Like rockfish, Lingcod exhibit a preference for untrawlable habitats, and therefore the bottom trawl is a poor survey method for assessing their populations. In the 2023 survey, 12 Lingcod were caught, which is similar to the catch rates in 2022 and 2019, but far less than the 52 caught in 2021. Individuals ranged in size from 29 cm to 65 cm, with an average length of 45.5 cm. They were caught in four regions, with CS and JW each producing five and GB and SJ producing one. Five sublegal Lingcod were retained whole for WDFW biologists to collect additional samples, fin-ray samples were taken for genetics analysis from four, and the remaining three were released alive.

Sablefish (aka “Black Cod”), which have been caught in the survey the previous five years, were again found in the survey this year. Fourteen individuals were caught—ten in JW and four in JE—compared to 6 in the 2022 survey. The lengths ranged from 36 cm to 63 cm, with an average of 46 cm. Fin clips were taken from seven individuals for genetic analysis, and all individuals were released alive.

Other less-frequently caught species caught in 2023 included a Fourhorn Poacher, a Northern Smoothtongue, and two Pacific Spiny Lumpsuckers.

All Invertebrates

An estimated 53,897 individual invertebrates from 86 different species/taxa weighing 1.2 mt were caught in the 2023 survey. Overall, the total estimated invertebrate biomass and abundance for Puget Sound was 14,577 mt and 768 million individuals. The biomass estimate is lower than in 2022 (19,565 mt) while the abundance estimate is slightly higher (2022 = 749 million individuals); invertebrate biomass has been decreasing since 2018, but this is the first year since 2017 that the abundance has not decreased (Figure 6). Among the regions, WI supported the highest biomass density at 53 kg/ha (Figure 7). Similar to recent years, however, JE and SS had the highest population densities at 2,398 ind/ha and 2,316 ind/ha, respectively. Compared to 2022, biomass densities only increased in two of the regions—WI and HC (+183% and +2%, respectively)—while the largest decrease occurred in JW (-65%). Compared to the 5-year mean +-SD ranges, WI, HC, and SS fell within their range, but the remaining regions fell below. WI’s major increase can be largely attributed to higher catch rates of Metridium spp., Dungeness Crab, and several species of shrimp. These species groups also attributed to the 166% increase in abundance densities in WI. HC also had a large increase (111%) in abundance compared to 2022, which was primarily attributed to higher catches of “Other inverts”, particularly Rosy Tritonia, jellyfish species, and California Market Squid. Overall, abundance density estimates increased in all but two regions—JE and JW, which were also the only two regions to fall below the 5-year mean +- SD ranges for population density.

By weight, the most dominant species groups were Metridium anemones, Dungeness Crab, and shrimp, comprising a respective 32%, 29%, and 29% of the total invertebrate catch (Figure 8). By number of individuals, shrimp were by far the predominant species group, comprising 95% of the total number of invertebrates caught. Of the 14 species of shrimp identified, Alaskan Pink Shrimp and Dock Shrimp were by far the most abundant species. The remaining (i.e., not Metridium, Dungeness Crab, or shrimp) invertebrate species contributed 1% or less to the total invertebrate catch by weight or by number. Compared to the 5-year mean +-SD ranges, only Metridium, Bivalves, and Other Invertebrates fell within their ranges in terms of biomass, while the other species groups fell below. In terms of abundance, Dungeness Crab, Shrimp, Other Brachyuran Crabs, and Other Invertebrates fell below while the others fell within their ranges.

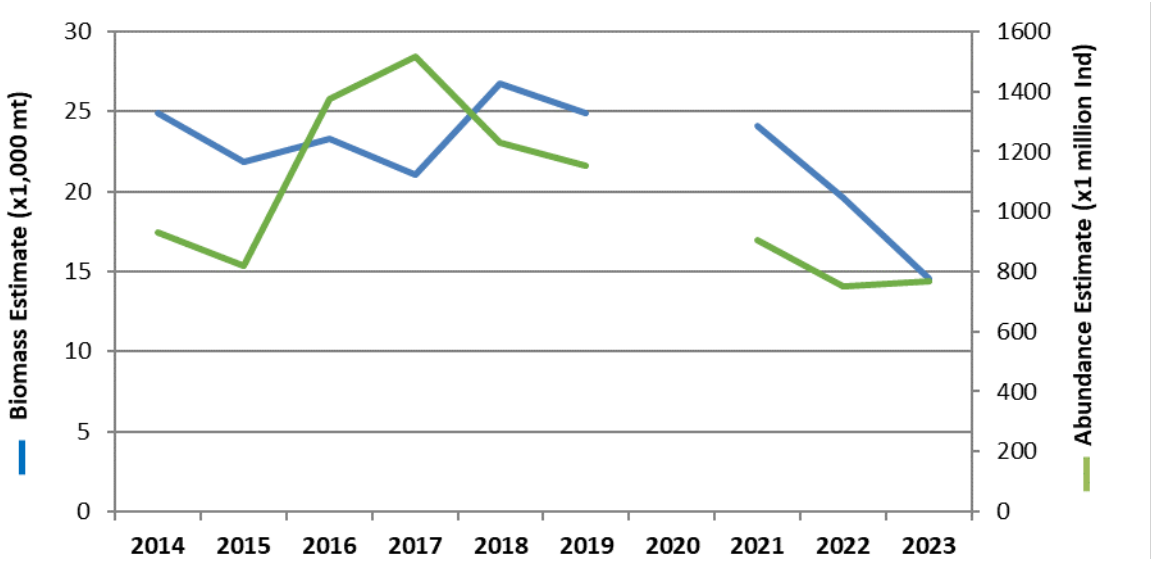

Figure 6: Estimates of invertebrate biomass (x 1,000 mt) and abundance (x 1 million individuals) throughout Puget Sound from the annual bottom trawl surveys since 2014. No survey was conducted in 2020.

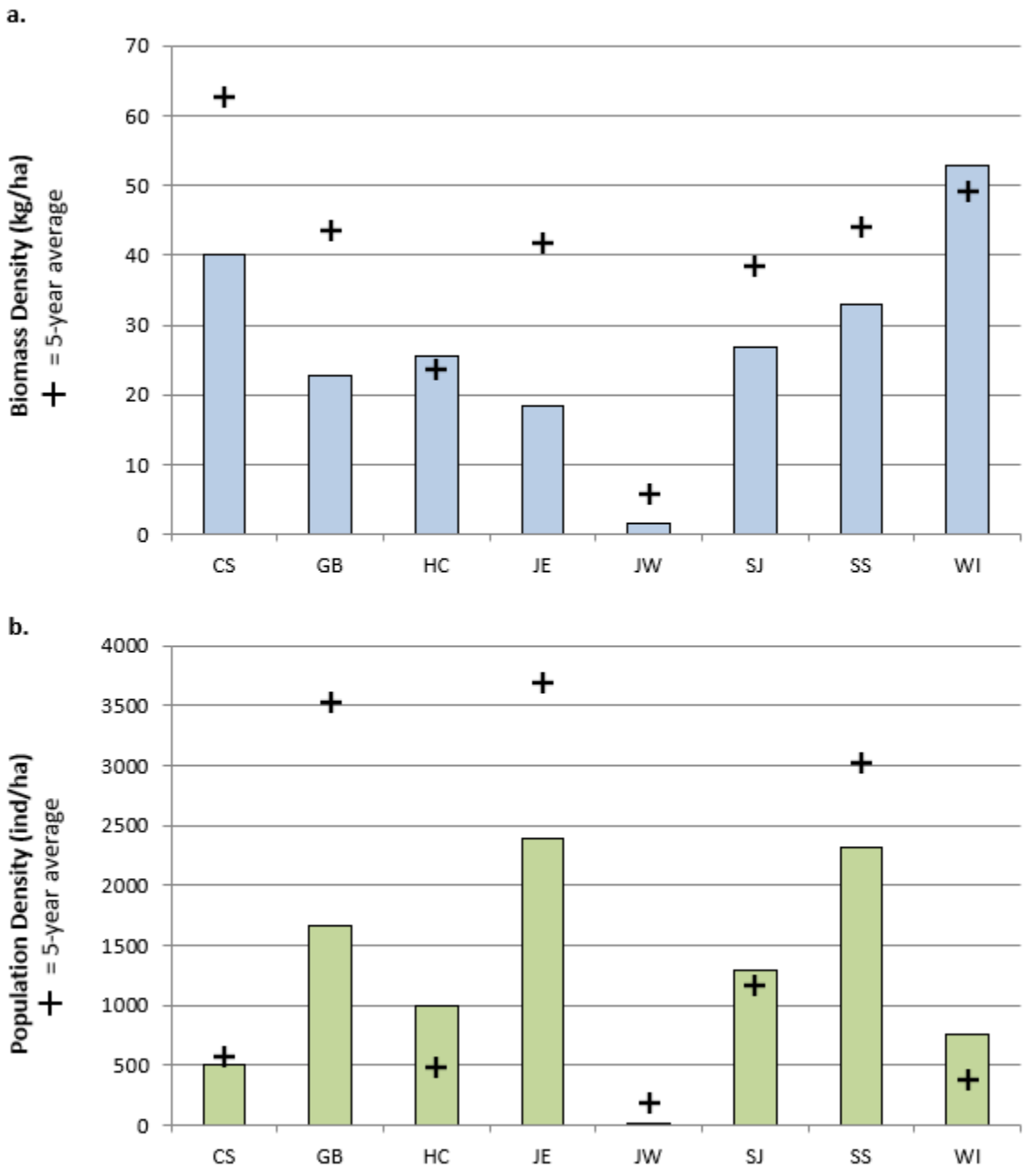

Figure 7: Estimates of invertebrate biomass density (kg/ha; graph a.) and population density (ind/ha; graph b.) in each of the eight regions of Puget Sound from the 2023 trawl survey. Plus signs indicate the mean from 2017-2022, excluding 2020.

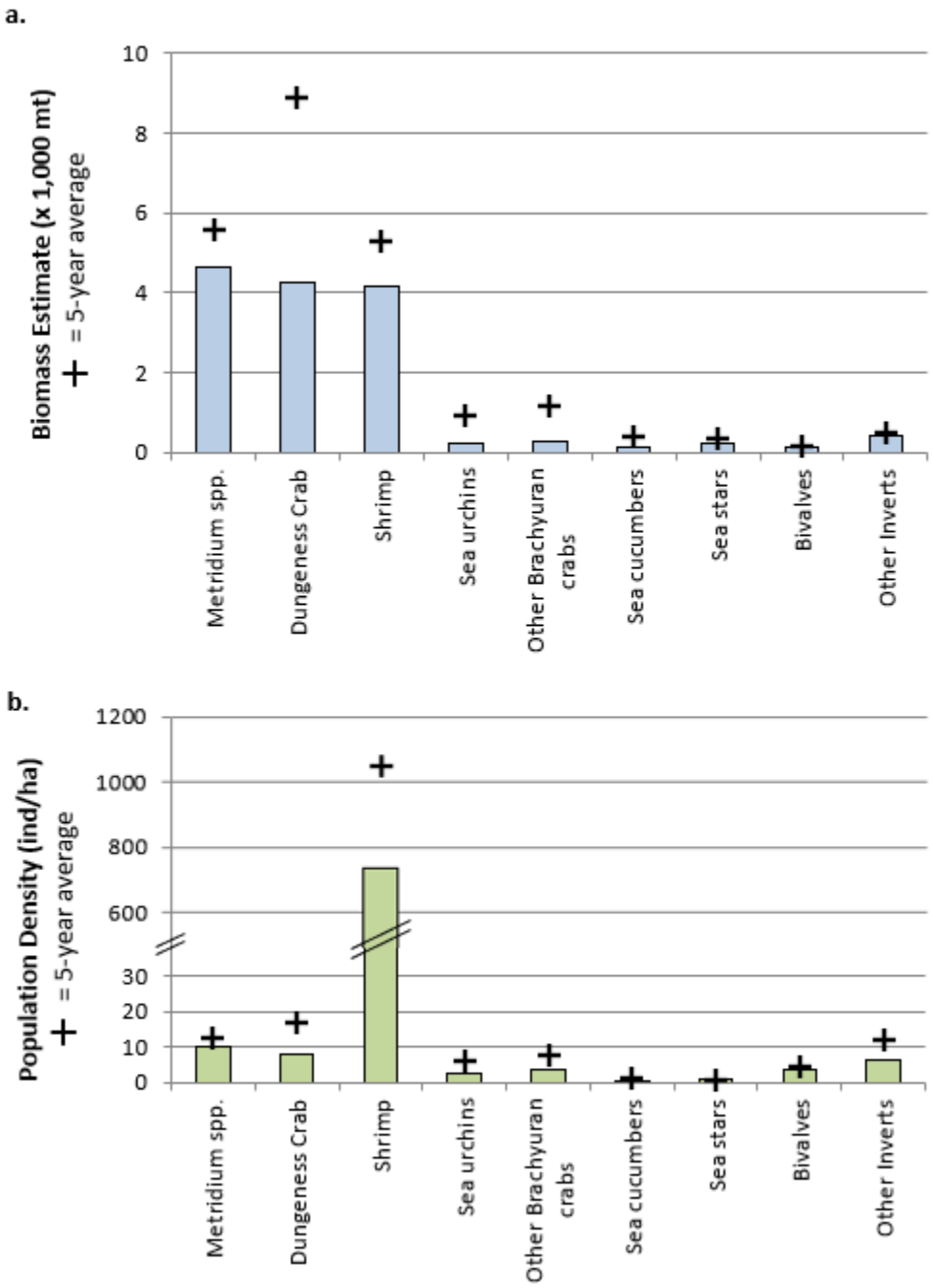

Figure 8: Estimates of invertebrate biomass (x 1,000 metric tons; graph a.) and abundance (x 1 million individuals; graph b.) from the 2023 survey. Species were combined into groups by taxa, with the exception of Dungeness Crab and Metridium spp, which were the two most prominent species. Plus signs indicate the mean from 2017-2022, excluding 2020.

Dungeness Crab

Dungeness Crab, a popular commercial and sport fishing target, had lower estimates than in 2022. Biomass in 2023 was estimated at 4,266 mt compared to 6,889 mt in 2022, while abundance in 2023 was estimated at 8 million individuals compared to 14 million in 2022. SJ harbored the largest density of Dungeness by biomass (14 kg/ha) while HC harbored the largest density by abundance (37

individuals/ha). Catch of Dungeness in SS had been low in recent years, but for the first time since the inception of the trawl survey in 1987, no Dungeness were caught in SS. Males outnumbered females in GB, HC, SJ, and <barely> WI. During the survey, 215 females and 235 males were caught for a total of 450, which was roughly half of the catch rate from 2022.

Spot Prawn

Spot Prawn, another popular commercial and sport fishing target, comprised 28% of the total shrimp biomass in 2023, with an estimate of 1,150 mt and 49.8 million individuals; this biomass estimate is similar to that in 2022 of 1,220 mt, but the abundance estimate is lower compared to 62.1 million individuals in 2022. On a regional basis, JE supported the largest population by both biomass and population densities, comprising 40% and 35% of both totals, respectively. SJ supported the second highest densities, comprising 28% of the biomass and 26% of the abundance. All other regions contributed 18% or less to either density total.

Sea Stars

A total of 55 sea stars, representing 13 species and weighing a total of 14.1 kg, were caught in the 2023 survey compared to 45 sea stars weighing 18.7 kg in 2022; this catch equates to a Sound-wide biomass estimate of 250 mt and an abundance estimate of 902,000 individuals. Compared to 2022 estimates, the 2023 biomass estimate was lower while the population estimate was higher; this was the first increase in abundance since 2018 (Figure 9). Sea stars were caught in all 8 regions, with HC supporting the highest biomass density and CS the highest population density. Low population levels during 2015 and 2016 are believed to be directly tied to the sea star wasting disease epidemic; the 2017 and 2018 bottom trawl data seemed to indicate the beginning of a recovery, but data from recent years suggest that the population is roughly maintaining levels rather than exhibiting a substantial rebound to pre-epidemic levels. Additionally, just 3 Sunflower Stars, which was one of the most affected species in the epidemic, were caught in 2023 compared to 7 in 2022, 17 in 2021, 21 in 2019, and 16 in 2018; two were found in JE, and one was found in WI.

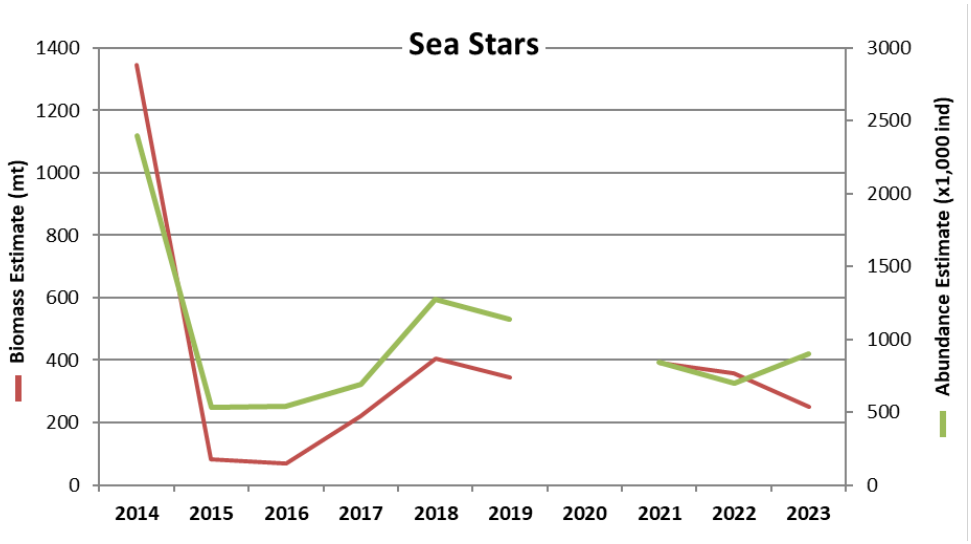

Figure 9: Estimates of sea star biomass (mt) and abundance (x 1,000 individuals) throughout Puget Sound from the annual bottom trawl surveys since 2014. No survey was conducted in 2020.

OTHER RESULTS

While the primary objective of the bottom trawl survey is to gather population data for bottomfish, the regularity and scope of the survey, and the vast number of fish handled during it, provide a unique opportunity to assist other research. In total, we collected 219 genetic samples from Pacific Cod, Lingcod, Spiny Dogfish, Sablefish, and 12 species of rockfish. We also collected 172 age samples (otoliths) from rockfish and Pacific Cod; all of these samples were or will be sent to the respective labs (Genetics and Aging) at the WDFW for analysis or to partner researchers for ongoing, collaborative projects. Additionally, 529 fish or other samples were preserved for other researchers. The majority of these fish were collected for other researchers at WDFW – including members of the Forage Fish unit, Shellfish unit, TBIOS, and Wildlife programs – to aid in their projects. The UW/Burke Museum received 5 fish specimens needed for their fish collection and genetic bank studies or to verify identifications. A researcher at NOAA received fin clips from 40 Walleye Pollock for genetic research, and King County biologists received 38 English Sole for their toxics research. Additionally, a professor at San Francisco State University received 6 ratfish egg cases for her ratfish development research. Lastly, since the end of the 2022 trawl survey, at least 10 data requests from various researchers and other WDFW divisions were fulfilled using bottom trawl survey data.

CONCLUDING NOTES

The 2023 WDFW bottom trawl survey saw a return to "normal" operations compared to the COVID operations of the previous two years. This meant that staff were able to sleep on the boat and the boat was able to anchor at night rather than running back to a port, which increased efficiency and decreased overall costs. The Marine Fish Science and TBIOS units coordinated their sampling schedules throughout the survey period to reduce extra running time on the boat's behalf, and all planned stations were sampled to continue the time series of the index design. Based on the abnormal number of mud tows encountered during last year's survey, new sideboards with mesh screens were built for the sampling table to aid in rinsing and draining the catch; however, no mud tows were encountered this year – a welcome relief to the crew that also improved survey efficiency.

WDFW staff continue to use iForms to electronically input most data in the field and utilize barcodes for sample identifiers, which greatly reduces data entry errors, increases the ability to backup data while in the field, and improves the efficiency with which data are error-checked and finalized in the database. We also continue to use the Marport mensuration gear to monitor the net in real time to determine when the net is on bottom (i.e., fishing). The Trawl Explorer unit (mounted to the headrope) was updated in 2021 to record the depth and temperature data for future analysis, but the 2022 data were unusable due to a hardware malfunction, and it has yet to be determined whether the 2023 data fared better. The Hobo footrope accelerometers were also working on every tow, and between survey seasons we plan to analyze the data collected over the past several surveys to improve the area swept calculation process and thereby increase the precision of the population estimates. The results of that analysis will also be used to develop a correction factor that can be applied to previous index survey estimates.

One of the benefits of the annual bottom trawl survey is the potential for detecting signs of repopulation after years of overfishing or disease. The 2017 survey saw the reappearance of sablefish after a 5-year absence in the survey, so the continued presence of the species in recent surveys is promising. Additionally, the sea star populations following the 2013-15 "Sea Star Wasting Disease" epidemic and mass die-off along the West Coast have remained relatively consistent the past few

years. The decline of sea star populations in Puget Sound was captured in this bottom trawl dataset, and the Sunflower Star was exceptionally susceptible to the disease. Sunflower Stars are currently being considered for ESA listing and the trawl survey dataset is being used as one source of population data to inform this decision.

The WDFW bottom trawl survey is the largest, most geographically expansive, methodologically consistent, 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 (e.g., oil spills, earthquakes), and/or environmental shifts. In 2020, a multi-year survey report covering the 2002-2007 trawl surveys was published as a WDFW technical report (Blaine et al., 2020), which can be found on the WDFW website. The next multi-year survey report covering the index surveys is currently in progress (Blaine et al., in prep).

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 SFSU are researching the embryonic development of Spotted Ratfish; NOAA is building a collection of fish genetics; and WDFW is collaborating with UW on studies of rockfish and Pacific Cod genetics; 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.

The 2024 bottom trawl survey will occur from 29 April – 24 May 2024.

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For more details on the bottom trawl survey, contact Jen Blaine (jennifer.blaine@dfw.wa.gov).

B. Annual Pacific Herring Assessment in Puget Sound

Consistent with previous years, Pacific herring stocks in Puget Sound (southern Salish Sea) were assessed by WDFW staff through spawn deposition field surveys from January through June using the established methods of Stick et al. (2014) and Sandell et al. (2019). WDFW staff based in the Olympia, Mill Creek, and Port Townsend offices 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, fecundity, etc., of the herring stocks). A summary of the results of annual surveys are shared on the Puget Sound Partnership's Vital Sign webpage as an indicator of the health of the Puget Sound (https://vitalsigns.pugetsoundinfo.wa.gov/VitalSignIndicator/Detail/36).

WDFW monitors 21 herring spawning areas in Puget Sound (Figure 10) and two coastal areas (Willapa Bay and Grays Harbor), based primarily on the timing and location of spawning activity. Historically there were three distinct genetic groupings (Cherry Point, Squaxin Pass, and the "all other stocks" complex); however, recent research focusing on SNP sequencing has determined that, at present, only the Cherry Point and Elliott Bay stocks are unique – the remaining spawning areas now comprise the "Other Stocks" complex (Petrou et al., 2021). Within this group, research has identified differences in spawn timing that include "Early Winter" (Jan-Feb), "Late Winter" (Feb-March), and "Spring" (April and later) groupings; however, only five of the spawning areas have been fully analyzed to date.

The 2023 spawn deposition field season began the first week of January and continued until mid-June. Over 3,500 points were surveyed during this season and included all 21 primary spawning areas of Puget Sound herring stocks. The estimated spawning biomass (ESB) in 2023 was 17,943 mt, which was about 68% above the previous 10-year average but still below the recent 2020 high estimate (18,559 mt). This was mainly driven by another record-high Orchard-Port Madison spawning area return (7,473 mt), and new record-high ESB for the Purdy spawning area (3,031 mt). The Quilcene Bay spawning area, which has been one of the most abundant stocks in recent years had its lowest ESB (1,465 mt) in over a decade, but it still had the fourth highest ESB of the 2023 season, just behind the Skagit Bay spawning area (1,818 mt). The genetically distinct, late-spawning Cherry Point stock ESB continued to decline, and for the first time since surveys began in 1973, we did not document any evidence of spawning by this stock; we were unable to survey north of the Canadian

border, though, so it is possible this stock spawned outside of our survey area. Other areas we failed to detect spawning in 2023 were northwest San Juan Island, Wollochet Bay, Quartermaster Harbor, and Elliott Bay. Spawning was observed in south Hood Canal and Discovery Bay after two consecutive years without observing spawning.

Coastal surveys of Willapa Bay and Grays Harbor stocks were limited by staff availability and adverse weather and were not surveyed in 2023. In general, herring spawning biomass for these areas is relatively small compared those of the southern Salish Sea.

The estimated spawning biomass totals are provided in Table 2. Figure 11 shows the marked shift from a broadly based spawn deposition (heaviest in the North through mid-1990s) towards the dominance of the few stocks mentioned above beginning in 2016. In addition to shifts in abundance, we've also observed recent shifts and expansions in spawning habitat, with several new areas documented in 2023. As a result of these recent shifts, we've begun updating spawning area maps online annually (https://wdfw.maps.arcgis.com/home/webmap/viewer.html?webmap=19b8f74e2d41470cbd80b1af8dedd6b3).

The annual ESB is used for setting the harvest guideline for the commercial herring fishery in Puget Sound. Herring are harvested primarily with lampara net gear in Puget Sound, and the fishery is a limited-entry fishery with an annual harvest guideline of up to 10% of the annual ESB. The fishery has regional seasonal closures and is limited to use for bait or human consumption. Herring harvest is largely driven by demand for bait by local recreational fisheries. Despite recent ESB increases, commercial harvest has remained relatively stable. The 10-year average of commercial landings of herring in Puget Sound is 215 mt, and the commercial landings in 2023 were 210 mt.

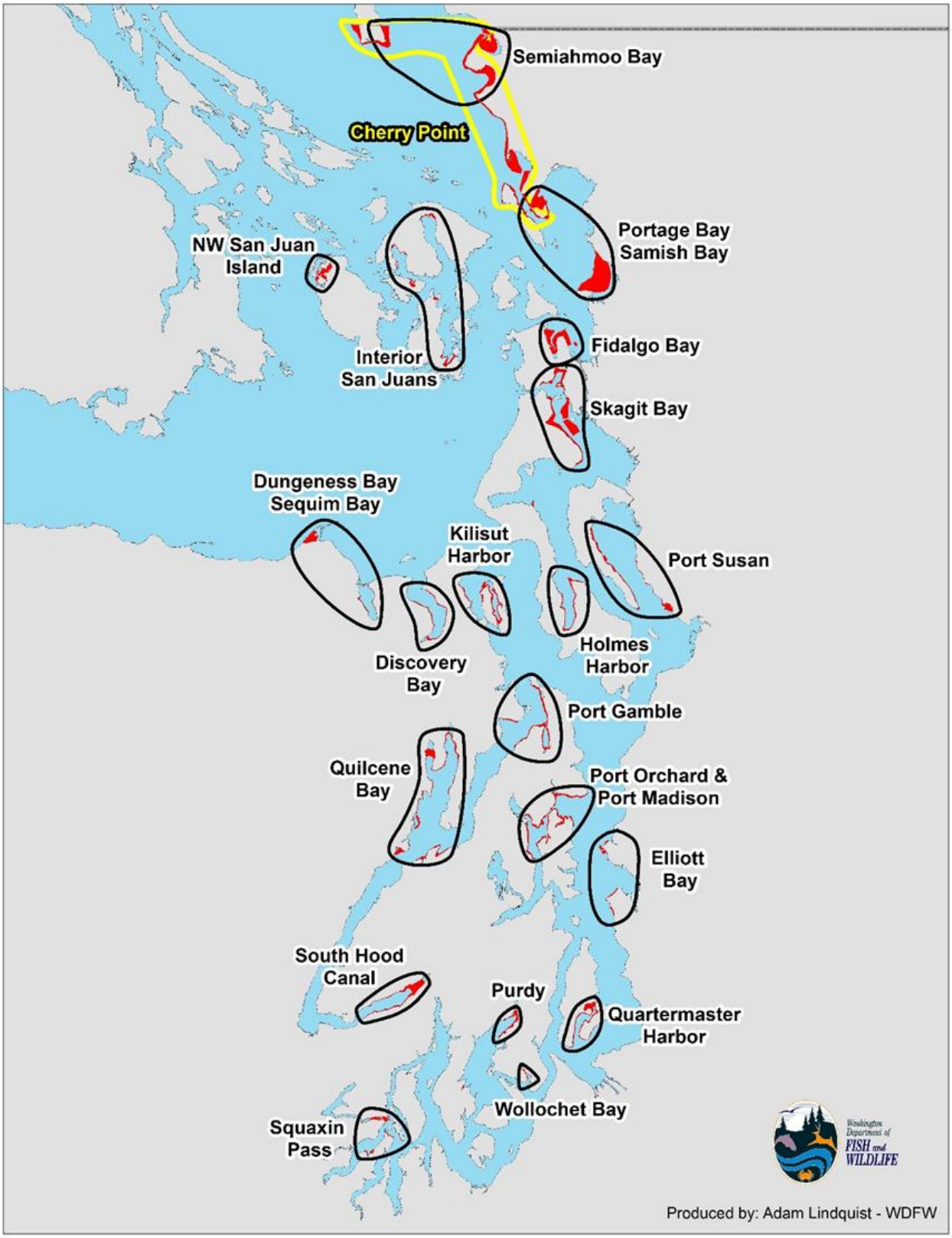

Figure 10: Map of the documented herring spawning areas in the southern Salish Sea.

Table 2: Pacific Herring biomass estimates by stock from spawn deposition surveys, 1973-2023.

	South Sound			Central Sound			Hood Canal			Strait of Juan de Fuca			Whidbey Basin			North Sound						Totals
Year	Squaxin Pass	Purdy Lagoon	Wollochet Bay	Quarter-master Harbor	Elliott Bay	Port Orchard-Port Madison	South Hood Canal	Quilcene Bay	Port Gamble	Kilisut Harbor	Discovery Bay	Dungeness / Sequim Bay	Holmes Harbor	Skagit Bay	Port Susan	Interior San Juan Islands	NW San Juan Islands	Fidalgo Bay	Samish/ Portage Bay	Semi-ahmoo Bay	Cherry Point	Southern Salish Sea
1973																					13,606	13,606
1974																					12,667	12,667
1975	270					805				253									99	700	9,378	11,505
1976	1,940			1,231		406	446	253	1,036	449	632	43	114	434		9	142		70	291	10,745	18,241
1977	18			1,282		1,223	403	210	2,291		1,350	85	122	206		16	26		29	575	10,067	17,904
1978	53			1,687				13	1,800	230	1,184	9									9,955	14,930
1979	124			1,761		1,139			1,624		800								302		9,033	14,783
1980	620			1,751		1,935			2,095	433	2,921	343	71	411				250	914		8,463	20,207
1981	700			1,612		808			1,590	294	2,785							414		914	5,642	14,760
1982				1,613		1,101	161		1,327		2,137		71		1,262			165	281	1,260	4,846	14,225
1983				825		1,498			2,184		2,339	179			1,268			581	144	793	7,315	17,124
1984				1,257		1,173			2,436		2,852	28			1,411			673	145	700	5,353	16,029
1985				605		1,284			2,165		1,313	16	829		1,198			690	71	2,109	5,225	15,507
1986				1,071		1,747			1,860		1,421	212			847			663	72	1,328	5,145	14,366
1987				838		2,302		62	1,856		1,445			1,408	1,103		363	805			2,820	13,002
1988				680		1,547			1,261		774			1,216	517					1,783	4,017	11,794
1989				815		1,578			2,173		1,111		629		313	491			53	1,543	3,631	12,336
1990	513			618		1,628			2,693	330	776		345		264	355	198			1,751	4,534	14,005
1991	855			526		655	324	185	2,049	556	839				222	54	270	979		1,870	4,195	13,581
1992	699			470		285	131		2,059		660	10			494	15		1,269	238	1,362	3,637	11,329
1993	541			975		276			1,380	488	669	0			1,536	428		1,285	180	1,725	4,440	13,923
1994	204			1,281		385			2,592	265	340				331			1,095	416	1,260	5,737	13,906
1995	142			1,815		783		741	2,865		237	260		808	329			1,064	176	1,129	3,724	14,075
1996	339			730		731	217	298	1,867	345	678	163	305	668	100	251	48	535	577	1,106	2,808	11,765
1997	135			1,272		327	205	422	1,287	279	181	143	481	810	751	27	72	843	462	563	1,428	9,687
1998	62			859		444	92	1,045	881	282	0	102	421	190	1,891		97	766	583	834	1,199	9,746
1999	430			1,140		1,820	468	2,235	1,510	728	279	319	159	821	494	179		912	503	787	1,148	13,933
2000	337		129	674		1,593	127	2,201	2,231	97	144	125	255	586	712	116	82	669	178	840	733	11,828
2001	1,449		121	1,197		1,821	170	1,897	1,614	555	124	84	249	1,969	533	198	56	856	426	996	1,126	15,441
2002	2,858		96	377		797	151	2,345	1,644	702	134	119	520	2,009	703	143	119	785	450	918	1,207	16,076
2003	1,997		138	844		984	188	831	965	406	188	40	615	2,706	408	65	12	516	271	986	1,461	13,622
2004	751		47	660		635	160	2,125	1,140	167	229	20	611	1,129	389	61	0	308	318	571	1,573	10,893
2005	396		61	686		1,776	191	1,021	1,245	154	30	0	452	1,060	142	37	0	210	198	789	1,823	10,270
2006	685		24	895		1,916	221	2,295	702	49	1,202	0	1,177	2,564	291	259	0	293	374	1,158	2,010	16,116
2007	505		32	400		1,442	64	2,152	749	22	38	31	519	1,121	583	30	0	144	316	1,020	1,968	11,135
2008	930	450	41	445		1,076	202	2,296	189	0	225	63	622	1,217	313	54	0	142	371	601	1,227	10,463
2009	748	113	86	765		1,604	142	2,780	965	0	186	42	948	940	229	0	0	14	290	898	1,217	11,965
2010	463	454	10	130		318	194	1,825	393	0	24	68	611	365	138	22	0	93	589	825	702	7,221
2011	513	645	19	87		112	142	4,031	1,328	0	0	94	2,724	425	125	0	0	108	351	1,456	1,180	13,340
2012	534	122	28	98	263	197	239	2,382	367	0	95	39	615	402	55	5	0	81	390	797	1,016	7,726
2013	503	236	9	142	194	167	181	1,880	248	0	0	64	531	412	26	0		91	629	516	824	6,651
2014	357	76	35	40	26	82	102	2,810	154	5	5	65	416	267	62	5		200	706	2,566	910	8,888
2015	294	29	0	50	122	83	256	3,717	313	0	11	7	414	259	64	34		73	507	5,309	475	12,017
2016	236	0	0	0	99	0	226	6,496	163	0	221	40	448	44	55	0		5	929	1,631	468	11,060
2017	271	20	5	0	68	0	90	4,482	164	0	93	153	70	176	103	0		5	451	2,097	337	8,587
2018	381	15	0	11	199	12	58	5,816	451	0	232	93	341	310	67	61	0	0	379	1,603	249	10,279
2019	14	110	0	22	0	1,867	38	2,960	207	0	102	78	385	208	64	167	0	0	204	1,175	290	7,891
2020	110	884	0	0	380	7,077	31	7,118	191		150	57	64	539	33			0	729	922	274	18,559
2021	75	239	0	0	23	2,472	0	3,289	201	0	0	34	724	219	24			0	402	2,395	157	10,254
2022	126	4	0	15	0	6,783	0	1,688	174	13	0	1,195	0	488	59	1,331		15	360	584	95	12,931
2023	430	3,031	0	0	0	7,473	55	1,465	124	16	289	513	656	1,818	68	336	0	21	437	1,211	0	17,943

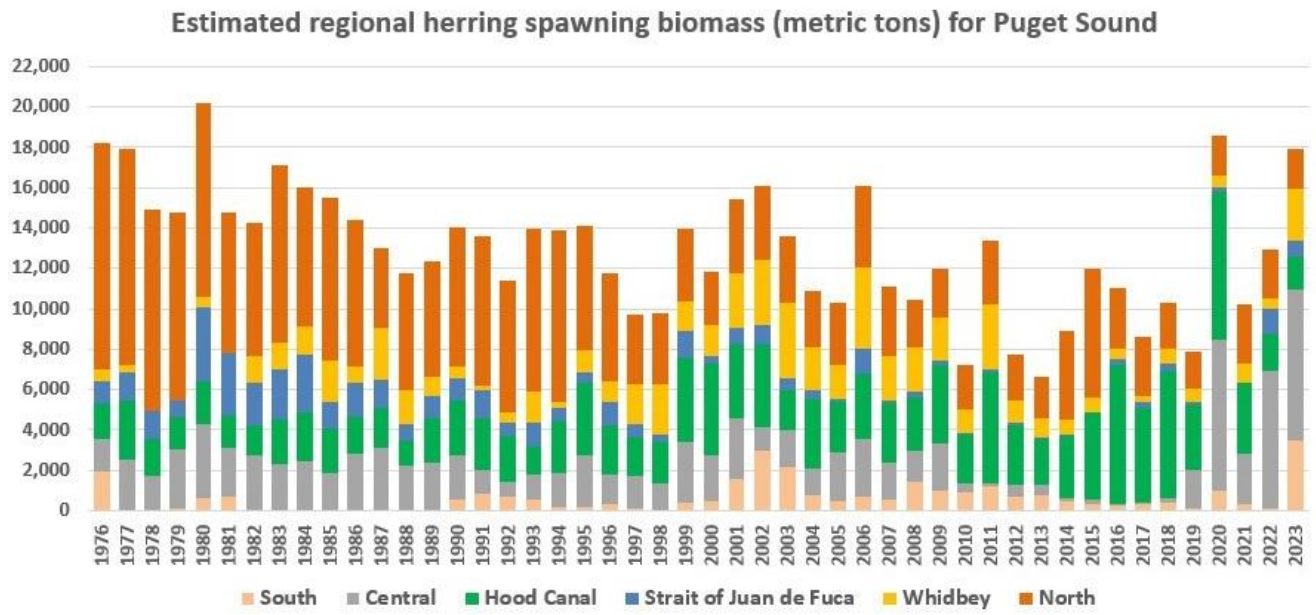

Figure 11: Pacific Herring spawning biomass estimates by basin in the southern Salish Sea, 1976-2023.

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For more details on the Herring survey, contact Phill Dionne (phillip.dionne@dfw.wa.gov).

C. Remotely operated vehicle (ROV) studies of ESA-listed rockfish in the greater Puget Sound/Georgia Basin DPS

No ROV surveys were conducted by the Puget Sound Groundfish Unit in 2023, but planning has begun for a survey of Puget Sound that is expected to start in August 2024. Unit staff have been updating species distribution models and exploring model outputs to determine the best survey design under current budget and staffing constraints. During 2023, staff also worked to finalize the report from the 2015-16 survey, but higher agency priorities have delayed this process.

During this “off season”, the unit has worked to configure and test the new Seaeye Falcon ROV (Figure 12) and Applied Acoustics USBL tracking system acquired in 2021. Most tests were conducted in Lake Washington and Puget Sound, and some were used to assist with locating and retrieving lost equipment for the WDFW Salmon program and the University of Washington.

For more details on the WDFW ROV program, contact Bob Pacunski (robert.pacunski@dfw.wa.gov).

Figure 12: WDFW's ROV vessel *Salish Rover* and the new Seaeye Falcon ROV.

D. Hook-and-line efforts in the DPS to collect Bocaccio rockfish samples for genetic analysis

The Puget Sound Groundfish Unit received a NOAA grant in 2022 to target Bocaccio rockfish in Puget Sound with the goal of collecting sufficient genetic material to determine the relatedness of Puget Sound Bocaccio to coastal populations. From September 2022 to October 2023, unit staff completed 63 trips to 36 sites in Puget Sound and the San Juan Islands for a total of 369 angler hours. Despite targeting known Bocaccio habitat (as documented with ROV observations), no Bocaccio were collected in this effort. However, 268 fish across 14 species were caught, and fin clips were collected from 92 of these fish for genetic studies of rockfish and Pacific Cod being conducted by University of Washington graduate students.

For more details on this survey, contact Bob Pacunski (robert.pacunski@dfw.wa.gov).

E. Coastal Semi-Pelagic Rockfish Rod-and-Reel Survey

Background

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 recreationally sought after, nearshore groundfish species has recently motivated survey design changes to address this data need. From 2014 to 2018, the WDFW conducted a series of experimental rod-and-reel studies focused on the development of a catch-per-unit-effort survey that could describe relative changes in abundance over time of all groundfish species found on Washington's nearshore rocky reefs. Results of these studies were considered in the creation of a coastwide survey strategy piloted in 2018. This strategy is composed of two annual legs, or separate surveys: one focused on rockfish that typically school above rock piles in the spring and another targeting demersal groundfish species in the fall. The annual Semi-Pelagic Rockfish and Demersal Groundfish Relative Abundance Surveys were respectively implemented in the spring and fall of 2019 and were continued with standardized methods through 2022. Methods and preliminary data of both surveys were evaluated by the Pacific Fishery Management Council's Scientific Statistical Committee (SSC) for future use in stock assessments in the fall of 2022. Suggestions from this workshop were addressed with adjustments made to survey methodology prior to the start of the 2023 season. Methods and preliminary results of the 2023 Semi-Pelagic Rockfish Survey, focused on all schooling rockfish species of Washington's nearshore waters including Black, Yellowtail, Blue, Deacon, Canary, and Widow rockfish, are summarized here.

Methods

Method adjustments suggested by the SSC in 2022 were primarily focused on increasing the total number of stations surveyed in the finite number of fishing days limited by survey cost, weather conditions, and vessel availability. Changes implemented in 2023 to the standardized methods described below were made following these recommendations. These adjustments included the removal of isolated distant stations, the reduction of fishing effort allocated to each station, and the addition of new stations.

The initial study area of the Semi-Pelagic Rockfish Survey included the entire Washington outer 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 13A). Marine Area 1, south of Leadbetter Point, was removed from the survey in 2023 due to its limited known and widely dispersed rockfish habitat making it cost inefficient to include. Location depths were limited to under 40 fathoms, which included the extent of Black Rockfish typical depth range and all locations where the WDFW rod-and-reel surveys have previously encountered Black Rockfish. Within the initial study area, 125 specific GPS coordinates located at rocky reefs were chosen as fixed index stations in 2019. Of the 125 stations defined in 2019, two stations isolated in Marine Area 1, and one located on the central coast, were removed for the 2023 survey. The remaining 122 stations were scheduled to be surveyed in the spring of 2023 at the GPS locations defined in 2019 (Figure 13B).

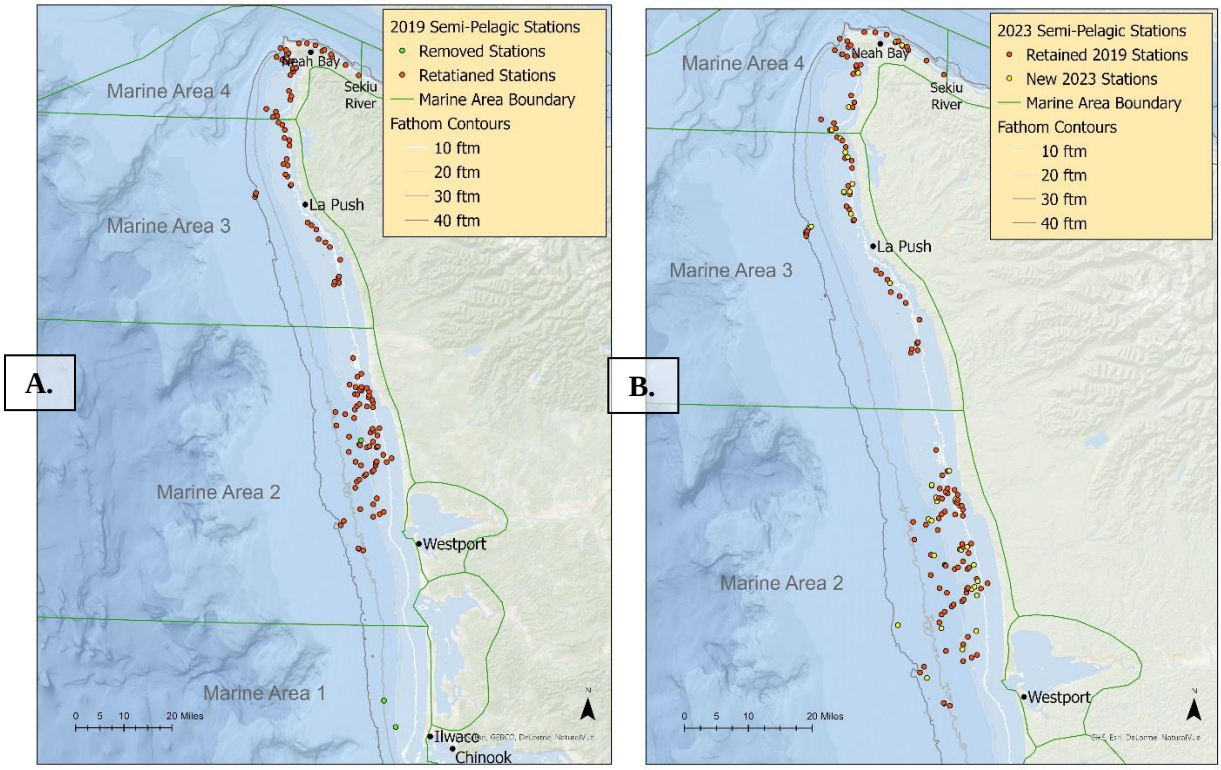

Figure 13: Semi-Pelagic Survey index stations implemented in 2019 (A) and amended in 2023 (B).

An additional 40 stations were added to the Semi-Pelagic Survey in 2023. New survey locations were chosen within the confines of the Washington Coastal Survey Grid scheme, initially developed in 2014 by WDFW to facilitate the sampling distribution of nearshore groundfish surveys. This design includes a grid of one-kilometer cells superimposed over the Washington coast that encompasses the entire study area. For the purpose of station selection, grid cells were evaluated for rockfish habitat with WDFW rod and reel survey data collected from 1998 through 2022. Grid cells where at least one rockfish, Lingcod, Cabezon, or Kelp Greenling had been captured in a previous survey were defined as having known rockfish habitat. One-kilometer grid cells with known rockfish habitat in Washington's Marine Areas 2 through 4 were then selected for new station development.

Of the 40 selected grid cells, 18 were chosen to increase the encounter rate of Deacon Rockfish and/or Yellowtail Rockfish that are commonly captured in the Semi-Pelagic Survey at low encounter rates. Cells that have regularly captured these two schooling species in previous surveys were incorporated into the 2023 survey. The remaining 22 selected grid cells were chosen randomly from cells with habitat within specific Marine Areas and depth bins so that survey locations remained evenly distributed across known rockfish habitat by Marine Areas 2 through 4 and within 10 fathom depth bins (Table 3). Fixed survey stations were then chosen as single GPS positions within each grid cell at the center of the rocky substrate that would most likely provide rockfish catch. The final target station list of the 2023 Semi-Pelagic Survey included 162 stations spanning Marine Areas 2 through 4 and at depths down to 40 fathoms (Figure 13B).

Table 3: Distribution (number) of stations surveyed in the 2023 Semi-Pelagic Rockfish Survey by marine area and depth bin.

	0-10 Fathoms	11-20 Fathoms	21-30 Fathoms	31-40 Fathoms	Grand Total
Marine Area 2	19	38	25	5	87
Marine Area 3	17	16	4	2	39
Marine Area 4	9	22	4	1	36
Grand Total	45	76	33	8	162

Fishing operations were scheduled from March to May, remaining consistent with historic WDFW spring survey timing. All locations were surveyed after recreational fishing began on March 11. Three recreational charter vessels staffed with five hired anglers and two to four WDFW scientific staff were used for survey operations. All contracted skippers had at least ten years of professional captain experience fishing for rockfish on the Washington Coast, and each angler had extensive experience fishing for rockfish on the Washington Coast. Fishing gear and tackle have been unaltered since 2019 and were kept consistent across all stations surveyed. Terminal tackle consisted of two shrimp flies tied on a leader above a dropper weight. 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. Stations to be visited on any given charter day were chosen before leaving port by the lead biologist after consultation with the vessel's captain and consideration of ocean conditions. Fishing effort at each station was reduced in 2023 from four to three 8-minute fishing drifts. A fishing "drift" was 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. Each drift began within 50 yards of the station's GPS position. At each station, captains took time to scout for fish aggregations and hard bottom/high relief areas near the station coordinates before setting up each drift. All fishing effort was completed with the vessel unanchored and drifting. Captains were allowed to slow drifts to maintain an effective fishing speed and maintained a similar drift speed and direction for all drifts at a single station.

Five anglers fished for the total fishing time at each station surveyed. The same five anglers fished all stations each charter day. Individual anglers were assigned a position on the vessel to fish for all drifts at each station. A "six-pack" charter vessel was used for all stations in Marine Area 3 and stations at Cape Alava in Marine Area 4. Due to space limitations on this vessel, three anglers were evenly spread out on the starboard side of the vessel, and two anglers fished on the port side — one toward the bow and another mid-ship. Each angler was assigned a fishing position for the entire fishing day. All other stations were fished on larger recreational charter vessels that allowed for established fishing positions on one side of the vessel, evenly spread out from bow to stern. Before fishing began at each station on the larger vessels, anglers were randomly assigned to one of the established fishing positions.

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.

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, and total fishing time per station. Individual angler's fishing time, catch by species, gear loss, and fishing depth (benthic or pelagic) were recorded for each angler and drift. Catch was identified to species, measured (fork length), externally sexed, and scanned for previously implanted tags. A caudal fin clipping no larger than one centimeter squared was collected, preserved on blotter paper, and recorded by individual fish for the first 30 individuals of all rockfish species, Kelp Greenling, Cabezon, and Lingcod encountered in each Marine Area visited. Fish that were not chosen for ancillary 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 China Rockfish, Copper Rockfish, Deacon Rockfish, Quillback Rockfish, Tiger Rockfish, Vermilion Rockfish, Cabezon, and Kelp Greenling were tagged with a Floy tag and released.

Weather conditions, including the intensity and direction of tide, wind, and swell, were also recorded before fishing began at each station. A model SBE 19+ V2 water column profiler (CTD) was deployed at select stations surveyed. Stations that are central to groupings of stations were chosen for CTD deployment in an effort to represent conductivity, temperature, dissolved oxygen, chlorophyll a, pH, and water clarity at multiple stations in a time-effective manner.

Results

All 162 scheduled stations were successfully surveyed over 21 fishing days from March 13 through May 1. Average drift speeds at each station ranged from 0.1 to 1.5 knots, and all stations were fished while drifting. Total angler rod hours at successfully surveyed stations ranged from 1.8 to 2.2 for a coastwide total of 330.9 rod hours expended.

As expected, CPUE of Black Rockfish was highest among all species encountered in each Marine Area (Table 4). Other predominant species included Canary Rockfish, Deacon Rockfish, Lingcod, and Yellowtail Rockfish. Less than 25 individuals of all other species encountered were captured. Coastwide catch rates of Black Rockfish, Canary Rockfish, Yellowtail Rockfish, and Lingcod increased from the 2022 survey while Deacon Rockfish catch rates decreased. However, with the addition of new stations in 2023, the total number of stations where Deacon Rockfish were encountered increased from 2022 as was the case with all predominant species (Table 5).

Table 4: Catch of groundfish species in the 2023 Semi-Pelagic Survey. Coastwide total catch of individuals and CPUE (number of individuals per rod hour) by Marine Area and depth bin is included.

		Black Rockfish	Blue Rockfish	Buffalo Sculpin	Cabezon	Canary Rockfish	China Rockfish	Copper Rockfish	Deacon Rockfish	Kelp Greenling	Lingcod	Pacific Sandab	Quillback Rockfish	Silvergray Rockfish	Vermilion Rockfish	Widow Rockfish	Yelloweye Rockfish	Yellowtail Rockfish
Total Catch		1722	2	1	24	76	20	8	93	12	217	1	8	1	5	1	3	207
Marine Area 4 CPUE	**0-10 Fathoms**	1.99			0.17		0.11	0.06	0.06	0.06	0.77		0.06					
	11-20 Fathom	2.31	0.02		0.16	0.41	0.32	0.11	0.36	0.07	0.95		0.02		0.05			0.91
	21-30 Fathom	2.34			0.12	1.72	0.12	0.12	0.25		0.12		0.12					1.11
	31-40 Fathom	0.47									0.47							
	All Depths	2.18	0.01		0.15	0.44	0.23	0.10	0.26	0.06	0.80		0.04		0.03			0.68
Marine Area 3 CPUE	**0-10 Fathoms**	8.59	0.03		0.12		0.06	0.03	1.34	0.12	0.39							0.39
	11-20 Fathom	7.46			0.22				0.57	0.06	0.28						0.03	0.44
	21-30 Fathom	0.49				0.86	0.12		0.98		1.10			0.12	0.24		0.12	5.99
	31-40 Fathoms					0.46					0.69		0.23		0.23		0.23	
	All Depths	6.80	0.01		0.14	0.12	0.04	0.01	0.91	0.08	0.44		0.01	0.01	0.04		0.04	0.98
Marine Area 2 CPUE	**0-10 Fathoms**	6.71									0.44							0.03
	11-20 Fathom	6.70		0.01	0.03						1.03							0.05
	21-30 Fathom	4.46				0.30			0.02	0.04	0.41		0.08					0.47
	31-40 Fathom	1.41				1.79			0.19		0.47	0.09				0.09		4.89
	All Depths	5.73		0.01	0.01	0.19			0.02	0.01	0.69	0.01	0.02			0.01		0.45
Coastwide CPUE		5.20	0.01	0.00	0.07	0.23	0.06	0.02	0.28	0.04	0.66	0.00	0.02	0.00	0.02	0.00	0.01	0.63

Table 5: The number of stations that encountered predominant species in the Semi-Pelagic Survey from 2019 to 2023.

	2019	2020	2021	2022	2023
Black Rockfish	102	41	104	92	137
Canary Rockfish	24	6	16	14	19
Deacon Rockfish	37	1	40	27	31
Lingcod	34	23	63	48	85
Yellowtail Rockfish	39	5	33	21	40

Catch was biologically sampled according to the methods described above. All fish brought onboard were measured, sexed externally, and scanned for internal tags. Black Rockfish lengths had a general positive trend with depth (Figure 14). In total 471 genetic fin clip samples were collected, and 154 tagged fish were released. No recaptured fish were encountered.

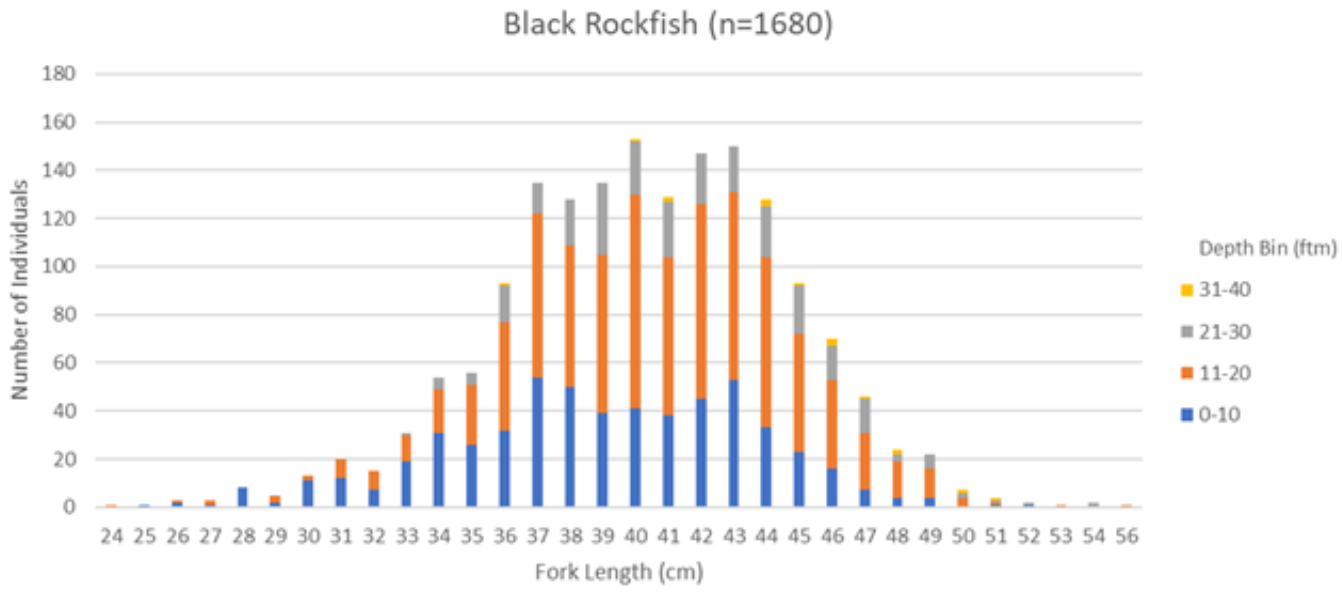

Figure 14: Length frequency of Black Rockfish catch on the 2023 Semi-Pelagic Rockfish Survey.

In addition to the biological samples, 46 water column profiles were collected coastwide (Table 6). All values at maximum depth were within an expected range although notably low pH values of less than 7.5 were encountered in three casts in and around Makah Bay, Marine Area 4.

Table 6: Range of ocean condition values observed at maximum depth of water column profiles collected in the spring of 2023 by depth bin and marine area. Samples collected at a descent rate of 0.5-2 meters/second are summarized here.

Marine Area	Depth Bin	Total Profiles	Max Depth (M)	Dissolved Oxygen (ML/L)		Temperature (°C)		Salinity (PSU)		Chlorophyll (UG/L)		pH		BeamTransmission (%)	
				Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
2	0-10	4	21.61	5.44	6.92	7.91	8.54	29.24	31.33	3.00	4.46	7.77	8.03	33.09	82.85
2	11-20	10	39.03	4.89	6.32	8.19	8.80	30.91	32.27	0.70	5.01	7.85	8.02	33.68	94.20
2	21-30	7	61.20	4.86	6.16	8.44	8.89	31.82	32.49	0.51	4.05	7.81	8.03	43.93	89.66
2	31-40	3	68.08	4.73	5.45	8.90	8.96	32.46	32.83	0.23	0.39	7.85	7.92	84.16	91.69
3	0-10	5	21.40	5.73	5.98	9.06	9.23	29.64	32.00	0.82	3.27	7.64	7.72	12.25	75.79
3	11-20	4	30.76	5.24	6.14	8.84	9.04	30.28	32.20	0.77	1.81	7.69	7.82	39.73	86.66
3	21-30	2	48.20	6.23	6.26	8.97	9.07	32.02	32.06	0.46	0.67	7.79	8.14	97.84	97.87
4	0-10	2	17.55	5.80	6.30	9.38	9.85	30.79	30.83	1.53	1.58	7.51	7.62	90.33	91.46
4	11-20	8	35.56	2.77	6.17	7.92	9.37	30.17	33.46	0.14	2.05	7.42	7.84	54.29	92.87
4	21-30	1	44.76	2.97	2.97	8.04	8.04	33.40	33.40	0.10	0.10	7.49	7.49	91.92	91.92

For more information about the Black Rockfish survey, contact Rob Davis (robert.davis@dfw.wa.gov).

F. Coastal Demersal Groundfish Relative Abundance Rod-and-Reel Survey

Background

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 recreationally sought after, nearshore groundfish species has motivated survey design changes to address this data need. From 2014 to 2017, the WDFW conducted a series of experimental rod-and-reel studies focused on the development of a catch per unit effort (CPUE) survey that could describe relative changes in abundance over time of all groundfish species found on Washington's nearshore rocky reefs. Results of these studies were considered in the creation of a coastwide survey strategy composed of two annual legs, or separate surveys: one focused on rockfish that typically school above rock piles in the spring and another targeting demersal groundfish species in the fall. The annual Semi-Pelagic Rockfish and Demersal Groundfish Relative Abundance Surveys were respectively implemented in the spring and fall of 2019 and were continued annually with standardized methods through 2022, with limited coverage in 2020 due to the COVID-19 pandemic. Methods and preliminary data of both surveys were evaluated by the Pacific Fishery Management Council's Scientific Statistical Committee (SSC) for future use in stock assessments in the fall of 2022. Suggestions from this workshop were addressed with adjustments made to survey methodology prior to the start of the 2023 season. Specifically, this review recommended to increase the maximum depth of the Demersal Groundfish Survey to include a greater range of focus species distributions.

The Demersal Groundfish Survey continued in 2023, targeting species that are generally found individually or in small groups directly on rocky substrate on the nearshore Washington coast that include China, Copper, Quillback, Tiger, Vermilion, and Yelloweye Rockfish, as well as Kelp Greenling, Lingcod, and Cabezon. Ongoing and modified methods and preliminary results of the 2023 survey are summarized here.

Methods

The Demersal Groundfish Survey study area includes the Washington coast Marine Areas 2, 3, and 4, from the nearshore waters just outside of Grays Harbor to the confluence of the Sekiu River with the Strait of Juan de Fuca (Figure 15). The initial study area defined in 2019 was limited to waters less than 40 fathoms deep, where focus species are typically found.

To address the suggested depth expansion by the SSC, data from historical WDFW rod-and-reel surveys, WDFW setline surveys, and the International Pacific Halibut Commission's Fishery Independent Setline surveys collected on the Washington coast (International Pacific Halibut Commission, 2022), were examined for locations at depths greater than 40 fathoms where nearshore demersal species have been found. Cabezon, Copper Rockfish, China Rockfish, Kelp Greenling, and Vermilion Rockfish were not seen in these deep-water sets, and all known capture locations of these species were included in the site selection sampling frame of the current survey. However, Quillback Rockfish were minimally encountered in the examined data at five unique locations on the Washington coast from 40 to 70 fathoms, and Yelloweye Rockfish and Lingcod, which have a distribution that is concentrated much deeper than all other demersal groundfish focus species, were seen frequently at

locations outside of the current survey's sample area down to 110 fathoms. These typical depth distributions on Washington's coast were also corroborated with charter captain anecdotal descriptions. In 2023, the Demersal Groundfish Survey study area was expanded out to the 60-fathom contour line to better represent the distribution of Quillback Rockfish. Due to the extended range of Yelloweye Rockfish and Lingcod, their distributions were not considered in the maximum depth extension but were considered in new stations developed within the expanded study area.

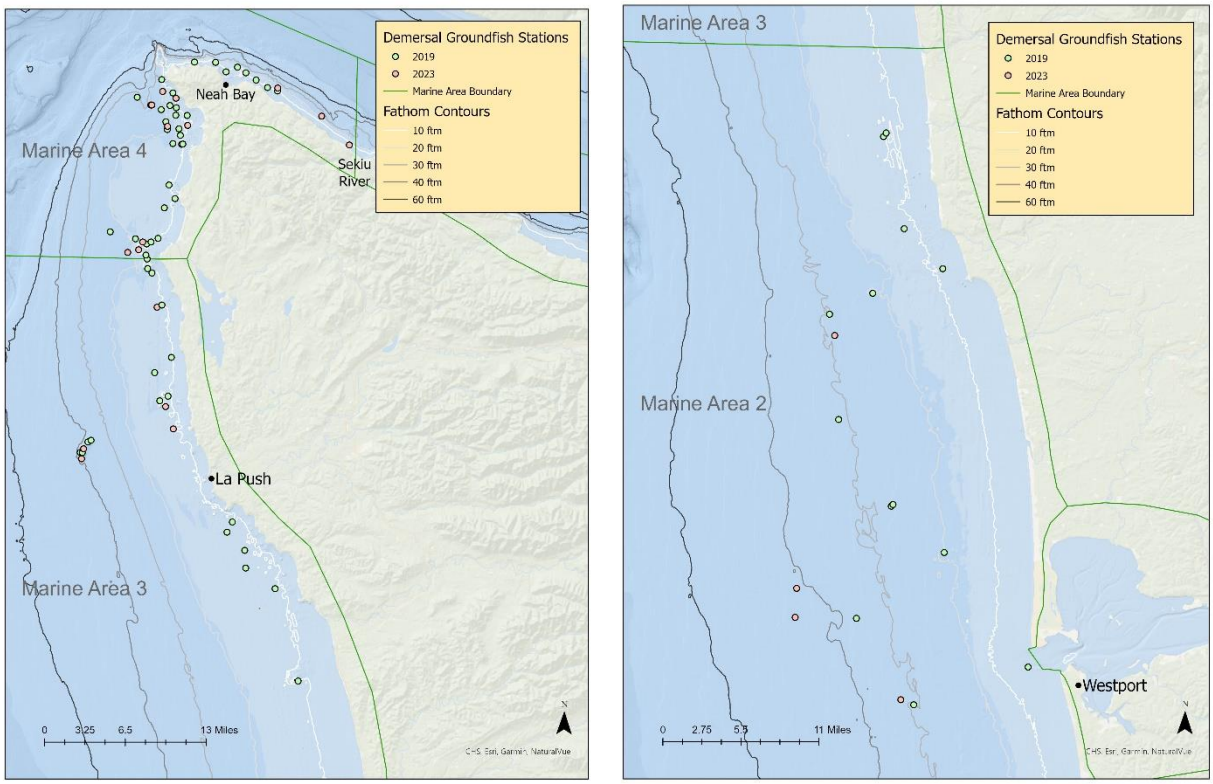

Figure 15: Demersal Groundfish Survey index stations implemented in 2019 in green and 2023 in pink on the northern (left) and southern (right) Washington coast.

Survey stations were initially developed in 2019 as 64 specific GPS coordinates located at rocky reefs within the study area. All 64 stations were scheduled to be surveyed in the fall of 2023 at the GPS locations defined in 2019. An additional 20 stations were added in 2023 to increase encounter rates of species that are commonly present in the Demersal Groundfish Survey but at low encounter rates. These "low encounter" species include Copper Rockfish, Quillback Rockfish, Cabezon, and Kelp Greenling. New stations were selected with similar methods used to select the original demersal groundfish stations in 2019. New survey locations were chosen within the confines of the Washington Coastal Survey Grid scheme which includes a grid of one-kilometer cells superimposed over the nearshore waters of the Washington outer coast that encompasses the entire study area.

Grid cells where "low encounter" species have been regularly captured in previous rod and reel surveys were chosen for station development. Thirteen of the 20 selected grid cells contained stations that are included in the WDFW Semi-Pelagic Survey. These 13 stations were used for new demersal groundfish stations at the GPS locations defined in the Semi-Pelagic Survey. Coordinates for the remaining seven new stations were chosen at previous set locations that have encountered "low encounter" species within each selected grid cell. New stations were added so that the distribution of cells by marine area

and depth bin (Table 7) was kept similar to the distribution of the original 64 stations (
Table 8). However, depth distribution skewed slightly deeper with the increase of study area down to 60 fathoms and the selection of multiple cells to better represent the distribution of Quillback Rockfish and Copper Rockfish that are regularly found in depths over 20 fathoms. The final target station list of the 2023 Demersal Groundfish Survey included 84 stations spanning Marine Areas 2 through 4.

Table 7: Distribution of demersal groundfish stations in the 2023 Demersal Groundfish Survey (n=84).

	0-10 Fathoms	11-20 Fathoms	21-30 Fathoms	31-40 Fathoms	41-50 Fathoms	Grand Total
Marine Area 2	5%	1%	8%	4%	2%	20%
Marine Area 3	10%	11%	4%	4%	0%	27%
Marine Area 4	21%	21%	10%	0%	0%	52%
Grand Total	36%	33%	21%	7%	2%	100%

Table 8: Distribution of demersal groundfish stations implemented in 2019 (n=64).

	0-10 Fathoms	11-20 Fathoms	21-30 Fathoms	31-40 Fathoms	Grand Total
Marine Area 2	6%	2%	9%	3%	20%
Marine Area 3	11%	11%	2%	5%	28%
Marine Area 4	23%	20%	8%	0%	52%
Grand Total	41%	33%	19%	8%	100%

Fishing effort for the fall Demersal Groundfish Survey remained largely consistent with methods developed in 2019. Survey operations were conducted on three recreational charter vessels staffed with five hired anglers and two to three WDFW scientific staff. All contracted skippers had at least eight years of professional captain experience fishing for rockfish on the Washington coast, and each angler had over 10 years of experience fishing for rockfish on the Washington coast. Fishing gear and tackle have been unaltered since 2019 and were kept consistent across all stations surveyed. Terminal tackle consisted of a salmon mooching rig baited with a white worm, and leaders of this gear 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 was kept consistent among anglers for each drift.

The 2023 Demersal Groundfish survey was scheduled from mid-September to mid-October, consistent with historic fall survey timing. All fishing effort was conducted during daylight hours, and charter days ranged from 8-11 hours. Stations to be visited on any given charter day were chosen before leaving port by the lead biologist after consultation with the vessel's captain and consideration of ocean conditions. Fishing effort at each station consisted of four 8-minute fishing drifts that began within 50 yards of the station's GPS position. At each station, captains took time to scout for fish aggregations and hard bottom/high relief areas near the station coordinates before setting up each drift. Vessels drifted unanchored for all fishing effort. A fishing "drift" was 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. Captains were allowed to slow drifts to maintain an effective fishing speed and maintained a similar drift speed and direction for all drifts at a single station.

Five anglers fished for the total fishing time at each station surveyed. The same five anglers fished all stations each charter day. Individual anglers were assigned a position on the vessel to fish for all drifts at each station. A "six-pack" charter vessel was used for all stations in Marine Area 3 and stations at Cape Alava in Marine Area 4. Due to space limitations on this vessel, three anglers were evenly spread

out on the starboard side of the vessel and two anglers fished on the port side, one toward the bow and another mid-ship. Each angler was assigned a fishing position for the entire fishing day. All other stations were fished on larger recreational charter vessels that allowed for established fishing positions on one side of the vessel evenly spread out from bow to stern. Before fishing began at each station on the larger vessels, anglers were randomly assigned to one of the established fishing positions.

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 seconds hooks were in the water, which excluded any time that fishing gear was out of the water either to land a fish or work on the gear. All angler fishing effort was done on or near the bottom; schools of fish in the water column were not targeted.

Effort information collected included station number, GPS location of the start and end of each drift, depth at the onset of fishing, disposition of vessel (anchored or drifting), drift speed and direction, number of anglers, total vessel fishing time per station, and terminal tackle gear type. Individual angler's fishing time, catch by species, gear loss, and fishing depth (benthic) were recorded for each angler and drift. Catch was identified to species, measured (fork length), externally sexed, and scanned for previously implanted tags. A caudal fin clipping no larger than one centimeter squared was collected, preserved on blotter paper, and recorded by individual fish for the first 30 individuals of all rockfish species, Kelp Greenling, Cabezon, and Lingcod encountered in each marine area visited annually. Fish that were not chosen for ancillary 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 China Rockfish, Copper Rockfish, Deacon Rockfish, Quillback Rockfish, Tiger Rockfish, Vermilion Rockfish, Cabezon, and Kelp Greenling were tagged with a Floy tag.

Weather conditions, including the intensity and direction of tide, wind, and swell, were also recorded before fishing began at each station. A model SBE 19+ V2 water column profiler (CTD) was deployed at select stations surveyed. Stations that are central to groupings of stations were chosen for CTD deployment in an effort to represent conductivity, temperature, dissolved oxygen, chlorophyll a, pH, and water clarity at multiple stations in a time-effective manner.

Results

All 84 scheduled stations were successfully surveyed over 13 charter days from September 6 through October 6. Average drift speeds at each station ranged from 0.1 to 1.1 knots, and all stations were fished while drifting. Five anglers fished all stations, and total angler rod hours at successfully surveyed stations ranged from 2.36 to 3.13 hours.

Black Rockfish was the most predominant specie captured in Marine Areas 2 and 3, while China Rockfish was the predominant specie seen in Marine Area 4 (Table 9). Other predominant demersal groundfish species included Cabezon, Copper Rockfish, Kelp Greenling, Lingcod, Quillback Rockfish, and Yelloweye Rockfish. Catch was diverse with 19 different groundfish species encountered, including 12 different rockfish.

Table 9: Catch of groundfish species in the 2023 Demersal Groundfish Survey. Coastwide total catch of individuals and CPUE (number of individuals per rod hour) by Marine Area and depth bin is included.

		Black Rockfish	Cabezon	Canary Rockfish	China Rockfish	Copper Rockfish	Deacon Rockfish	Kelp Greenling	Lingcod	Pacific Sandab	Petrale Sole	Quillback Rockfish	Red Irish Lord	Rosethorn Rockfish	Spiny Dogfish	Tiger Rockfish	Vermilion Rockfish	Widow Rockfish	Yelloweye Rockfish	Yellowtail Rockfish
	Total Catch	238	61	91	241	67	67	74	53	4	1	66	1	1	1	13	11	2	36	62
Marine Area 4 CPUE	**0-10 Fathoms**	0.90	0.21	0.10	1.73	0.27	0.10	0.60	0.23			0.23				0.02				
	11-20 Fathoms	1.02	0.30	0.55	2.16	0.60	0.40	0.47	0.25			0.22	0.02				0.05			0.32
	21-30 Fathoms	0.99	0.13	0.63	0.39	0.72	0.99	0.20	0.10			0.39					0.20			0.92
	All Depths	0.96	0.22	0.39	1.53	0.50	0.43	0.45	0.20			0.27	0.01			0.01	0.07			0.35
Marine Area 3 CPUE	**0-10 Fathoms**	2.25	0.90		1.27			0.67	0.45											
	11-20 Fathoms	1.42	0.37	0.09	1.30	0.09	0.43	0.28	0.28			0.03				0.22	0.03		0.03	0.12
	21-30 Fathoms	0.55		4.91		0.18	0.36					0.91					0.18	0.18	1.82	0.55
	31-40 Fathoms			0.89					0.27			1.68		0.09		0.44	0.09	0.09	2.13	0.71
	All Depths	1.26	0.38	0.64	0.94	0.06	0.26	0.29	0.29			0.40		0.02		0.19	0.05	0.03	0.56	0.24
Marine Area 2 CPUE	**0-10 Fathoms**	2.44	0.81					0.15	0.52											
	11-20 Fathoms	1.06				1.42			0.35			0.35								
	21-30 Fathoms	0.25		0.05					0.10	0.15	0.05	0.29								0.10
	31-40 Fathoms	0.68							0.17	0.17										
	41-50 Fathoms			0.65								0.33			0.16				0.16	0.65
	All Depths	0.92	0.23	0.10		0.08		0.04	0.23	0.08	0.02	0.18			0.02				0.02	0.12
	Coastwide CPUE	1.04	0.27	0.40	1.05	0.29	0.29	0.32	0.23	0.02	0.00	0.29	0.00	0.00	0.00	0.06	0.05	0.01	0.16	0.27

Coastwide catch rates of Cabezon, China Rockfish, and Lingcod decreased from the 2022 survey, while Copper Rockfish and Kelp Greenling catch rates remained similar, and Quillback and Yelloweye rockfish catch rates increased. However, with the addition of new stations in 2023, the total number of stations where each species was encountered was higher than in any previous survey, with the exception of Cabezon (Table 10).

Table 10: The number of stations that encountered predominant demersal groundfish species in the Demersal Groundfish Survey from 2019 to 2023.

	2019	2021	2022	2023
Cabezon	23	20	34	27
China Rockfish	32	35	39	43
Copper Rockfish	18	20	23	28
Kelp Greenling	27	30	27	35
Lingcod	30	29	25	39
Quillback Rockfish	16	11	19	28
Yelloweye Rockfish	6	6	6	8

Catch was biologically sampled according to the methods described above. All fish brought onboard were measured (Table 11). Age structures were taken from 150 groundfish found on the extremes of their species' size distribution, and 318 genetic fin clip samples were collected. All catch was scanned for internal tags, and 496 tagged fish were released. One externally tagged Deacon Rockfish was recaptured near Cape Alava at the same station it was released at in the spring of 2022.

Table 11: Mean, minimum, and maximum fork length in cm of focus species measured on the 2023 Demersal Groundfish Survey.

Species	Mean Length (cm)	Minimum Length (cm)	Maximum Length (cm)
Cabezon	51.19	34	72
China Rockfish	31.13	20	41
Copper Rockfish	37.80	24	47
Kelp Greenling	34.70	19	44
Lingcod	60.98	45	87
Quillback Rockfish	34.67	19	48
Tiger Rockfish	38.77	30	46
Vermilion Rockfish	45.73	36	57
Yelloweye Rockfish	45.31	25	69

Thirty-six water column profiles were successfully collected over the survey period (Table 12). Hypoxic oxygen readings (<1.4 ml/l) were noted in five profiles taken in Marine Area 3 at depths from 14.1 to 70.0 meters.

Table 12: Range of water column ocean condition values observed at maximum depth of profiles collected in the fall of 2023 by station depth bin and Marine Area. Samples collected at a descent rate of one-half to two meters/second are summarized here.

Marine Area	Depth Bin	Total Profiles	Max Depth (M)	Dissolved Oxygen (ML/L)		Temperature (°C)		Salinity (PSU)		Chlorophyll (UG/L)		pH		BeamTransmission (%)	
				Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
2	0-10	3	27.26	2.95	4.02	10.97	13.03	32.24	32.78	1.26	1.94	7.85	7.95	46.28	65.55
2	11-20	1	40.42	2.42	2.42	8.68	8.68	33.35	33.35	0.61	0.61	7.79	7.79	85.16	85.16
2	21-30	4	57.65	1.95	2.76	8.50	9.95	32.89	33.45	0.42	0.94	7.63	7.78	47.64	85.21
2	31-40	2	66.13	1.92	2.58	8.41	8.53	33.36	33.48	0.57	0.58	7.71	7.75	72.12	80.47
3	0-10	3	18.09	1.86	2.53	9.24	10.15	33.34	33.41	0.59	4.65	7.69	7.85	52.46	89.76
3	11-20	4	29.82	0.57	5.36	8.33	13.93	31.88	33.62	0.89	2.15	7.57	8.06	50.20	85.55
3	31-40	2	70.00	0.97	1.06	8.08	8.09	33.67	33.68	0.41	0.48	7.60	7.69	90.22	91.99
4	0-10	5	19.31	2.95	4.61	9.76	12.50	32.78	33.06	0.67	1.54	7.53	7.89	87.59	94.79
4	11-20	5	31.18	1.99	5.23	8.85	13.86	31.88	33.51	0.34	1.78	7.65	8.05	83.67	94.20
4	21-30	7	48.31	2.22	5.43	8.42	13.86	31.90	33.50	0.33	4.95	7.62	7.98	76.41	95.47

References Cited

International Pacific Halibut Commission. (2022). Retrieved 15 November 2022, from https://www.iphc.int/data/fiss-survey-raw-survey-data/

For more information about the Demersal Groundfish Survey, contact Rob Davis (robert.davis@dfw.wa.gov).

G. Rod-and-Reel Deep Water Experimentation 2023

Background

Current WDFW rod-and-reel survey efforts have been limited to waters on the Washington coast less than 40 fathoms deep, where nearshore priority species are mostly distributed. However, some of the groundfish consistently encountered in nearshore surveys have distributions that extend much further off the Washington coast. Yelloweye Rockfish, Yellowtail Rockfish, Canary Rockfish, and Lingcod are commonly encountered in current shallow-water WDFW rod-and-reel surveys but are known to extend commonly down to 110 fathoms on the Washington coast.

Setline surveys, such as the International Pacific Halibut Commission's Fishery Independent Setline Survey (International Pacific Halibut Commission, 2022) and WDFW experimental setline studies, have typically been modified and used to represent the rocky habitat species found at these depths. While setline gear effectively samples deep water rocky reefs in a standardized way, it is cost restrictive. The cost of attaining significant abundance data, particularly of Yelloweye Rockfish that have a patchy distribution on the Washington coast, has restricted the use of this survey type by WDFW.

Alternatively, rod-and-reel surveys are more cost-effective but functionally challenging in deep water where weather conditions and the complexity of fishing methods tend to compound with depth and distance from shore. Current methods and gear types used in WDFW nearshore rod-and-reel studies are not designed for fishing waters deeper than 60 fathoms; however, other rod-and-reel surveys, most notably NOAA's hook-and-line survey of shelf rockfish in the Southern California Bight (Harms, Wallace, & Stewart, 2010), have been effective in deep water. In the fall of 2023, the WDFW conducted deep-water experimentation on the Washington coast to evaluate the use of rod-and-reel gear at depths over 50 fathoms and to identify specific reef locations at these depths for further study. This report summarizes methods and initial results from this experimentation.

Methods

Three "Deep-Water Experimentation" fishing days were scheduled during the 2023 WDFW Demersal Groundfish Survey season in September and October. General study locations for this study included Grays Canyon in Marine Area 2 and the "Prairie" in Marine Areas 3 and 4, west of the Juan de Fuca Canyon (Figure 16).

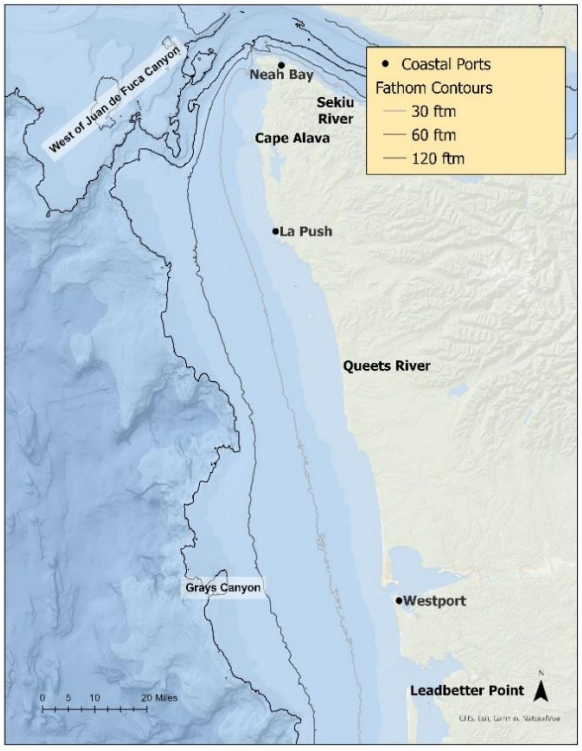

Figure 16: Deep-Water Experimentation general study locations: west of Juan de Fuca Canyon and Grays Canyon.

Within these two study areas, specific fishing locations spaced at least one kilometer apart at depths over 50 fathoms were selected. Fishing locations were chosen by the vessel's captain so that as many locations as possible could be fished in a single charter day prioritizing:

1. Locations that have not been visited in a previous survey where Yelloweye Rockfish are known to inhabit.
2. IPHC FISS stations that consistently encounter Yelloweye Rockfish annually.
3. Locations that have not been visited in a previous survey where Lingcod, Yellowtail Rockfish, or Canary Rockfish are known to inhabit.

Each location surveyed was fished with a mixture of fishing gear supplied by the vessel and the WDFW. WDFW fishing gear consisted of 78-inch, heavy-action Ugly Stick Bigwater conventional rods with a 40–80-pound rating and Penn General Purpose (309M) level-line reels having a gear ratio of 2.8:1. Reels were spooled with 80-pound braided line that was tied directly to a snap swivel.
Three different terminal tackles were used at each fishing location:

1. A modified version of the standard gear in the Demersal Groundfish Survey that consisted of a mooching rig baited with an artificial worm. This was made of a 3-foot, 60-pound monofilament line attached from the mainline to a sinker with a Demersal Groundfish Survey standard mooching rig leader attached between the monofilament and sinker via a three-way swivel.
2. Baited shrimp flies modeled after the standard terminal tackle used in NOAA's hook-and-line survey of shelf rockfish in the Southern California Bight. This terminal tackle design consisted of a 96-inch, 60-pound monofilament leader with hooks attached via five-inch dropper loops. Hooks were spaced 16 inches from a top barrel swivel, 16 inches between hooks, and 16 inches from the bottom hook to a snap swivel that connected to a sinker.

3. The typical tackle the vessel captain uses in the area to catch groundfish that consisted of a 2-pound pipe jig with treble hook and a lead head swim bait tied above on a 60-pound monofilament leader.

The weight of the sinkers used for each drift was chosen by the vessel's captain after taking into consideration depth and weather conditions but was kept consistent among anglers for each drift. As many unique fishing locations as possible were fished each charter day. Captains scouted potential fishing locations for fish aggregations or high-relief areas before setting up each fishing location. Fishing effort at each location consisted of three fishing drifts of equal active fishing time that began as close as possible to each other and covered the same target area. Captains slowed down drifts to maintain an effective and consistent fishing and drifting speed and to maintain a consistent direction for all drifts at a single location. Each subsequent drift at each location was fished with a different terminal tackle. Artificial mooching rigs were fished on the first drift, baited shrimp flies on the second drift, and the captain's choice of pipe jigs was fished on the third drift.

Five anglers fished for the total fishing time at each station surveyed. The same five anglers fished all stations each charter day. Individual anglers were assigned a position on the vessel to fish for all drifts at each station. Fishing positions were established on one side of the vessel, evenly spread out from bow to stern. Before fishing began at each station, anglers were randomly assigned to one of the established fishing positions.

At the beginning of each drift, all anglers were told to begin fishing, and a timer was started. Once the allotted time for each drift was reached, all anglers were told to retrieve their gear. Anglers were allowed to retrieve their gear as many times as necessary during the drift to land their catch or maintain gear. Individual angler times per drift were recorded as the total time that 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 fished with their terminal tackle on or near the bottom.

Results

Due to poor ocean conditions and other higher priorities of the Demersal Groundfish Survey over the study period, only one of the three scheduled Deep-Water Experimentation charter days were completed. Four locations near Grays Harbor Canyon were studied. Depths fished over the study ranged from 411 to 511 feet. Wind speed ranged from 10 to 14 knots, and the swell was at 5 feet, which was acceptable for fishing at the target depths with the skipper slowing the drift down to 0.32 to 0.67 knots. Anglers were allowed to fish the first three drifts at the first location for 13 minutes each drift. In all subsequent drifts, the regulated fishing time was reduced to 9 minutes. Angler fishing time varied considerably both by drift and by angler, and angler fishing time generally increased with depth (Figure 17). Individual fishing time per angler-drift ranged anywhere from 4.7 to 15.2 minutes. The extended retrieval time in deeper water contributed to larger variances in angler fishing time per drift as successful anglers on or near the surface when master time was called had much less fishing time than those still fishing. Additionally, retrieval time in deeper water was extremely affected by the type and quantity of fish on the hook upon retrieval, further exacerbating this variance. Angler time per drift did not change drastically with gear type; average angler time per drift with mooching rigs was 9.8 minutes, with shrimp flies was 10.0 minutes, and with pipe jigs was 10.3 minutes.

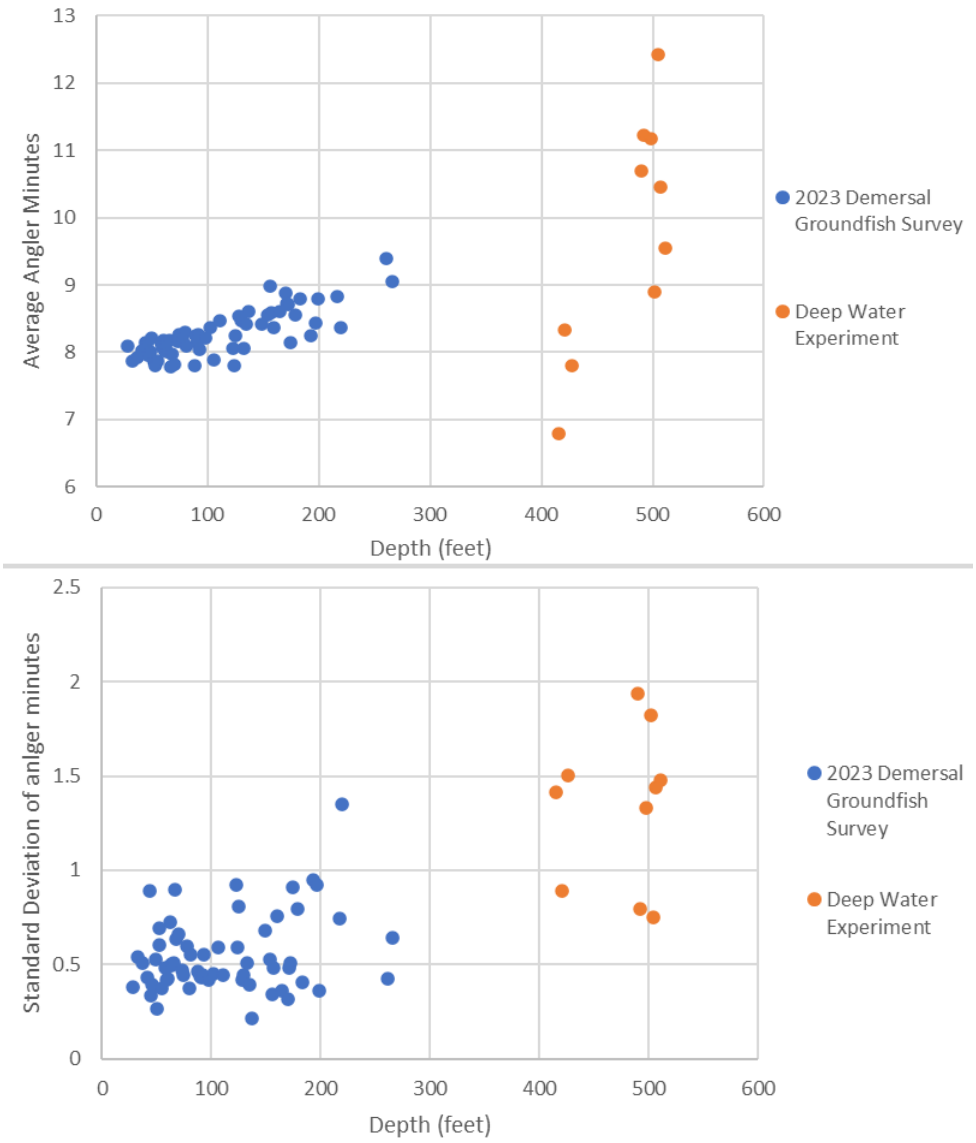

Figure 17: Mean of individual angler fishing time per fishing depth (top) and standard deviation of individual angler times per fishing depth (bottom) for the deep-water experimental drifts with a regulated fishing time of 9 minutes. Drifts of the 2023 Demersal Groundfish Survey are included for reference.

Catch of schooling Yellowtail and Canary Rockfish were much higher than expected (Table 13), causing multiple instances where anglers were unable to get through the pelagic schools to fish the bottom. Yelloweye Rockfish and Lingcod catch was much lower than expected likely due to this effect. Baited shrimp flies performed better than both the mooching rigs and pipe jigs for all rockfish encountered and were the only terminal tackle type to successfully catch Yelloweye Rockfish; however, the large catch of semi-pelagic species with this gear type caused massive snarls both within and between angler gears. Managing this larger terminal tackle type was time consuming but practicable on the *F/V Tornado*, which was used for this study and is one of WDFW's larger charter vessels. Pipe jigs were the only terminal tackle type to encounter Lingcod.

Table 13: Total number of each groundfish species encountered in the Deep-Water Experimentation study by terminal tackle gear type.

	Mooching Rig	Baited Shrimp Flies	Pipe Jig	Grand Total
Black Rockfish		1		1
Canary Rockfish	8	28	4	40
Lingcod			2	2
Redbanded Rockfish		1		1
Rosethorn Rockfish		1		1
Yelloweye Rockfish		2		2
Yellowtail Rockfish	18	44	25	87

Further deep-water experimentation is needed to test the effectiveness of rod-and-reel survey methods and terminal tackle gear types, and to document specific fishing locations for future survey development. Specifically, small "six-pack" charter vessels, frequently used in WDFW rod-and-reel surveys, were not evaluated, and the general location west of the Juan De Fuca Canyon was not fished in this study due to time constraints. This area has the highest abundance of Yelloweye Rockfish known on the Washington coast, and testing gear and methods on smaller charter vessels in this area would be beneficial to understanding the effectiveness of rod-and-reel gear in Washington's waters below 50 fathoms.

References Cited

Harms, J.H., Wallace, J.R., & I.J. Stewart. 2010. Analysis of fishery-independent rod-and-reel-based data for use in the stock assessment of Bocaccio Rockfish. Fisheries Research, 106:298-309.

International Pacific Halibut Commission. 2022. Retrieved 15 November 2022, from https://www.iphc.int/research/design-and-implementation/

For more information about this survey, contact Rob Davis (robert.davis@dfw.wa.gov).

H. Coastal Pelagic Species Nearshore Survey Activities

Background

Within the California Current Ecosystem (CCE), coastal pelagic species (CPS) comprise a large portion of the available forage fish assemblage and historically supported a thriving commercial fishery. Population abundance and distribution of these fish are tightly linked to ocean conditions and are typically highly variable, with ranges that can expand and contract dramatically. These fishes serve as vital sources of food for other fish species, birds, and marine mammals.

In 2017 the West Coast Pelagic Conservation Group (WCP), a Pacific Northwest industry consortium, partnered with NOAA Southwest Fisheries Science Center (SWFSC) to conduct a "proof-of-concept" acoustic-seine surveillance of nearshore CPS assemblages. The goal was to complement the perennial NOAA SWFSC CCE Acoustic Trawl Survey, which is limited to waters in excess of 20-50 meters bottom depth and is limited to night trawl sampling for species and biological sampling. A commercial purse seine vessel, the *F/V Lisa Marie,* was outfitted with a Simrad EK60 to acoustically sample transects in waters inaccessible to the NOAA research vessel *Reuben Lasker (Lasker)*. Success of the 2017 pilot survey led to surveys in 2019, 2021, and 2022 with expansion of spatial coverage from Washington and Oregon to include northern California and onboard biological and species composition sampling by Washington Department of Fish and Wildlife (WDFW) biologists.

After three years of successful survey work, the *F/V Lisa Marie* was outfitted with a new hull-mounted transducer blister to move closer to the end goal of an array of four wide-bandwidth transducers for optimal acoustic surveying. The final two transducers were installed prior to the continuation of the survey in 2023. The 2023 survey included additional collaboration with NOAA Northwest Fisheries Science Center (NWFSC) and the NOAA research vessel *Bell M. Shimada* (*Shimada*) in consideration of the upcoming integration of the CCE Acoustic Trawl Survey with the Joint U.S.-Canada Integrated Ecosystem and Pacific Whiting (Hake) Acoustic Trawl Survey. This collaboration will continue into 2024 until the surveys are fully integrated in 2025. This report provides an overview of 2023 survey methods employed on the *F/V Lisa Marie* in 2023 and a summary of data collected. A complete report will be provided by SWFSC.

Survey objectives:

1. Estimate distributions and abundances of CPS, particularly the northern and central sub-populations of Northern Anchovy, Pacific Sardine, Jack Mackerel, Pacific Mackerel, and Pacific Herring in the California Current Ecosystem.
2. Continuously sample acoustic backscatter during daylight hours (sunrise to sunset).
3. Set on fish near the sea surface using purse seine gear at three to four locations a day when fish are seen while transecting acoustic lines.
4. Collect species compositions of each set to include three baskets of fish collected from the overall catch and biological data (length, weight, sex, maturity, age structures) from priority species (Table 14) and all other species as time allows.

5. Make comparison sets with the *Shimada* and *Lasker* to compare catch composition and size distributions, especially regarding Pacific Whiting. (New for 2023)
6. Set on fish during the night to compare daytime versus nighttime catch composition and size distributions of all species. (New for 2023)
7. Deploy a CTD collecting temperature, salinity, depth, dissolved oxygen, chlorophyll-a, water clarity, and pH measurements at comparison set locations and at alternating ends of acoustic transect lines. (New for 2023)

Table 14: Priority species list.

Priority Species
Jack Mackerel
Market Squid
Northern Anchovy
Pacific Herring
Pacific Mackerel
Pacific Sardine

Methods

Timing

This survey was completed between July 21 and September 3, 2023 (Table 15 and Table 16). Comparison work with the *Shimada* was completed between July 21 and August 12, with a break between July 26 and August 5 due to poor weather conditions and delays in staffing of the *Lasker*. Acoustic transects and associated sets began on August 10 and continued through September 2.

Locations

All 63 planned nearshore acoustic transect lines were completed from Bodega Bay, California to Cape Flattery, Washington (Figure 18). These lines were 5 nautical miles long east-to-west and spaced at 10 nautical miles north-to-south. Lines were run in a straight line with minimal deviations between the east and west waypoints and could be run in either direction, west-east or east-west. Purse seine sets were deployed on assumed fish aggregations indicated on or near the realized transect line. Additional catch comparison sets were made between Point Conception and Bodega Bay near set locations designated by the *Shimada*.

Vessel and Staff

The *F/V Lisa Marie*, a 78.5-foot steel hull commercial fishing vessel captained by Rick Blair, was used for the entirety of this survey. In addition to Rick, the *Lisa Marie* employed three deckhands who manned the purse seine net as it came aboard and one skiff operator who deployed the net aboard the skiff. The crew for the 2023 survey were deckhands Dave Yokum, Daison Clerc, and Orion Thomas, and skiff operator Dino Thomas. Onboard WDFW staff included Kristen Hinton and Zac Calef. Andy

Blair, president of West Coast Pelagic Conservation Group; Mike Okoniewski, secretary of the West Coast Pelagic Conservation Group; and Greg Shaughnessy, vice president of West Coast Pelagic Conservation Group and chief operating officer of Ocean Gold Seafoods, were also integral in the permitting and planning processes for this survey.

Gear

The principal acoustic gear included Simrad EK80 Wide-Bandwidth Transceivers connected to hull-mounted Simrad 38 kHZ (ES38-7C) and 200kHz (ES200-7C) transducers. All acoustic gear was calibrated in Gig Harbor, Washington by SWFSC Acoustic Engineer Josiah Renfree on June 13, 2023. The purse seine net used for enumerating the acoustic backscatter from the acoustic gear was approximately 440 meters long and 40 meters deep with a 17-mm-wide mesh.

Effort

All acoustic lines were completed during daylight hours (between sunrise and sunset) from Bodega Bay, California to Cape Flattery, Washington. Acoustic transect lines were run in a straight line either east-to-west or west-to-east at approximately 7 knots, and deviations were kept to a minimum. Along these lines, assumed fish aggregations were either documented for return during nighttime hours or set on immediately at the discretion of the vessel's captain. Sets were made during both day and night from Point Conception, California, to Cape Flattery, Washington. For each set, the purse seine was deployed off the rear of the vessel via a skiff and hauled on the starboard side of the vessel, where subsamples of catch could be collected while the skiff stood by on the port side (Figure 19 and Figure 20).

Data Collection

Effort Data

Acoustic information was collected continuously via the Simrad EK80 software and Matlab programing written by SWFSC. These data were logged to an external hard drive and backed up automatically every five minutes to a separate hard drive.

A paper logbook detailing the location, time, depth, and sea surface water temperature of the beginning and end of each transect line was kept for the duration of the survey. Any pause in the transect line, deviation from the line, stop to set, or continuation of the transect line was documented. Each set's time, location, depth, temperature, and haul weight were documented in the paper logbook as well as within the Rose Point Coastal Explorer .nob file of transect lines provided by SWFSC. Within this .nob file, tracks were also recorded while transiting the transect lines to better error check the EK80 files' GPS locations throughout the entirety of the survey.

Catch and Biological Data

Total catch weight (haul weight) was enumerated by the vessel's captain and documented for each set. From each set, three baskets of one brailer-net scoop, separated spatially as much as possible from the seine net, were collected while the rest of the catch was released unharmed (Figure 21). Each basket was individually sorted to species, enumerated, and weighed. Once all fish were counted and weighed, 50 fish from each species were randomly selected for biological sampling. From each fish selected, length (standard length for Northern Anchovy and Pacific Sardine, fork length for all others), individual

weight, and sex were collected. For all CPS (Table 14) and groundfish, maturity and age structures (except for Pacific Herring) were also collected.

Data Flow

All fishing effort, catch, and biological information were collected on paper and later transcribed into a Microsoft Excel spreadsheet. All biological information of fish selected for age structure sampling were also transcribed into WDFW's in-house Biological Data System (BDS), in which age structures can be tracked and age readings can be documented. All acoustic data were saved directly to a hard drive that was backed up to a secondary hard drive every five minutes throughout the entirety of the survey.

Age structures were delivered to the WDFW ageing lab, and ages were provided to SWFSC for Pacific Sardine from 2022 and 2023 in November 2023. All acoustic, set, biological, and species composition data were shared with SWFSC for analysis.

CTD Deployment

A model SBE 19+ V2 water column profiler (CTD) fitted with a dissolved oxygen sensor (SBE 43) was deployed at all comparison set locations as well as either the start or end of each acoustic transect line. A pH meter (model SBE18) and transmissometer (model C-Star 25cm Red) were added to the CTD in 2023, giving pH and water clarity measurements at each cast. Additionally, the fluorometer was replaced with a new model (ECO-FL-RT). All data collected via the CTD were shared with SWFSC for analysis.

Table 15: Number of sets per day; note there was some overlap of comparison sets and acoustic line sets on August 10 and August 11; August 12 had only one comparison set and no acoustic line sets.

Date	Number of Comparison Sets
7/21/2023	Transit
7/22/2023	3
7/23/2023	3
7/24/2023	1
7/25/2023	1
7/26/2023	On Anchor
7/27/2023	On Anchor
7/28/2023	On Anchor
7/29/2023	On Anchor
7/30/2023	On Anchor
7/31/2023	On Anchor
8/1/2023	On Anchor
8/2/2023	Transit
8/3/2023	Transit/OnAnchor
8/4/2023	On Anchor
8/5/2023	On Anchor
8/6/2023	2
8/7/2023	4
8/8/2023	1
8/9/2023	On Anchor
8/10/2023	1
8/11/2023	1
8/12/2023	1

Date	Number of Sets on Acoustic Lines
8/10/2023	1
8/11/2023	1
8/12/2023	
8/13/2023	2
8/14/2023	2
8/15/2023	1
8/16/2023	3
8/17/2023	2
8/22/2023	2
8/23/2023	1
8/24/2023	6
8/25/2023	1
8/26/2023	4
8/27/2023	4
8/28/2023	5
8/29/2023	4
8/30/2023	3
8/31/2023	4
9/1/2023	4
9/2/2023	2

Table 16: Survey dates while running acoustic transect lines.

Date	First Transect	Last Transect
8/10/2023	91	91
8/11/2023	93	99
8/12/2023	101	105
8/13/2023	107	113
8/14/2023	115	119
8/15/2023	122	124
8/16/2023	126	130
8/17/2023	132	138
8/18/2023	In Port	In Port
8/19/2023	In Port	In Port
8/20/2023	In Port	In Port
8/21/2023	In Port	In Port
8/22/2023	140	148
8/23/2023	150	156
8/24/2023	158	164
8/25/2023	166	172
8/26/2023	174	180
8/27/2023	182	186
8/28/2023	188	192
8/29/2023	194	198
8/30/2023	200	202
8/31/2023	204	208
9/1/2023	210	214
9/2/2023	216	216
9/3/2023	Transit	Return to Gig Harbor

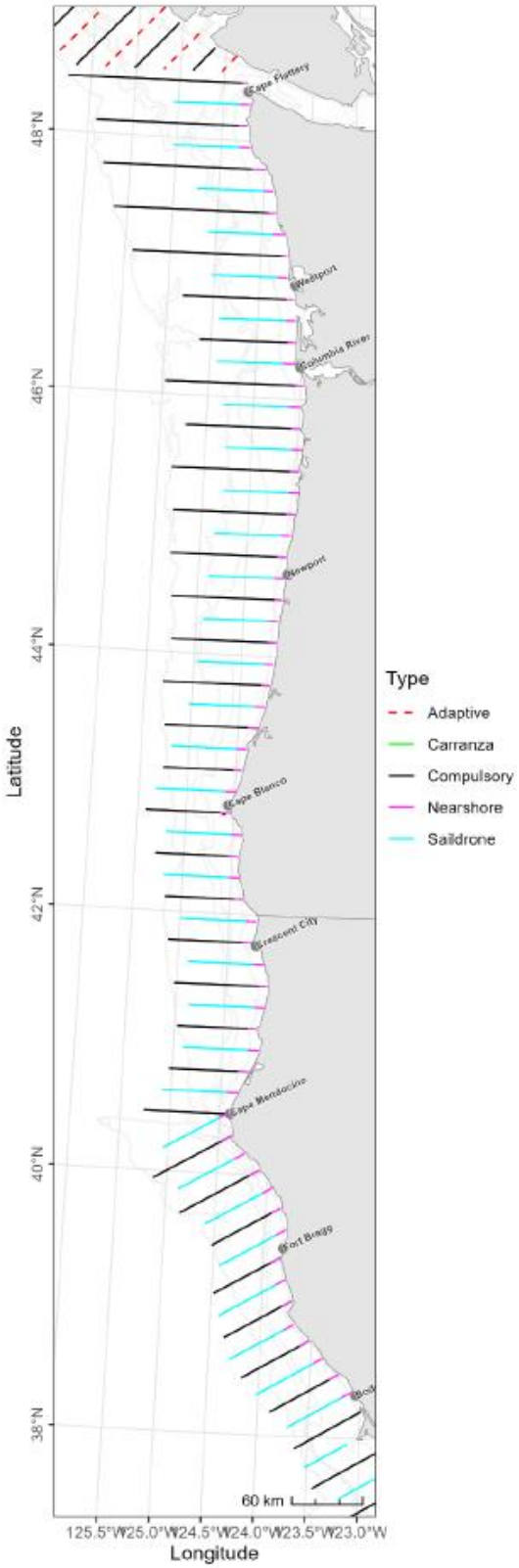

Figure 18: Planned transect lines for the entirety of the California Current Ecosystem Survey. (Figure courtesy of Kevin Stierhoff, SWFSC).

Figure 19: Purse seine being hauled in along the starboard side of the *Lisa Marie*.

Figure 20: View of the *Lisa Marie* from the skiff while gear is being hauled in.

Figure 21: Brailer net sample being taken from the overall purse seine catch for species composition and biological information.

Results

F/V Lisa Marie departed Gig Harbor on 15 July 2023, and transited to Santa Barbara, California, where WDFW staff boarded on 21 July 2023. Comparison set work began 22 July with a botched set due to mechanical failure near Point Conception, California. After this set, it was deemed by NOAA's SWFSC lead scientist that the *Lisa Marie* should continue northward while making as many comparison sets as possible. A scheduling delay of the *Lasker* due to a multitude of mechanical and staffing issues prohibited any timely comparison sets; as such, comparison sets were only made with the *Shimada*. Due to scheduling issues, these comparison sets were made nearly a month after the *Shimada* had made their targeted Pacific Whiting sets.

A total of 18 sets were made as comparison sets between the *Lisa Marie* and the *Shimada* (Table 15). These sets were made on assumed fish aggregations near locations where *Shimada* caught Pacific Whiting during their survey. From these sets, a total of 19 different species were identified, counted, and weighed for a total count of 12,315 individuals at a total of 129.8 kg (Table 17). Of the individually identified species, biological information was taken from 10 of them. A total of 933 lengths, 933 weights, 620 sexes, 620 maturities, and 616 age structures were taken (Table 18). Of these 933 individuals, 770 were from the priority species list (Table 14) and 101 were very small Pacific Whiting. Locations of sets and their species compositions can be seen in Figure 22.

During the survey timeframe of 10 August 2023 through 3 September 2023, 63 transect lines were run over 20 days (Table 16). A total of 52 sets associated with acoustic lines were made over the entirety of the survey (Figure 18 and Table 15). From these sets, 26 different species were identified, counted, and

weighed for a total count of 7539 individuals at a net weight of 584.9kg (Table 19). Of the individually identified species, biological information was taken from 19 of them. A total of 2096 individual lengths, 2096 weights, 1838 sexes, 1199 maturities, and 963 age structures were taken (Table 20). Of these 2096 individuals, 1586 were from the priority species list. Locations of sets and their species compositions can be seen in Figure 23. All data were sent to SWFSC for further analysis, and any analyses can be found in their Technical Memorandum describing the distribution, biomass, and demography of CPS in the CCE.

Table 17: Total catch taken for species compositions in comparison sets.

Species	Total Count	Total Weight (kg)
Anchovy	1527	26.6045
Butterfish	7	0.043
Comb Jelly	6676	21.967
Egg Yolk Jelly	1	0.559
Jack Smelt	1	0.057
Krill	4	
Lanternfish	1	0.001
Lizardfish	1	0.0085
Market Squid	559	2.6665
Moon Jelly	3	2.6405
Pacific Hake	143	1.3225
Pacific Sardine	41	2.656
Pyrosome	2128	34.0693
Salp	1003	27.9678
Saury	107	3.056
Sea Elephant	3	0.277
Sea Nettle	2	4.4085
Squid	106	1.28
Toadfish	2	0.2605
Grand Total	12315	129.8446

Table 18: Counts of biological data taken by species for comparison sets.

Species	Count of Lengths	Count of Weights	Count of Sexes	Count of Maturitues	Count of Age Structures
Butterfish	7	7			
Jacksmelt	1	1	1	1	
Lanternfish	1	1			
Lizardfish	1	1			
Market Squid	252	252			
Northern Anchovy	477	477	477	477	477
Pacific Sardine	41	41	41	41	38
Pacific Saury	50	50	50	50	
Pacific Whiting (Hake)	101	101	51	51	101
Toadfish	2	2			
Grand Total	933	933	620	620	616

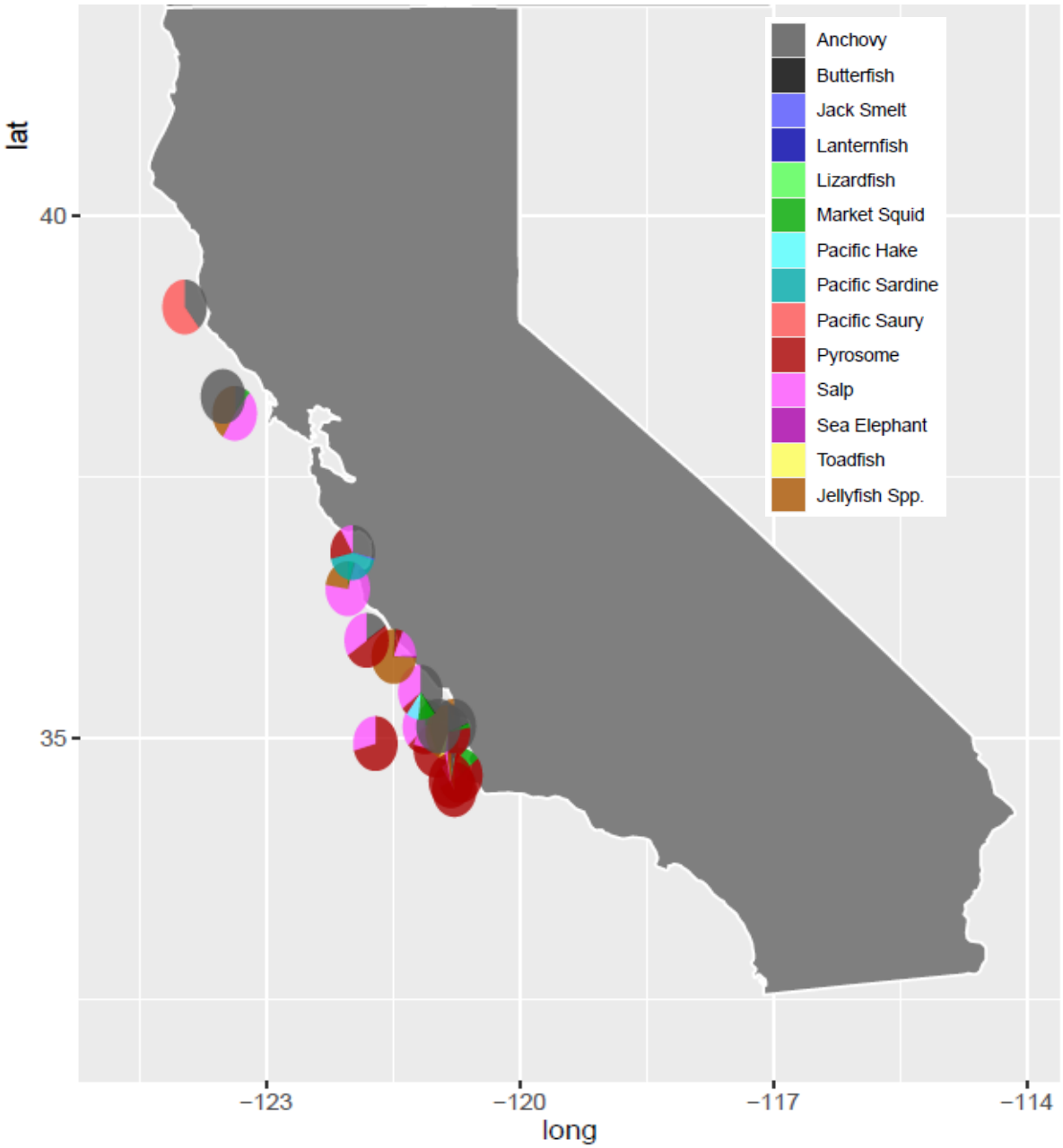

Figure 22: Locations of sets and their species compositions made by *Lisa Marie* in comparison with *Bell M. Shimada* Pacific Whiting sets. Species with low catch rates may not be evident at this scale.

Table 19: Total catch taken for species compositions in acoustic line sets.

Species	Total Count	Total Weight (kg)
Anchovy	415	10.6885
Comb Jelly	30	23.585
Egg Yolk Jelly	38	52.176
Eulachon	4	0.1505
Jack Mackerel	212	173.2395
Jack Smelt	117	12.618
King Salmon	6	0.489
Market Squid	4	0.038
Moon Jelly	24	18.415
Pacific Herring	1263	73.3355
Pacific Herring	274	1.99
Pacific Mackerel	9	6.609
Pacific Sardine	946	132.233
Pacific Saury	171	7.748
Pile Perch	8	0.206
Pink Shrimp	3	0.0095
Poacher	1	0.001
Sablefish	15	1.6965
Salp	92	5.703
Sea Nettle	42	29.369
Slender Sole	6	0.2355
Surf Smelt	626	6.564
Surf Smelt (calculated)	84	0.26825
Tomcod	1	0.002
Unidentified Smelt	1445	1.53
Unidentified Smelt (calculated)	1118	3.68075
Water Jelly	576	22.2715
Whitebait Smelt	8	0.093
Yellowtail Rockfish	1	0.003
Grand Total	7539	584.948

Table 20: Counts of biological data taken by species for acoustic line sets.

Species	Count of Lengths	Count of Weights	Count of Sexes	Count of Maturitues	Count of Age Structures
Chub Mackerel	9	9	9	9	9
Eulachon	4	4	4		4
Jack Mackerel	230	230	230	230	224
Jacksmelt	77	77	77		
King Salmon	6	6			
Market Squid	4	4			
Northern Anchovy	103	103	103	103	103
Pacific Herring	638	638	615	248	
Pacific Sardine	602	602	602	601	601
Pacific Saury	64	64	1		
Pacific Tomcod	1	1	1		
Pile Perch	8	8			
Poacher	1	1			
Sablefish	15	15	13		15
Slender Sole	6	6	6		6
Surf Smelt	79	79	79	8	
Unidentified Smelt	240	240	97		
Whitebait Smelt	8	8			
Yellowtail Rockfish	1	1	1		1
Grand Total	2096	2096	1838	1199	963

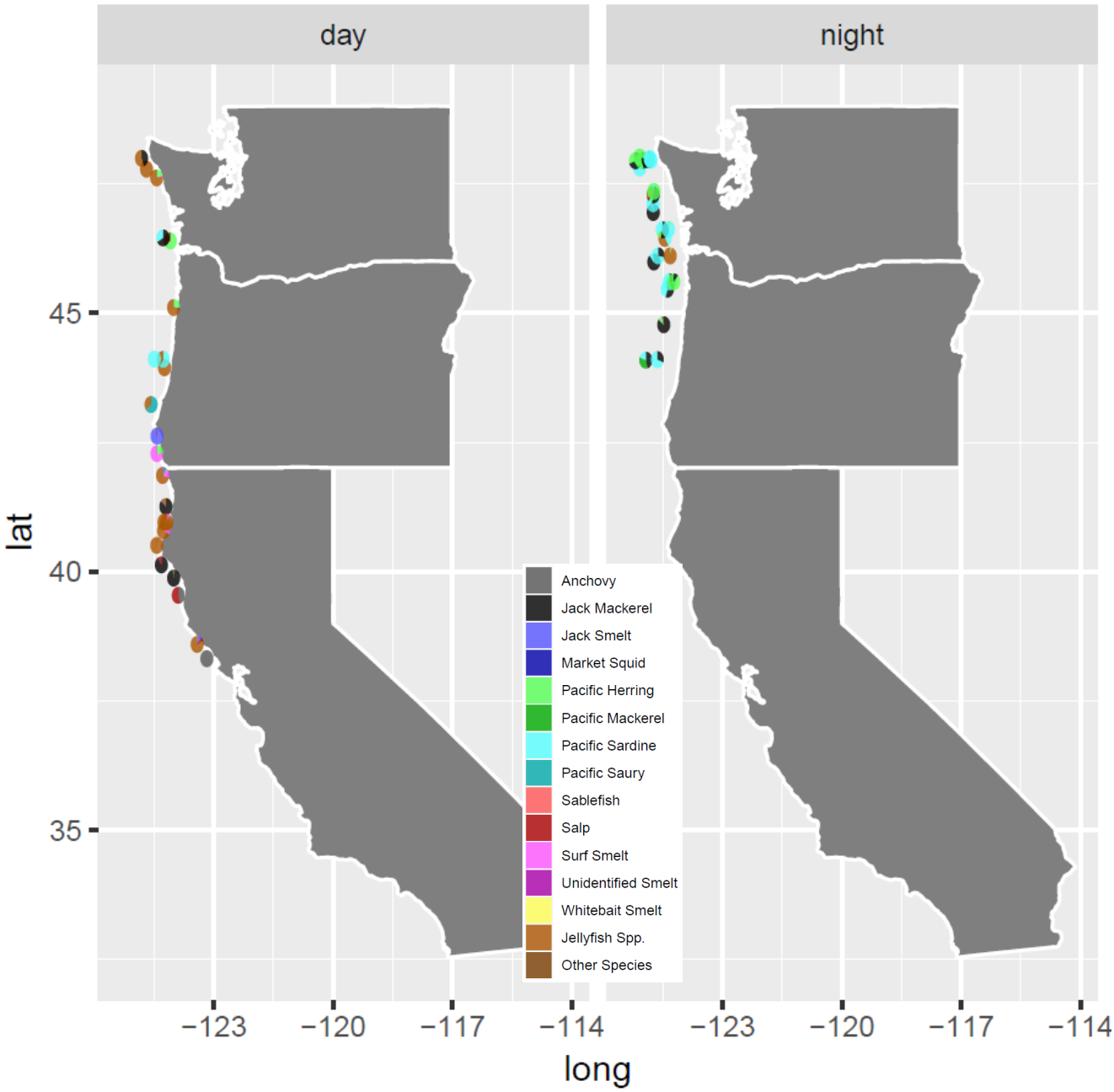

Figure 23: Locations of sets along acoustic lines and their species compositions. Species with low catch rates may not be evident at this scale.

For more information about this survey, contact Kristen Hinton (kristen.hinton@dfw.wa.gov).

III. FISHERY MONITORING

A. Puget Sound Port Sampling/Creel Surveys of Recreational Fisheries

Estimates are made for the recreational harvest of bottomfish, Pacific Halibut, salmonids, and other fishes caught in Puget Sound on an annual basis in Washington waters. Catch composition is obtained via angler-intercept surveys (i.e., creel sampling) conducted by WDFW's Puget Sound Sampling Unit at boat ramps and public boat launches throughout the region. Recreational effort information is obtained through phone surveys conducted by an outside consulting company (CIC Research) at two-month intervals. Total catch is estimated for each species and fishing mode at every two-month interval (i.e. "waves") throughout the year. In 2024 WDFW, in collaboration with CIC Research, will be launching an internet-based survey in conjunction with the current phone survey to evaluate whether there are potential biases. The longer-term goal is to move towards an internet-based effort survey to increase the response rate and consequently estimate precision, while ultimately lowering survey costs.

For more details, contact Anne Stephenson (Puget Sound Sampling Unit; ann.stephenson@dfw.wa.gov) or Kathryn Meyer (Effort Survey Contact; kathryn.meyer@dfw.wa.gov)

B. Ocean/Coastal Port Sampling/Creel Surveys of Recreational and Commercial Fisheries

WDFW supports groundfish stock assessments and management of fisheries through multiple, interrelated groups that collect and process biological and catch data: the Fish Program's Ocean Sampling Program and the Coastal Marine Fish Science (CMFS) Unit's commercial fishery and recreational fishery sampling groups.

Ocean Sampling Program for Recreational Fisheries – The Ocean Sampling Program (OSP) is responsible for catch estimation of ocean salmon and groundfish recreational fisheries. OSP uses port-exit counts, primarily, and dockside angler interviews of recreational landings at Ilwaco- Chinook, Westport, La Push, and Neah Bay to track quota attainment for Chinook and Coho Salmon, and to estimate catch of groundfish species. In addition, dockside samplers collect biological and tag data from salmon and length data from groundfish.

*For more details, please contact Kyle Vandegraaf (*kyle.vandegraaf@dfw.wa.gov).

CMFS Unit Commercial Fishery Sampling – Data on commercial groundfish, CPS, and Hagfish fisheries are collected by CMFS group technicians at all primary coastal ports: Westport, Ilwaco, Chinook, Bellingham, Blaine, Neah Bay, and La Push. The commercial sampling team has two major objectives: (1) to collect biological data – such as sizes, otoliths, and gonads – from commercially landed groundfish to support research and stock assessments; and (2) to collect groundfish catch data via commercial fisheries logbooks, fish receiving tickets, and species composition sampling of mixed-species market categories, which support fisheries monitoring and in-season management decision making.

During 2022 and 2023, WDFW fishery managers proposed and approved the necessary changes to WAC 220-353-050 to add rockfish to the exempted species that can be landed dressed, while keeping the requirement for all other species to be landed whole (or "round"). A WDFW commercial permit is required to land dressed rockfish into Washington, which applicants must apply and be approved for on an annual basis. The first permit was signed and approved by the director in July of 2023. Our port samplers worked closely with fishery managers to put together training materials for the dressed-

rockfish rule making, including an infographic showing the cut diagram to be made on rockfish, to be distributed to the interested stakeholders for this fishery. Port samplers also worked with WDFW agency IT staff to expand our electronic data collection application to support associated data from the dressed-rockfish fishery and ensure the smooth transfer of that data to our web-based biological database (BDS) and their upload to PacFIN.

The CMFS Unit produces periodic reports intended to inform fishery managers and fishery assessment authors by describing the biological and catch data collection methods and including an inventory of data collected. Descriptions of port and fishery dynamics offer context for the changes to data collection methods. Collectively, the series of reports serve to document changes in fishery monitoring and sampling goals, and approaches and procedures in response to evolving fishery management science and management needs. The most recent report, published in June 2020, summarizes activities and accomplishments from 2015 through 2018 (Downs et al. 2020).

The CMFS Unit also monitors commercial coastal pelagic fishery landings in support of stock assessments and fishery management at Ilwaco and Westport. The only active fishery during the reporting period was the baitfish fishery, which harvests Northern Anchovy from the northern subpopulation (NSNA) distributed off Washington, Oregon, and northern California coasts. The NSNA are subject to management under the Pacific Fishery Management Council Coastal Pelagic Species Fishery Management Plan. NSNA have never been formally assessed, primarily due to the extremely low level of catch; thus, the status of the subpopulation is unknown. Biological sampling of landings was started in 2014 to provide time series data for potential assessment in the future as the need arises. Further details on anchovy monitoring can be found below in section V: O.

References cited

Downs, D., K. Hinton, J. Fuller, T. Zepplin, K. Lawson, L. Wargo, T.S. Tsou. 2020. Washington Coastal Commercial Groundfish Fisheries Monitoring Program: Progress Report 2015-2018. Washington Department of Fish and Wildlife. Fish Program Report Number FPA 20-07.

CMFS Unit Recreational Fishery Sampling – The CMFS Unit's recreational groundfish sampling program directly supports research and stock assessment by collecting biological data from recreationally caught groundfish species landed at Westport, La Push, and Neah Bay. Comprehensive biological information includes fork length in centimeters, weight in grams, sex information, and age structure collection (otolith or Lingcod dorsal fin ray). This biological information enhances data collection efforts of the WDFW Ocean Sampling Program previously described.

IV. 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, except for the synthesis report of LeClair et al (2018).

References Cited

LeClair, L., R. Pacunski, L. Hillier, J. Blaine, 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.

V. REVIEW OF AGENCY GROUNDFISH RESEARCH, ASSESSMENT, AND MANAGEMENT

A. Hagfish

The Washington Hagfish Commercial Fishery, which opened in 2005 under developmental regulations, is small in scale, exporting hagfish for both frozen and live-fish food markets in Korea. Hagfish are caught in long-line barrels constructed from olive oil or pickle barrels modified with an entrance tunnel and dewatering holes (Figure 24). Fishing occurs on soft, muddy habitat along the entire outer coast of Washington and northern Oregon. The fishery operates, by rule, only in offshore waters deeper than 50 fathoms and is open access. Licensed Washington fishers can fish federal waters off of 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 predominantly catches Pacific Hagfish, but Black Hagfish are landed incidentally. A few trips attempting to target Black Hagfish were successful in the recent past, and a small-scale market is developing for the frozen product. Pacific Hagfish predominate from 50-80 fa, while Black Hagfish have been targeted with deeper sets, up to 300 fa; Pacific and Black Hagfish ranges appear to overlap between 80 and 100 fathoms. Currently, however, fish ticket landing data cannot distinguish between species, as only one species code exists. The median CPUE is about 4.5 pounds, but instances of high CPUE are not uncommon, as evidenced by reports of "plugged" barrels.

During the past few years, fleet participation and landings into Washington has been low in the hagfish fishery, and there are no current biological and management actions to report; however, the previous 5-year data from 2017 to 2022 is reported here. Biological sampling data collected from Pacific and Black Hagfish consist of length, weight, maturity, and egg counts for females at maturity stages 4 through 7; however, only Pacific Hagfish data are reported here. Male and female hagfish present similar size distributions (Figure 25). The largest specimen sampled was a 67-cm female, and the smallest a 24-cm specimen, sex unknown. An evaluation of maturity suggests year-round spawning. Fecundity is low, with the number of eggs in females at maturity stages 6 & 7 averaging 24 eggs per female (Table 21). Few females with developed eggs have been sampled; the 2017-2022 sample contained 12% mature females.

Management of the 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 – including logbooks, fish receiving tickets, and biological sampling of catch – have been developed to inform management. 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 and Beulig (2013). Interest remains in conducting a study similar to research completed in California to evaluate

escapement relative to barrel dewatering-hole size, but funding sources have not yet been identified.

Figure 24: Barrels used in the WA commercial hagfish fishery.

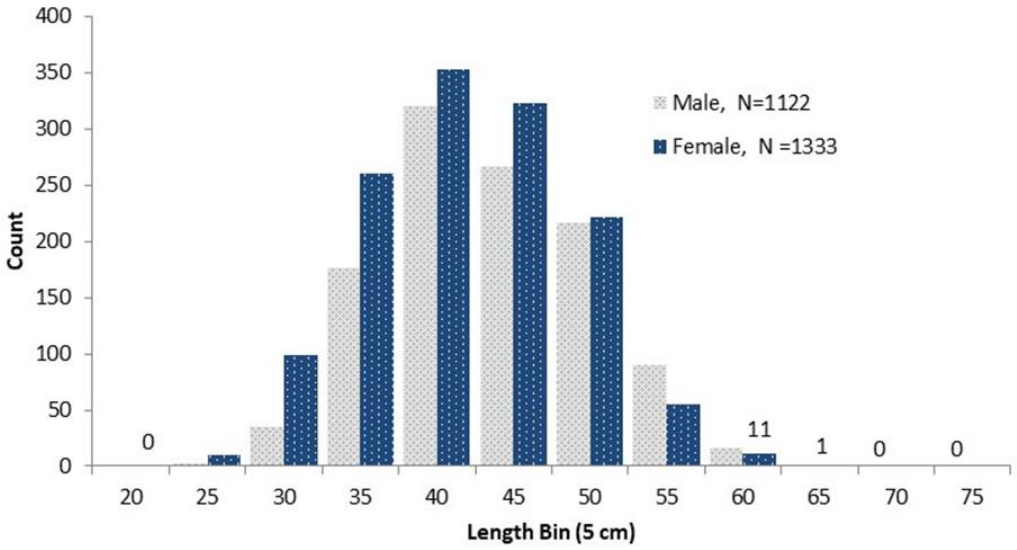

Figure 25: Length (cm) of male and female Pacific hagfish, 2017-2022.

Table 21: Average egg count per mature female Pacific Hagfish collected from Washington landings during 2017-2022.

Pacific Hagfish	Sample Count	Egg count minimum	Egg count maximum	Egg count average
Maturity stage 6	145	9	49	25
Maturity stage 7	18	5	39	19
Total	163			24

References Cited

Martini, F., and A. Beulig. 2013. Morphometrics and Gonadal Development of the Hagfish *Eptatretus cirrhatus* in New Zealand. PLoS ONE 8(11): e78740. https://doi.org/10.1371/journal.pone.0078740.

For more information about the hagfish fishery, contact Donna Downs (donna.downs@dfw.wa.gov).

B. North Pacific Spiny Dogfish and other sharks

In 2022, the WDFW in collaboration with Oregon State University and NOAA, initiated a Broadnose Sevengill Shark (*Notorynchus cepedianus*) tagging study in the south portion of the Salish Sea. This large, apex predator is found in temperate waters around the world, but until recently, only one record of occurrence existed within Puget Sound. Tagging efforts in 2022 and 2023 led to the capture and tagging of 9 Sevengill Sharks in the South Sound. An array of receivers in Washington and along the Oregon coast have detected several of the acoustically tagged animals over the past two years. Sampling efforts will continue in 2024 with the intent to tag another 3 animals. Additionally, during this study, a Tope Shark (*Galeorhinus galeus*), also known as a Soupfin Shark, was captured. Tope Sharks are highly migratory and are typically found along the west coast of the United States and British Columbia. This unexpected capture led to a publication outlining this range extension (in press).

Spiny Dogfish are regularly seen in ROV videos and caught in the Puget Sound Bottom Trawl Survey, where they are counted, weighed, and measured; a tissue plug for genetics is also taken from select individuals. Other shark species occasionally encountered in the bottom trawl survey include Brown Catsharks and Sixgill Sharks.

C. Skates

No specific, directed research or management to report. Longnose and Big Skates are regularly seen in ROV videos and caught in the Puget Sound Bottom Trawl Survey, where they are counted, weighed, and measured. Sandpaper skates are also occasionally encountered.

D. Pacific Cod

In 2023, WDFW engaged in a collaborative research effort with the University of Washington, the Alaska Fisheries Science Center, Department of Fisheries and Oceans Canada, and the Farallon Institute. UW geneticists are leading the study, which focuses on identifying the genetic underpinnings of Puget Sound Pacific Cod's apparent adaptability to the warmer bottom temperatures of Puget Sound. Work is anticipated to continue through 2024.

Pacific Cod are also caught in the Puget Sound Bottom Trawl Survey, where they are counted, weighed, and measured; otoliths for age analysis and fin clips for genetic analysis are also taken from a small subset of individuals.

E. Walleye Pollock

No specific, directed research or management to report. Walleye Pollock are regularly seen in ROV videos and caught in the Puget Sound Bottom Trawl Survey, where they are counted, weighed, and measured. Rough population estimates are produced as part of the survey analysis.

F. Pacific Whiting (Hake)

No specific, directed research or management to report. Pacific Hake are regularly seen in ROV videos and caught in the Puget Sound Bottom Trawl Survey, where they are counted, weighed, and measured. Rough population estimates are produced as part of the survey analysis.

G. Grenadiers

No specific, directed research or management to report.

H. Rockfishes

Multiple surveys – including ROV, hook-and-line, and hydroacoustic techniques –are conducted to study rockfish populations both within Puget Sound and along the coast. See Section II: C-G above for more information on these surveys.

I. Thornyheads

No specific, directed research or management to report.

J. Sablefish

No specific, directed research or management to report. While Sablefish used to be caught regularly – albeit in small numbers – in the Puget Sound bottom trawl survey, they were not encountered from 2011-2016, despite the annual survey efforts. Starting in 2017, however, the survey has begun to encounter them again: 8 were caught in 2017, 2 in 2018, 8 in 2019, 3 in 2021, 6 in 2022, and 14 in 2023.

K. Lingcod

Lingcod Age Structure Processing Lab – The Coastal Marine Fish Science Unit processes lingcod fins collected from Washington (coastal and Puget Sound) commercial and recreational fisheries, and periodically from Oregon fisheries by contract. Lingcod fins are processed for ageing using the fin cross-section method. The process includes four steps: drying, gluing, sectioning, and mounting. Each dried and glued fin is secured in a sectioning saw (Beuhler Isomet 1000), and seven-to-ten cross-sections (2.0 mm) are cut. The sections are mounted onto microscope slides with Cytoseal, dried for at least 24 hours, and sent to age readers. Sectioned fins are aged using the surface-read method. During 2023, the lab cut and mounted 2,002 fins.

Puget Sound Stock Assessment – Over the past several years, concerns have been raised by the public about Lingcod populations within Puget Sound, especially in the San Juan Archipelago (Marine Catch Area 7) and Central Puget Sound (Marine Catch Areas 9 and 10) where catch rates and angler effort are

traditionally highest. Specifically, some constituents are concerned that the current management regime is not protective enough, as legal-sized fish (26-36") are becoming less frequent in the catch 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, especially near urban centers, since 2010. The majority of lingcod fishing effort occurs in MCA 7, and although the CPUE has shown some variability over the past decade, there does not appear to be a directional trend in CPUE over time. 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 incidentally caught rockfish. The WDFW considers this a highly conservative management regime.

The WDFW fit a statistical catch-at-age model in Stock Synthesis, although the data do not appear sufficient to produce a stable model of the Puget Sound population of Lingcod. Input data included historical commercial landings and relatively uncertain recreational estimates, fishery dependent lengths and ages (within the slot limit), and an index of catch-per-unit-effort for the recreational fishery. The model is still being evaluated for stability, and alternative data-limited methods are being explored, with an anticipated final report towards the end of 2024.

L. Atka mackerel

No specific, directed research or management to report.

M. Flatfishes

No specific, directed research or management to report. Several species of flatfish are regularly seen in ROV videos, and 18 species have been caught in the Puget Sound Bottom Trawl Survey, where they are counted, weighed, and measured. Rough population estimates are produced as part of the survey analysis. The dominant flatfish species throughout Puget Sound is English Sole, which has been encountered at all depths and in all regions; the 2023 trawl survey estimate for English Sole throughout Puget Sound was 9,172 mt, similar to the 2022 estimate of 9,565 mt.

N. Pacific halibut & IPHC activities

WDFW had little to no involvement with IPHC sampling activities in 2023.

O. Other groundfish and forage fish work

Anchovy – Northern Anchovy (northern subpopulation) fisheries in Washington are conducted to provide live bait for recreational and commercial fisheries, and packaged bait for retail to recreational fishermen. Distinguished by gear type, fisheries for anchovy include a lampara-gear fishery and a seine-gear fishery. The lampara-gear fishery is primarily comprised of Albacore Tuna fishers that catch and hold anchovy in onboard live-wells to meet their own bait needs. The purse-seine fishery harvests and holds live bait in dockside net pens for retail sale to recreational and commercial fishers. The fishery occurs in federal waters (3-200 miles), inside 3 miles (state waters) on the southern Washington coast, as well as within the estuaries of Grays Harbor and Willapa Bay, and in the lower Columbia River. Participation in the fishery is not limited. The northern subpopulation of Northern Anchovy has never been formally assessed through a model-based method, as historically the WDFW did not monitor baitfish landings. To build a time series in support of potential assessment, the CMFS Unit began monitoring the commercial baitfish fishery in 2014 at both Westport and Ilwaco, although the

majority of sampling occurs at Westport.

Samples of 100 fish are collected weekly during the fishery season (roughly May to September). Fewer samples were collected in 2020 due to reduced fishing activity associated with the COVID-19 pandemic. Additionally, due to adverse fishing conditions, namely small Pacific Sardine and Pacific Herring in the areas of highest anchovy abundance, landings of NSNA decreased in 2023, thus fewer samples were taken throughout the season than in years prior. Table 22 presents an inventory of the number of fish sampled and data collected as annual mean weight and length. More complete reporting of these data can be found in an agency technical report in progress.

Table 22: An inventory of biological data and annual mean weight and length for Northern Anchovy sampled in the coastal bait fish fishery.

Year	Number sampled Length/Weight/Maturity	Number Aged	Mean Weight (g)	Mean Length (mm)
2015	1150	129	23	129
2016	1126	649	20	118
2017	933	929	14	111
2018	950	792	15	114
2019	1800	1790	16	112
2020	500		13	106
2021	1001		15	112
2022	950	935	15	110
2023	603		11	103

For more details on coastal anchovy, contact Kristen Hinton (kristen.hinton@dfw.wa.gov).

Pacific Sand Lance Research – There are no directed fisheries or estimates of abundance for Pacific Sand Lance in Washington, but the Washington Department of Fish and Wildlife continues its efforts to better understand this important forage fish and document and protect its critical habitat. In 2021, with support from a National Estuary Program (NEP) grant and a Washington Conservation Corps crew funded by the Washington Department of Natural Resources, the analysis of a pilot study to identify sand lance burying habitat was finished. This study used two survey methods, shore-based and boat-based, to sample nearshore substrate for buried Sand Lance. Both methods were effective, and buried Sand Lance were observed in Bellingham Bay, Whidbey Basin, Hood Canal, and central Puget Sound. The results of this study were presented to a special meeting of the Puget Sound Ecosystem Monitoring Program's Forage Fish and Food Webs work group and provided in our final report to NEP: *Puget Sound Sand Lance Habitat Characterization and Mapping NTA 2018-0242* (Olson, Biondo, and Dionne 2021). Attendees of the special meeting indicated that if information like that provided by these surveys were more widely available, it could be useful for the implementation of the State's Hydraulic Project Approval Program, and other habitat conservation programs, but additional resources are required to undertake the sampling and model development to provide this information.

Surf Smelt – While there are no estimates of biomass or established indices of abundance for smelt in Puget Sound, there are both commercial (beach seine) and recreational (dip net, jigging) fisheries that

primarily target surf smelt. Since 2014, the recreational fishery has been limited to the hours between 6am and 10pm, has been open only five days a week, and has a daily bag limit of 10 pounds per person. The commercial fishery has also been limited to the hours between 6am and 10pm, has been open only four days a week, has region specific seasons and closures (Figure 26), and has had an annual quota of 60,000 pounds that is reset on January 1 of each year. Since the commercial quota was established in 2014, it has been reached – and the fishery subsequently closed – by mid-October each year, until the onset of the pandemic in 2020, since which the quota has not been reached. The total annual landings since 2019 have been between 25,000 pounds and 35,000 pounds. This continued reduction in landings is most likely due to reduced demand and the departure of one of the primary commercial harvesters.

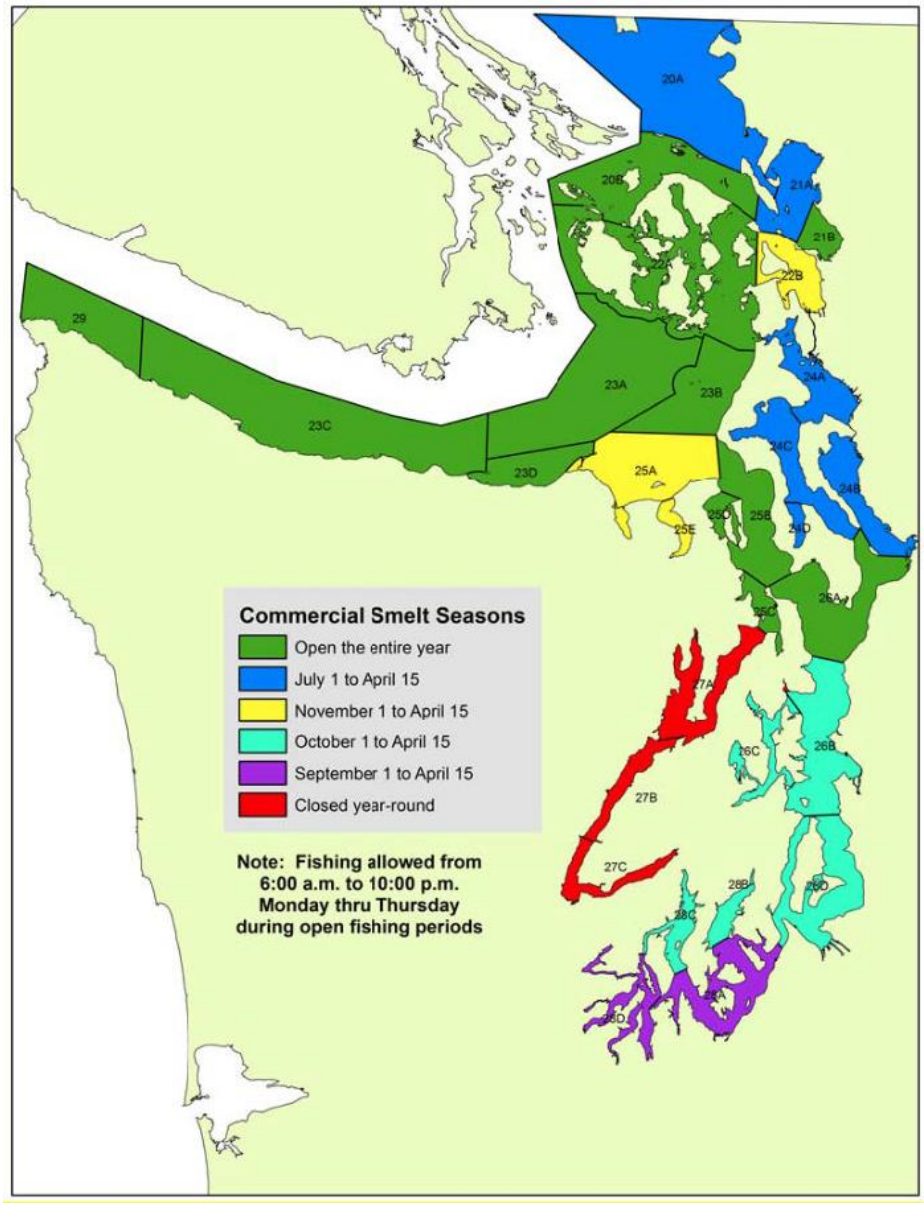

Figure 26: Map of commercial smelt fishery management regions and respective season openings.

Historical Groundfish Fishery Compendium and Catch Reconstructions – 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.

VI. ECOSYSTEM STUDIES

Puget Sound Ecosystem Monitoring Program (PSEMP) update – The Toxics Biological Observation System (TBiOS) team at WDFW has been conducting regular status and trends (S&T) monitoring of toxic contaminants in various indicator species within Puget Sound since 1989. This includes monitoring contaminant concentrations in fish and shellfish tissues and assessments of health effects on biota.

Most recently, TBiOS' regular S&T monitoring included assessments of English Sole (a benthic indicator) in spring of 2023 and Pacific Herring (a pelagic food-web indicator) in winter of 2024. Additionally, TBiOS continues to assess contaminants in Puget Sound's nearshore environment using two additional indicators: Bay Mussels and juvenile Chinook Salmon. TBiOS completed the sixth Puget Sound-wide assessment of contaminants using transplanted (i.e., caged) mussels over the winter of 2023/2024. Samples will be analyzed during the summer of 2024, with resulting data expected in fall/winter of 2024. To evaluate the effects of contaminants on the early life stages of salmon, TBiOS will conduct its fifth assessment of juvenile Chinook Salmon from up to 10 major rivers and deltas of Puget Sound in spring of 2024.

TBiOS also conducted an adult salmonid study during the fall of 2023, focusing on returning Chinook, Pink, and Chum Salmon from up to six major river systems. These efforts will continue in fall 2024, with a focus on Chum, Sockeye, and Coho Salmon. The goal of this study is to better understand contaminant accumulation in adult salmonids and potential health impacts on the people and resident killer whales that consume them. The data generated in this study will be shared with the Washington Department of Health to inform fish consumption advisories for salmonids returning to Puget Sound. Data from the English Sole, Pacific Herring, Bay Mussels, and juvenile Chinook studies are

summarized online at the Puget Sound Partnership's Toxics in Fish Vital Sign (PSP) website (https://vitalsigns.pugetsoundinfo.wa.gov/VitalSign/Detail/28). 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. Additional publications and reports for a number of these studies are available at the TBiOS list of publications online (https://wdfw.wa.gov/species-habitats/science/marine-toxics/publications).

For additional information on TBiOS research, contact Sandie O'Neill (*sandra.oneill@dfw.wa.gov*).

Puget Sound Partnership Vital Sign Indicator Development – In 2023, WDFW was awarded a grant from the Puget Sound Partnership's "Monitoring to Accelerate Recovery" fund. The goal of this project is to advance the methodology applied to Puget Sound Bottom trawl data and ultimately produce a suite of indices representative of both individual species and species-guilds. The intent is for these indices to serve as the 'Groundfish and Benthic Invertebrates' Vital Sign indicators. The individual species indices will represent relative abundance for fish and invertebrates with current or former exploitation histories, noting important trends over time, while the species guild indices will track community and ecosystem responses to environmental change. The specific objectives of the project are: 1.) to evaluate the practicability of combining survey data collected under different sampling designs and identify a subset of years to include in the analysis, 2.) to group species into trophic guilds based on a meta-analysis of diet, ecological, and life history factors, and 3.) to apply a spatiotemporal model to the survey data to develop standardized indices of abundance for both individual species and guilds. The grant will fund a temporary Research Scientist to conduct the work, and deliverables will be completed by May 31, 2025.

For additional information on this work, contact Kat Meyer (*kathryn.meyer@dfw.wa.gov*).

VII. PUBLICATIONS

No known (to editor's knowledge) publications outside of agency technical reports were produced during the reporting period.

VIII. CONFERENCES AND WORKSHOPS

In 2023-24, staff presented at, participated in research presented at, and/or arranged symposia at, several regional scientific meetings and workshops, and provided outreach to several community groups. The following list of conferences, workshops, and outreach events/meetings is not exhaustive and only represents the PSMFS and MFF Units:

- British Columbia Forage Fish network – forage fish research and management presentation
- Dogfish Ageing Workshop, Raleigh North Carolina, Spiny Dogfish Management, Management/Research – multiple attendees

- Forage fish survey training to biologists through Coastal Training Program
- Forage fish survey training to citizen scientists from several Marine Resource Committees
- Northeast Pacific Shark Symposium, Seattle WA, Sharks of the Pacific, Research/ Management/Student
- Pacific Crab Research Group Workshop, Kingston, WA – trawl survey analysis presentation
- PSEMP Marine Waters and Forage Fish and Food Webs Workgroups – forage fish and bottom trawl survey presentations
- South Sound Anglers – forage fish research and management presentation
- West Sound Partners for Ecosystem Recovery Working Group – forage fish acoustic trawl survey summary presentation
- Whidbey Island Beach Watchers – marine groundfish seminar to citizen scientists in training
- World Fisheries Congress – several attendees

IX. COMPLETE STAFF CONTACT INFORMATION

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