CANADA

British Columbia Groundfish Fisheries and Their Investigations in 2019

April 2020

Prepared for the
Technical Sub-Committee of the Canada-United States Groundfish Committee

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I. Agency Overview

Fisheries and Oceans Canada (DFO) has its regional headquarters office (RHQ) for the Pacific Region (British Columbia and Yukon) in Vancouver, British Columbia, with area offices and science facilities at various locations throughout the Region. Groundfish fishery management is conducted by the Groundfish Management Unit within the Fisheries Management Branch at RHQ, while Groundfish stock assessment and research is conducted by Science Branch at the Pacific Biological Station (PBS) in Nanaimo, and at the Institute of Ocean Sciences (IOS) in Sidney. Within Science Branch, a variety of programs are responsible for delivering groundfish stock assessments and research and for providing science advice to fishery managers, species at risk coordinators, marine spatial planners, etc. Directors, division managers, and section heads are as follows:

Fisheries and Oceans Canada Minister: The Honourable Bernadette Jordan

Regional Headquarters Office (RHQ)

Regional Director General: Rebecca Reid

Fisheries and Aquaculture Management Branch

Regional Director of Fisheries Management: Andrew Thomson
Regional Director of Resource Management: Neil Davis
Regional Manager of Groundfish: Adam Keizer

Science Branch

Regional Director of Science: Carmel Lowe

Strategic Science Initiatives Division (SSID): Brenda McCorquodale
- Centre for Science Advice – Pacific: Al Magnan
- Strategic Partnerships and Programs: March Klaver

Stock Assessment and Research Division (StAR): John Holmes
- Groundfish Section: Greg Workman
- Quantitative Assessment Methods Section: Chris Rooper
- Fisheries and Assessment Data Section: Shelee Hamilton
- Marine Invertebrates Section: Ken Fong
- Salmon Assessment: Antonio Velez-Espino
- Salmon Coordinator: Diana Dobson

Aquatic Diagnostics, Genomics & Technology Division (ADGT): Lesley MacDougall
- Applied Technology: Henrik Kreiberg
- Genetics: John Candy
- Aquatic Animal Health: Mark Higgins

Ocean Science Division (OSD): Kim Houston
- Ecology and Biogeochemistry: Andrew Ross
- Modelling & Prediction: Jon Chamberlain

- State of the Ocean: Charles Hannah

Ecosystem Science Division (ESD): Eddy Kennedy
- Marine Spatial Ecology & Analysis: Miriam O
- Aquatic Ecosystem & Marine Mammals: Sean MacConnachie
- Freshwater Ecosystems: Jeffery Lemieux
- Nearshore Ecosystems: Cher LaCoste
- Regional Ecosystem Effects on Fish & Fisheries: Kim Hyatt

Canadian Hydrographic Service (CHS): Mark LeBlanc

Groundfish research and stock assessment work is conducted amongst the Groundfish, Fisheries and Assessment Data, and Quantitative Methods Sections within StAR. Groundfish specimen ageing and genetics are conducted in the Applied Technologies and Genetics Sections in ADGT. Acoustic fisheries research and surveys are led by the Ecology and Biogeochemistry Section in OSD. Ecosystem studies, marine protected areas research and planning, and habitat research is undertaken in collaboration with staff in the Ecosystems Science Division (ESD).

Fishery Managers and other clients receive science advice from StAR through the Canadian Centre for Scientific Advice Pacific (CSAP) review committee. Groundfish subject matter experts meet periodically throughout the year to provide scientific peer review of stock assessment working papers and develop scientific advice; every peer review process involves both internal (DFO) and external reviewers. The resulting Science Advisory Report summarizes the advice to Fishery Managers, with the full stock assessment becoming a Research Document. Both documents can be viewed on the Canadian Stock Assessment Secretariat website: http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm. The frequency of review meetings and production of stock assessment advice for fisheries managers varies depending on departmental, branch and regional priorities.

The Canadian Coast Guard operates DFO research vessels. These research vessels include the J.P. Tully, Vector, and Neocaligus. The principal vessel used for groundfish research for the last three decades, the W.E. Ricker, was officially decommissioned in October of 2017. The replacement vessel for the W.E. Ricker, the Sir John Franklin, is currently undergoing preparations for deployment for her inaugural field season, anticipated for 2020. In the interim period, at sea operations for groundfish surveys requiring a large vessel have been conducted aboard chartered commercial fishing vessels.

The Groundfish Trawl, Sablefish, Rockfish, Lingcod, North Pacific Spiny Dogfish, and Halibut fishery sectors continue to be managed as an integrated fishery with Individual Vessel Quotas (IVQs). IVQs can be for specific areas or coastwide. Within the general IVQ context, managers also use a suite of management tactics including time and area specific closures and bycatch limits. The 2019 Groundfish Integrated Fisheries Management Plan (IFMP) is available from the Federal Science Library: https://waves-vagues.dfo-mpo.gc.ca/Library/40804343.pdf.

Allocations of fish for financing scientific and management activities are identified in the Groundfish IFMP. Collaborative Agreements were developed for 2019-20 between Fisheries and Oceans Canada and several partner organizations to support groundfish science activities

through the allocation of fish to finance the activities. These agreements will be updated for 2020-21.

II. Surveys

A. Databases and Data Acquisition Software

GFBioField is a data acquisition software application created in-house by DFO staff in the Groundfish Surveys Program at the Pacific Biological Station in Nanaimo British Columbia. GFBioField was designed for real-time data capture and data entry during at-sea surveys but can also be used for dockside sampling and office-based data entry. Modified versions have been developed by Groundfish Surveys staff for use by other programs such as the Marine Invertebrates Section within the StAR Division, and the Aquatic Ecosystems and Marine Mammals Section and Regional Ecosystem Effects on Fish and Fisheries Section in the Ecosystem Science Division.

GFBioField uses a client-server architecture employing Microsoft SQL Server 2016 for the back-end data storage and business logic. Previous versions used a Microsoft Access 2007 project for the user interface. However, in 2018, DFO adopted Microsoft Office 2016 as the standard for all new workstations, and it was felt that continuing to maintain and support obsolete versions of the software would become increasingly difficult. Therefore, the GFBioField user interface was completely rebuilt as a Microsoft Access 2016 front-end. The new version was successfully deployed for the 2019 field season.

GFBio is an oracle database developed in-house by DFO staff in the 1990s, which houses groundfish research survey and commercial biological data collected in British Columbia from the 1940s to the present. GFBio now includes approximately 29 thousand trips and approximately 11.6 million individual fish specimens. In 2019, data entry activities concentrated on input of recent and historic groundfish research cruises and current-year commercial biological data from at-sea and dockside observers, as well as some non-groundfish survey data from other DFO surveys.

B. Commercial Fishery Monitoring and Biological Sampling

Groundfish commercial fisheries in British Columbia are subject to 100% catch monitoring, either by the at-sea observer program (ASOP) or by electronic monitoring, with all bottom trawl trips outside the Strait of Georgia accompanied by an at-sea observer, and all line trips subject to video monitoring. A dockside monitoring program (DMP) validates all commercial landings. Commercial fishery data from observer logs, fisher logs, and DMP are captured electronically in the groundfish modules of the Fishery Operations System (FOS) database, maintained by the Fisheries and Aquaculture Management Branch of DFO. Groundfish Science maintains GFFOS, which contains the groundfish FOS data, reformatted to be useful for scientific purposes.

In addition to monitoring catches at sea, the ASOP also provides biological samples of halibut, salmonids, and a variety of important commercial groundfish species from the observed trawl fishery. Biological samples are also collected from the hake fishery as part of the DMP. Additional commercial biological samples may also be collected by DFO staff at the dockside from sablefish trips or other trips that would not otherwise be sampled. Biological samples are uploaded to GFBio on a quarterly basis. In 2019, samples were collected from 323 commercial trips, resulting in approximately 24 thousand specimen records.

C. Research Surveys

The Fisheries and Oceans, Canada (DFO) Groundfish section of the Stock Assessment and Research Division conducts a suite of fishing surveys using bottom trawl, longline hook, and longline trap gear that, in aggregate, provide comprehensive coverage for all offshore waters of Canada's Pacific Coast. The randomized surveys include the Multispecies Synoptic Bottom Trawl, Hard Bottom Longline Hook, and Sablefish Longline Trap surveys (Figure 1). All the surveys follow similar random depth-stratified designs and have in common full enumeration of the catches (all catch sorted to the lowest taxon possible), size composition sampling for most species, and more detailed biological sampling of selected species. Most of the surveys are conducted in collaboration with the commercial fishing industry under the authorities of various Collaborative Agreements. In addition to these randomized surveys, a fixed-station longline hook survey targeting North Pacific Spiny Dogfish in the Strait of Georgia is completed every three years. The Groundfish section also routinely participates in the Canadian portion of the Joint Canada US Hake Acoustic Survey, collects groundfish information from a DFO Small-Mesh Bottom Trawl Survey, and funds an additional technician during the International Pacific Halibut Commission (IPHC) Setline Survey (Figure 2).

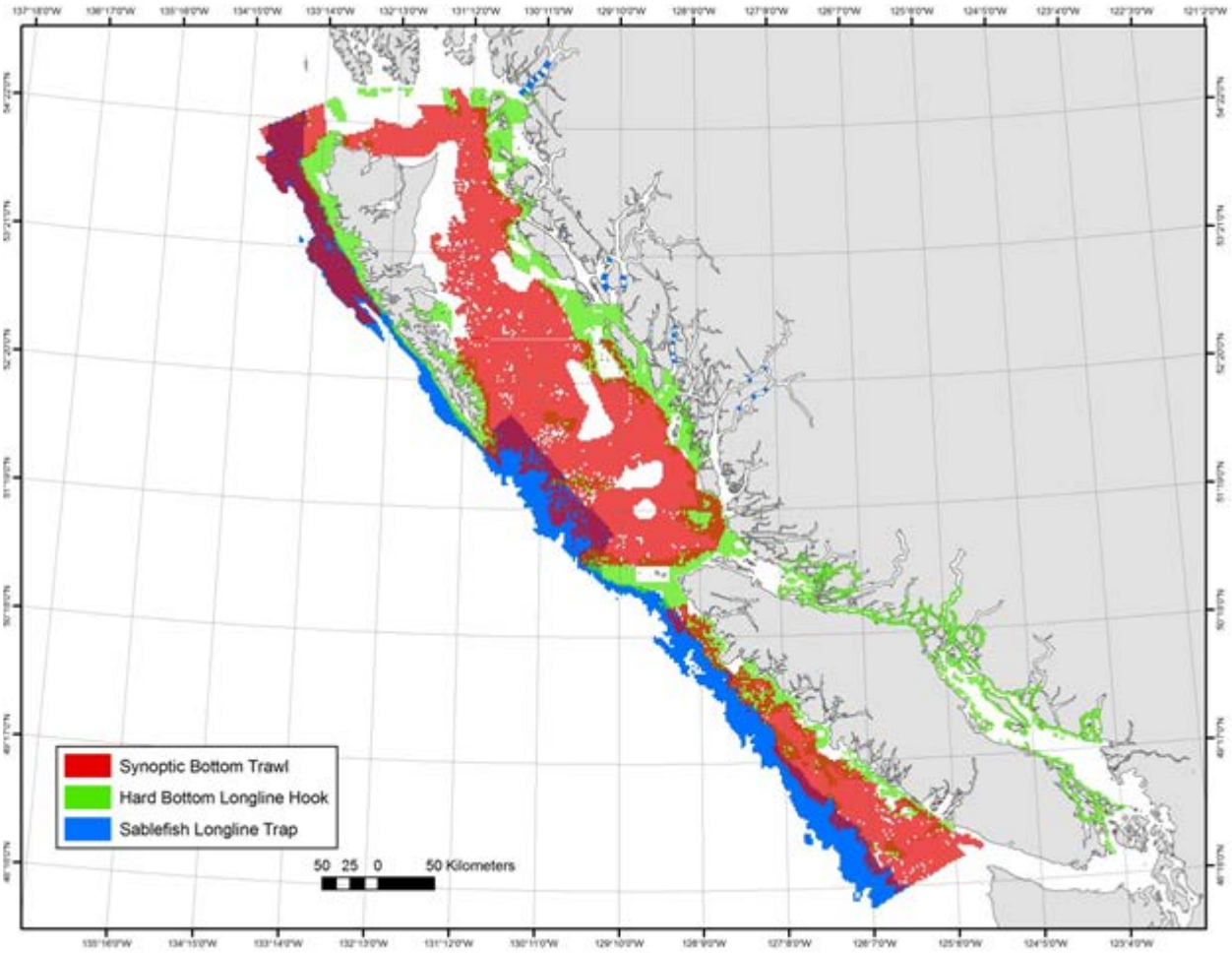

Figure 1. Random depth-stratified survey coverage.

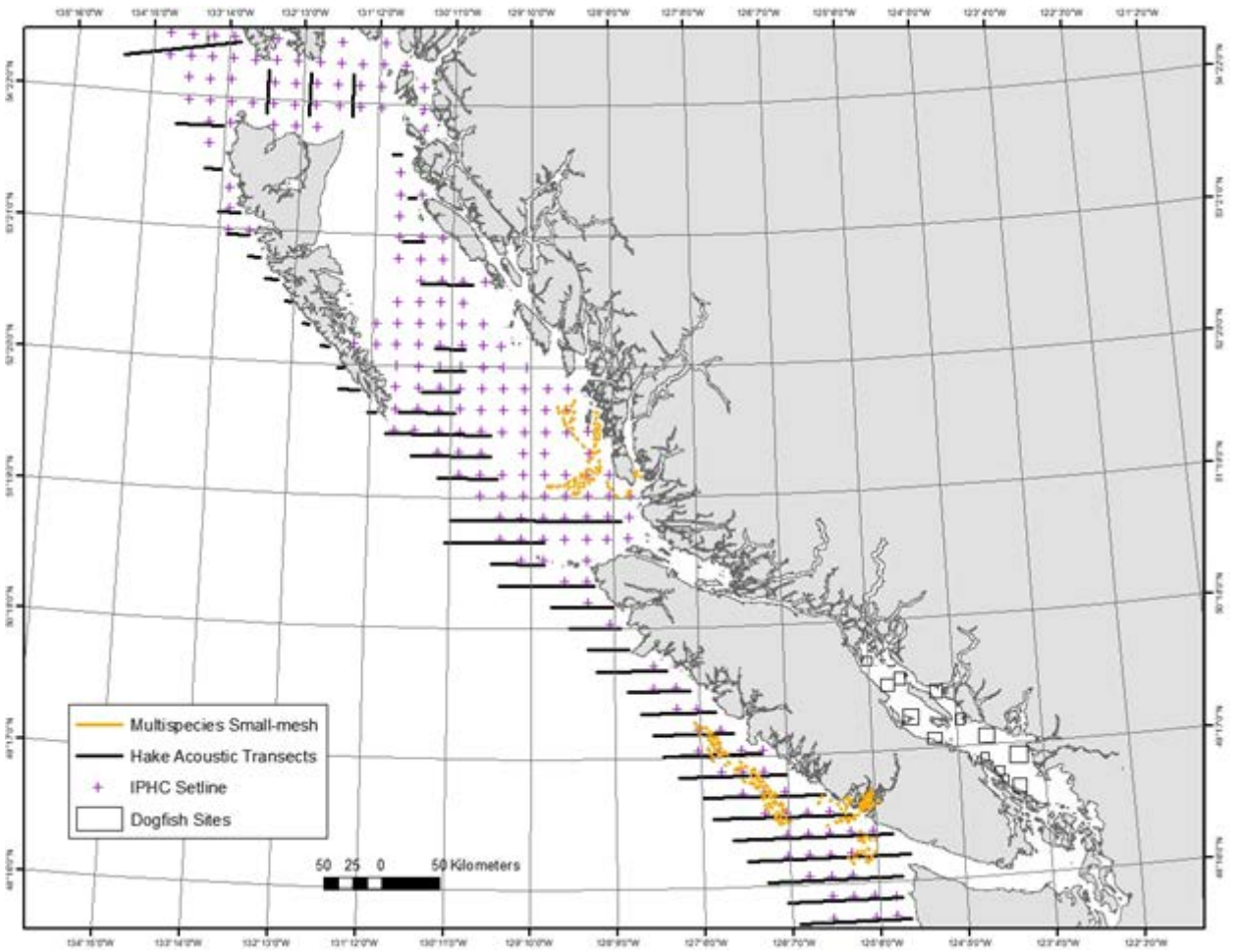

Figure 2. Non-random depth-stratified surveys that form part of the Groundfish surveys program including the Multi-species Small-mesh Bottom Trawl Survey, the Pacific Hake Acoustic Survey, the International Pacific Halibut Commission (IPHC) Setline Survey and the Strait of Georgia Dogfish Longline Hook Survey.

The **Multispecies Synoptic Bottom Trawl Surveys** are conducted in four areas of the BC coast with two areas surveyed each year, such that the whole coast is surveyed over a two-year period. Typically, the West Coast of Vancouver Island (WCVI) and West Coast of Haida Gwaii (WCHG) are surveyed in even-numbered years, while Hecate Strait (HS) and Queen Charlotte Sound (QCS) are surveyed in odd-numbered years (Figure 3). An additional synoptic bottom trawl survey has been conducted twice in the Strait of Georgia (SOG), but vessel availability and staffing constraints have precluded establishing a regular schedule for this survey.

These surveys are conducted under a collaborative agreement with the Canadian Groundfish Research and Conservation Society (CGRCS) and, in typical years, one survey occurs on a Canadian Coast Guard Vessel and one survey occurs on a chartered commercial fishing vessel. In aggregate, the surveys provide coast-wide coverage of most of the trawlable habitat between 50 and 500 meters depth.

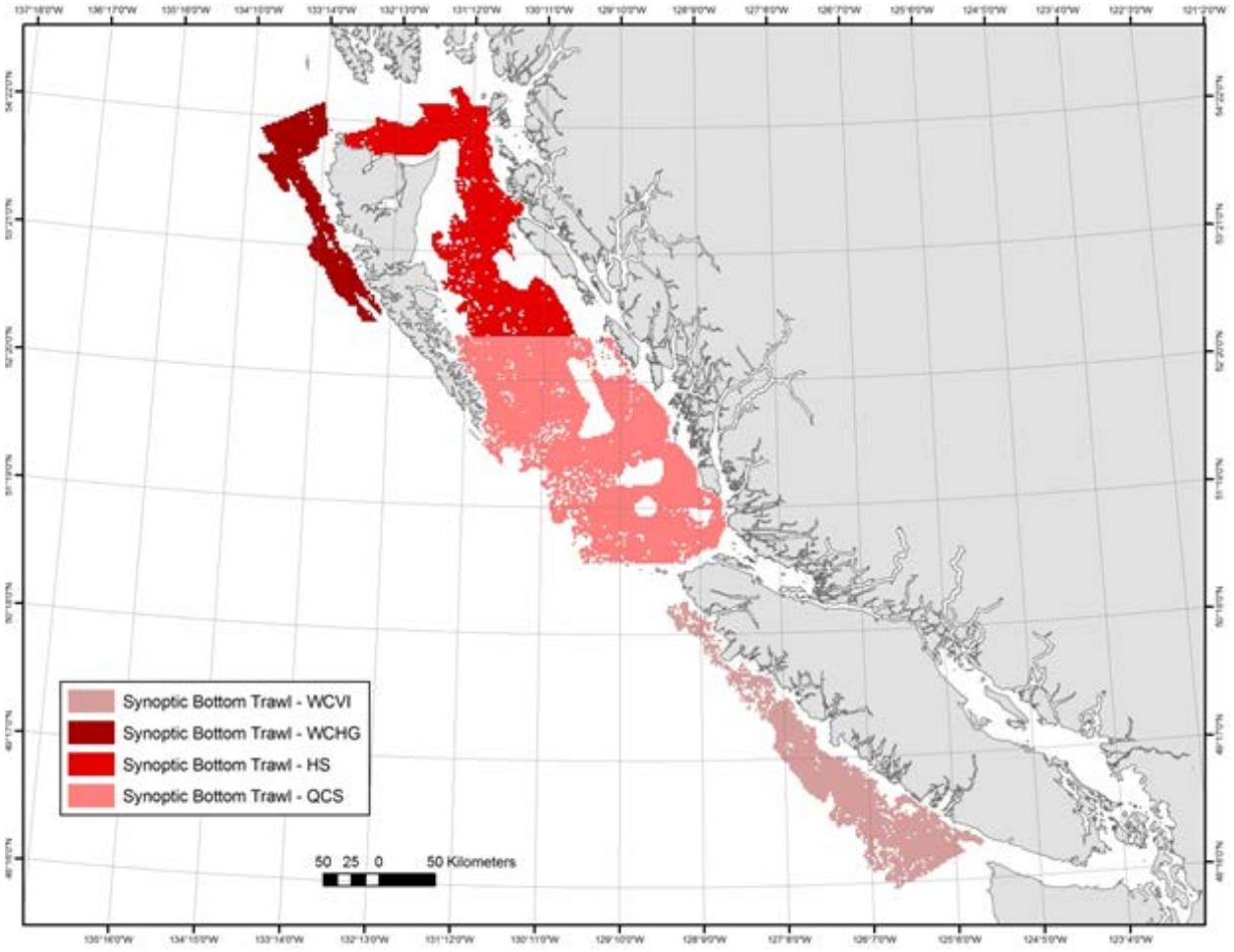

Figure 3. Multi-species Synoptic Bottom Trawl Survey coverage.

In 2019, the HS and QCS surveys were conducted on the chartered commercial vessel the F/V Nordic Pearl. The HS survey was completed from mid-May to mid-June while the QCS survey was completed from mid-July to early August. One hundred and thirty-six (136) and 242 successful tows were completed in the HS and QCS areas, respectively (Figure 4). In Hecate Strait, the dominant species in the catch were Spotted Ratfish (*Hydrolagus colliei*), Arrowtooth Flounder (*Atheresthes stomias*), and Rex Sole (*Glyptocephalus zachirus*). In Queen Charlotte Sound, the dominant species in the catch were Sablefish (*Anoplopoma fimbria*), Pacific Ocean Perch, (*Sebastes alutus*), and Arrowtooth Flounder (*Atheresthes stomias*).

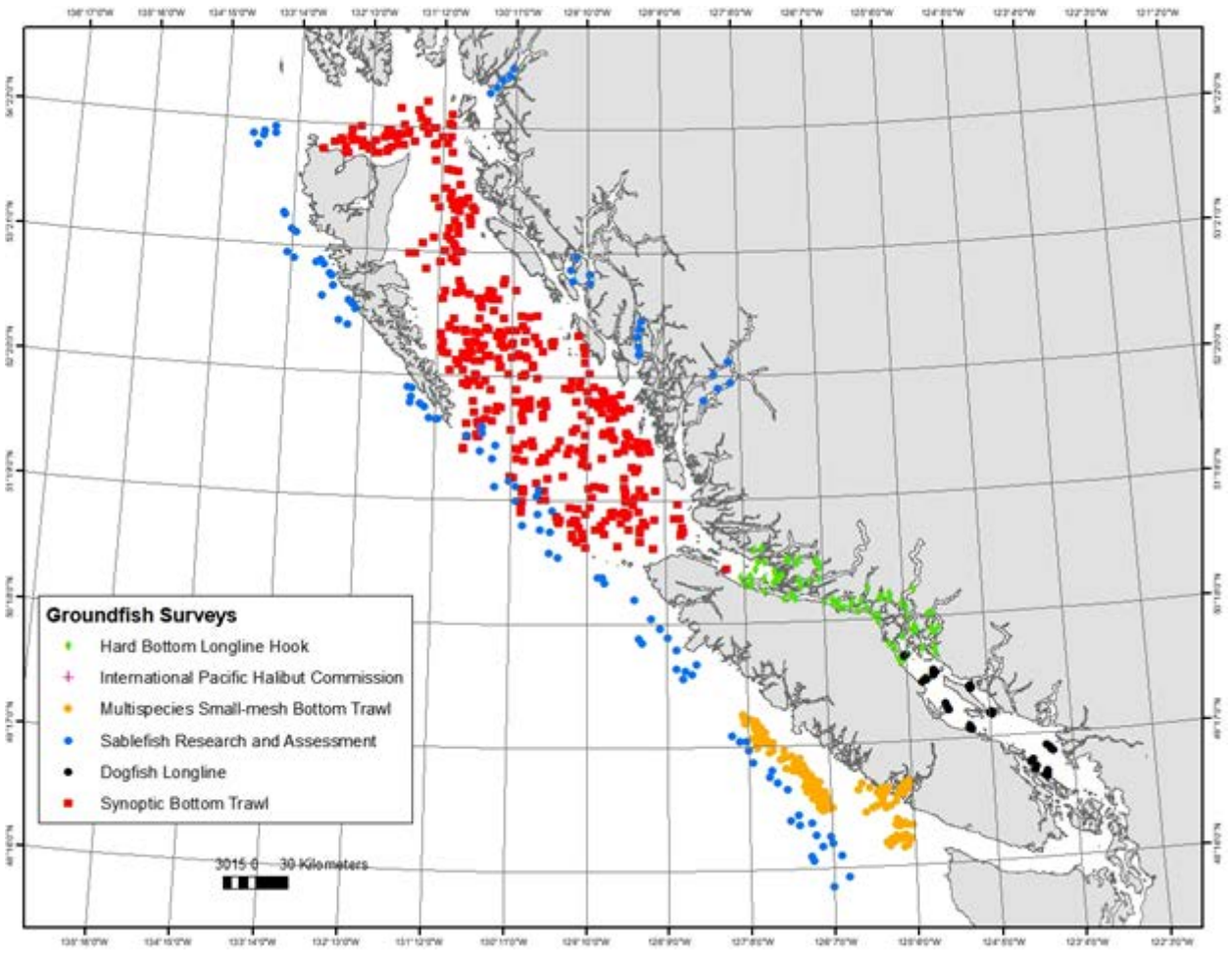

Figure 4. Fishing locations of the 2019 Groundfish surveys. The HBLL outside and IPHC FISS survey data were not available at the time of writing so have not been included.

The **Hard Bottom Longline Hook (HBLL) Surveys** are conducted annually in "outside" waters (not between Vancouver Island and the mainland) and "inside" waters (between Vancouver Island and the mainland). Both the "outside" and "inside" areas are divided into northern and southern regions, and surveys annually alternate between the regions, such that the whole coast is surveyed over a two-year period. The outside surveys are conducted under a collaborative agreement with the Pacific Halibut Management Association (PHMA) and occur on chartered commercial vessels, while the inside surveys are conducted by DFO and occur on a Canadian Coastguard vessel. In aggregate, the HBLL surveys provide coast-wide coverage of most of the untrawlable habitat between 20 and 220 meters depth.

In 2019 the northern region of the outside area and both the northern and a small part of the southern region of the inside area were surveyed (Figure 4). The outside HBLL survey was conducted on the chartered commercial longline vessels Banker II, Western Sunset, and Borealis 1 during August. A total of 197 sets were completed. Further details of the outside survey have not been included in this report because they were not available at the time of writing. The inside HBLL survey was conducted on the Canadian Coast Guard vessel Neocaligus from late July to late August. A total of 80 sets were completed including 71 in the northern region and 9 in the southern region. The 9 sets in the southern region were sites that

were omitted from the 2018 survey due to time constraints. In addition, 19 sets were completed at historic Strait of Georgia Dogfish Longline sites as part of a pilot study to compare the different gears, baits, depths and timing of the two surveys.

The **Sablefish Research and Assessment Survey** is an annual longline trap survey targeting sablefish. This survey releases tagged Sablefish at randomly selected fishing locations in offshore waters, as well as at fixed stations in four mainland inlets. The survey also provides catch rates and biological data for use in stock assessments. The survey is conducted under collaborative agreement with the Canadian Sablefish Association and occurs on a chartered commercial vessel. This survey covers the depth range of 150 m to 1500 m for the entire outer BC coast as well as a number of central coast inlets.

In 2019, the survey was conducted on the F/V Pacific Viking from early October to late November. A total of 89 and 20 sets were completed in the offshore and inlet areas, respectively (Figure 4). The most abundant fish species encountered by weight were Sablefish (*Anoplopoma fimbria*), followed by Pacific Halibut (*Hippoglossus stenolepis*), Lingcod (*Ophiodon elongatus*), North Pacific Spiny Dogfish (*Squalus suckleyi*), and the Rougheye/ Blackspotted Rockfish Complex (*Sebastes aleutianus/ melanostictus*).

The **Strait of Georgia Dogfish Longline Hook Survey** is a triennial fixed-station survey targeting North Pacific Spiny Dogfish. The survey, which visits 10 to 12 sites spread throughout the central Strait of Georgia, was first conducted in the late 1980s and then resurrected in 2004 with a study to explore a change from J to circle hooks and followed up with a survey using circle hooks in 2005. In 2019, the survey was conducted on board the Canadian Coast Guard vessel Neocaligus during the first two weeks of October. A total of 39 sets were completed at the 10 core sites (Figure 4). There is a hope that the Dogfish catch rate indices from the Hard Bottom Longline Hook (HBLL) Surveys could be used in place of this directed single-species survey.

The **Small-mesh Bottom Trawl Survey** is an annual fixed-station survey of commercially important shrimp grounds off the West Coast of Vancouver Island that was initiated in 1973. Catch rate indices generated by the survey have been used to track the abundances of several groundfish stocks. Groundfish staff provide assistance in catch sorting and species identification and also collect biological samples from selected fish species. The 2019 survey was conducted on the F/V Nordic Pearl from late April to mid-May and a total of 112 usable tows were completed. The most abundant fish species encountered were North Pacific Spiny Dogfish (*Squalus suckleyi*), Rex Sole (*Glyptocephalus zachirus*), Dover Sole (*Microstomus pacificus*), Slender Sole (*Lyopsetta exilis*), and Flathead Sole (*Hippoglossoides elassodon*).

The IPHC provides DFO an opportunity to deploy an additional technician during the International Pacific Halibut Commission's (IPHC) Fishery-independent Setline Survey (FISS). The technician is funded as part of a collaborative agreement with the Pacific Halibut Management Association (PHMA) and identifies the catch to species level on a hook-by-hook basis and collects biological samples from rockfish. This information has been collected every year since 2003 except for a one-year hiatus in 2013. At the time of writing, DFO has received the 2019 IPHC survey data, but they have not yet been added to GFBio so they are not included in this report.

Details of each survey are included in Appendix I.

III. Reserves

Canada has surpassed its marine conservation target commitment of protecting 10 percent of coastal and marine areas through effectively managed networks of protected areas and other effective area-based conservation measures by 2020, a commitment made under the United Nations Convention on Biological Diversity (UN CBD) Aichi Target 11. Approximately 14% of Canada's EEZ are now protected. One marine conservation target initiative is to put a network of Marine Protected Areas (MPAs) in BC's Northern Shelf Bioregion (NSB). A draft MPA network scenario was released for comment by stakeholders on the advisory committee on February 28, 2019, and consultation on this plan is ongoing. In 2020, the partners will continue to work through outstanding questions including scope and level of detail for the action plan, approach to phased implementation, and principles that will guide future governance and implementation. The Marine Protected Area Technical Team (MPATT) will consider all spatial advice received and work towards a revised network scenario and a socio-economic analysis will be completed on a revised scenario. A revised draft scenario will be shared with stakeholders, local governments and the public for review and comment in 2021.

The Hecate Strait/Queen Charlotte Sound Glass Sponge Reefs MPA that was designated under Canada's Oceans Act in February 2017 to protect glass sponge reefs in Hecate Strait and Queen Charlotte Sound will be part of the NSB MPA network, as will the Gwaii Haanas National Marine Conservation Area Reserve (NMCAR) and Haida Heritage Site. The Scott Islands marine National Wildlife Area (NWA), an area that conserves a vital marine area for millions of seabirds on the Pacific coast, will also be part of the NSB MPA. Fishing activity is currently not prohibited in the NWA.

Parks Canada and the Archipelago Management Board have introduced new zoning to the Gwaii Haanas NMCA which includes multiple use zones (IUCN protection level IV-VI) as well as high protection zones (IUCN Ib-III) and two small restricted access zones that are intertidal/terrestrial. These zones came into effect on May 1, 2019 (Figure X MCT Map). The two RCAs that were formerly within the GHNMCA boundaries have been rescinded and replaced with the new zoning. Parks Canada is also still working to establish an NMCAR in the Salish Sea.

Another major initiative is the designation of the Offshore Pacific Seamounts and Vents Closure. The Area of Interest (AOI) was designated in 2017 and an offshore groundfish fishing closure was put into place to protect seamount and vent communities (Figure 5). The Endeavour Hydrothermal Vents MPA, designated under Canada's Ocean Act in 2003, is within the Offshore AOI. The Endeavour MPA was designated to ensure the protection of hydrothermal vents, and the unique ecosystems associated with them. The regulation to establish the MPA prohibits the removal, disturbance, damage or destruction of the venting structures or the marine organisms associated with them while allowing for scientific research that will contribute to the understanding of the hydrothermal vent ecosystem.

The SGaan Kinghlass-Bowie Seamount MPA, which was designated in 2008, protects communities living on Bowie Seamount which rises from depths to 3000 m to within 24 m of the surface, as well as two other seamounts and adjacent areas (https://dfo-mpo.gc.ca/oceans/mpa-zpm/bowie-eng.html).

The other 162 Rockfish Conservation Areas (RCAs) designated as fishery closures between 2004-2007 (Yamanaka and Logan 2010), remain in place. The Glass Sponge Reef Conservation Areas are closed to all commercial and recreational bottom contact fishing

activities for prawn, shrimp, crab and groundfish (including halibut) in order to protect the Strait of Georgia and Howe Sound Glass Sponge Reefs (http://www.dfo-mpo.gc.ca/oceans/ceccsr-cerceef/closures-fermetures-eng.html).

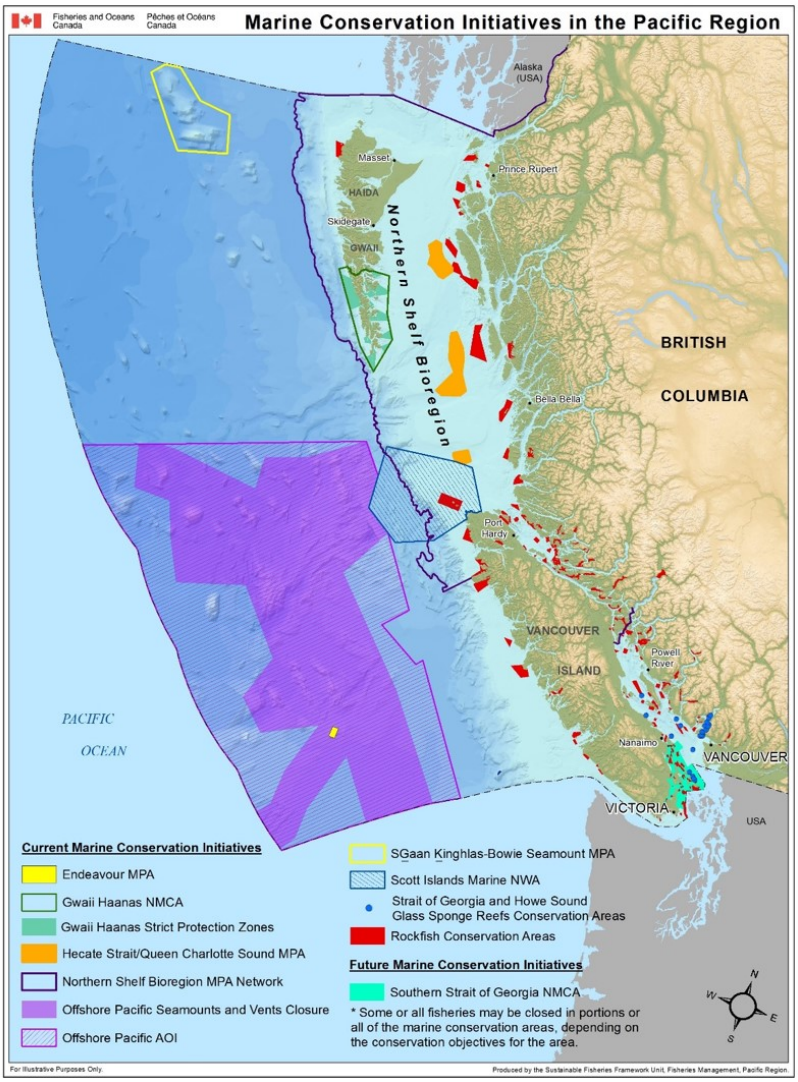

Figure 5. Marine Conservation Initiatives in the Pacific Region (Map by F. Yu).

IV. Review of Agency Groundfish Research, Assessment and Management

A. Hagfish

1. Research

No new research in 2019.

2. Assessment

Nothing to report.

3. Management

There is currently no fishery for Hagfish in BC, although there continues to be interest in redeveloping the fishery. One proponent has submitted a proposal that has been reviewed by DFO, but no decision has been made.

B. Dogfish and other sharks

1. Research

i) North Pacific Spiny Dogfish

Data collection continued in 2019 through the annual groundfish multi-species trawl and longline surveys, dedicated dogfish surveys, and at-sea observer sampling of the trawl fishery. North Pacific Spiny Dogfish are routinely sampled in both surveys and by observers, and in 2019 over 13,000 pieces were sampled.

Following the August 2019 inside Hard Bottom Longline Hook (HBLL) Survey, a gear comparison experiment was made between the HBLL gear and bait (size 14/0 circle hooks and squid bait) and the Dogfish Longline Hook Survey (size 14 circle hooks and 6 inch herring pieces) to compare catch rates of dogfish and rockfish on each gear type. Both types of gear were set at three dogfish sites. The purpose of the gear comparison was to begin to collect data which will be used to determine the feasibility of using a summer index to replace the index from the triennial October survey. Data have not yet been analyzed. The Dogfish Longline Hook Survey was then completed using the normal dogfish survey specifications in October (see Appendix 1).

ii) Other Shark Species

Other species of shark are sampled opportunistically during annual groundfish multi-species trawl and longline surveys and at-sea observer sampling of the trawl fishery. In 2019, samples included Bluntnose Sixgill Shark, Salmon Shark, Brown Cat Shark, Tope Shark, Blue Shark, and Pacific Sleeper Shark. In addition, anecdotal information on encounters with other shark species is also collected through the Shark Sightings Network (https://www.dfo-mpo.gc.ca/species-especes/sharks/info/sightings-eng.html).

2. Assessment

i) North Pacific Spiny Dogfish

North Pacific Spiny Dogfish were last assessed in 2010. No new assessment is currently scheduled.

In 2011, the Committee on the Status of Wildlife in Canada (COSEWC) assessed the conservation status of North Pacific Spiny Dogfish as Special Concern, citing low fecundity, long generation time (51 years), uncertainty regarding trends in abundance of mature individuals, reduction in size composition, and demonstrated vulnerability to overfishing as the causes for concern. Nevertheless, COSEWIC acknowledged that the population remains relatively abundant, and overfishing is currently unlikely.

COSEWC status reports are available at https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/cosewic-assessments-status-reports.html.

ii) Other Shark Species

As no directed commercial fisheries for sharks other than North Pacific Spiny Dogfish exist in British Columbia, there have been no requests for any stock assessments.

The Committee on the Status of Wildlife in Canada (COSEWC) has assessed the conservation status of a number of British Columbia shark species, and three species are listed under the Canadian Species at Risk Act (SARA):

- Basking Shark: Designated Endangered in 2007. Status re-examined and confirmed in 2018. Listed under SARA.
- Bluntnose Sixgill Shark: Designated Special Concern in 2007. Currently being re-examined. Listed under SARA.
- Tope Shark: Designated Special Concern in 2007. Currently being re-examined. Listed under SARA.

Blue Shark (North Pacific population) was examined by COSEWIC in 2016 and designated Not at Risk. White Shark and Brown Cat Shark were considered in 2006 and 2007 and placed in the Data Deficient category.

COSEWC status reports are available at https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/cosewic-assessments-status-reports.html.

3. Management

i) North Pacific Spiny Dogfish

North Pacific Spiny Dogfish are managed as part of the integrated mixed species multi-gear groundfish fishery under the Integrated Fisheries Management Plan (IFMP), and are permitted to be retained in the recreational fishery. There is currently no targeted fishing for Dogfish as markets have essentially collapsed, with the directed dogfish fleet harvesting 0% of its TAC in 2019 and the trawl fleet intercepting only 4.3% of its TAC. All fishery induced mortality at this time is as bycatch in directed fisheries for other species, with little to none of the catch being retained or landed. The hook and line fleet in aggregate has taken about 0.5% of their dogfish quota. Commercial TACs and landings for 2019 are provided in Appendix 2. To support groundfish research and account for unavoidable mortality incurred during the 2019 Groundfish surveys, research catches are allocated before defining the TAC. See Appendix 2 for details.

ii) Other Shark Species

Currently, there is no directed commercial fishery for other shark in Canadian Pacific waters; only Salmon Shark are permitted to be retained in the recreational fishery. Species at Risk Act prohibitions only apply to species listed as extirpated, endangered or threatened; thus, they do not apply to species of special concern. Nevertheless, commercial fisheries are no longer permitted to retain Species at Risk Act listed shark species − all bycatch for these species is to be released at sea with the least possible harm. Catch limits for the recreational fishery have been reduced to “no fishing” for all species listed under the Species at Risk Act, and “zero retention” (catch and release) for all other shark species except Salmon Shark. Codes of conduct have been developed for encounters with Basking Sharks (https://www.dfo-mpo.gc.ca/species-especes/publications/sharks/coc/coc-basking/index-eng.html) and other

sharks (https://www.dfo-mpo.gc.ca/species-especes/publications/sharks/coc/coc-sharks/index-eng.html).

C. Skates

1. Research

Data collection continued in 2019 through trawl and longline surveys. Most individual skates encountered on groundfish research surveys are sampled (length, weight if feasible, sex) and released alive if possible. Species sampled in 2019 were Longnose Skate (n=1029), Sandpaper Skate (n=235), Big Skate (n=218), Aleutian Skate (n=10), Roughtail Skate (n=1), and Alaska Skate (n=1). No skates were sampled from commercial fisheries.

2. Assessment

Big Skates and Longnose Skate were assessed in 2013 (King et al 2015). No new assessment is currently planned. No other skate species in British Columbia are assessed.

Based on tagging results and fishery spatial patterns, Big Skate and Longnose Skate were assessed based on four Skate Management Areas: 3CD (Groundfish Major Areas 3C, 3D, and Minor Areas 19 and 20 of 4B); 5AB (Major Areas 5A, 5B, and Minor Area 12 of 4B); 5CDE (Major Areas 5C, 5D, and 5E); and 4B (Minor Areas 13-18, 28, and 29 of Major Area 4B).

3. Management

Big and Longnose skates are currently managed under sector and area TACs. For all other species of skate there are no management measures in place.

Big and Longnose skates are IVQ (individual vessel quota) species managed as part of the integrated mixed species multi-gear groundfish fishery under the Integrated Fisheries Management Plan (IFMP). Commercial TACs and landings for 2019 are provided in Appendix 2. To support groundfish research and account for unavoidable mortality incurred during the 2019 Groundfish surveys, research catches are allocated before defining the TAC. See Appendix 2 for details.

Literature Cited:

King, J.R., Surry, A.M., Garcia, S., and Starr, P.J. 2015. Big Skate (*Raja binoculata*) and Longnose Skate (*R. rhina*) stock assessments for British Columbia. DFO Can. Sci. Advis. Sec. Res. Doc. 2015/070. ix + 329 p. https://waves-vagues.dfo-mpo.gc.ca/Library/362171.pdf

D. Pacific Cod

1. Research

Data collection continued in 2019 through trawl and longline surveys and at-sea observer sampling of the trawl fishery.

2. Assessment

Pacific Cod was assessed in 2018 but the research document is still awaiting translation before appearing on the CSAS website. The Science Advisory Report (SAR 2019/008) is available at http://www.dfo-mpo.gc.ca/csas-sccs/Publications/SAR-AS/2019/2019_008-eng.html.

Four stocks are defined for management purposes in BC: Strait of Georgia (4B); West Coast Vancouver Island (3CD); Queen Charlotte Sound (5AB); and Hecate Strait (5CD). Historically each area has been assessed separately; however, for the 2018 assessment, data from Areas 5AB and 5CD were combined into a single stock assessment, due to the lack of biological evidence for separate stocks and improved fits to the combined data compared to data from area 5AB alone. Area 3CD was assessed separately. Area 4B was not assessed as there is no directed commercial fishery there.

3. Management

Pacific Cod is an IVQ (individual vessel quota) species, managed as part of the integrated mixed species multi-gear groundfish fishery under the Integrated Fisheries Management Plan (IFMP). Commercial TACs and landings for 2019 are provided in Appendix 2. To support groundfish research and account for unavoidable mortality incurred during the 2019 Groundfish surveys, research catches are allocated before defining the TAC. See Appendix 2 for details.

E. Walleye Pollock

1. Research

Data collection continued in 2019 through trawl and longline surveys and at-sea observer sampling of the trawl fishery.

2. Assessment

Walleye Pollock was assessed in 2017 but the research document is still awaiting translation before appearing on the CSAS website. The Science Advisory Report (SAR 2018/020) is available at http://www.dfo-mpo.gc.ca/csas-sccs/Publications/SAR-AS/2018/2018_020-eng.html.

Walleye Pollock was assessed as two stocks based on differences in observed mean weights between northern British Columbia (~1kg/fish) and southern British Columbia (~0.5 kg/fish). The BC North stock encompasses Major areas 5C, 5D, and 5E, while the BC South stock encompasses Major Areas 3C, 3D, 5A, 5B, plus minor areas 12 & 20 in 4B. The Strait of Georgia (i.e. “Gulf” - Major Area 4B not including minor areas 12 & 20) was not assessed.

3. Management

Walleye Pollock is an IVQ (individual vessel quota) species, managed as part of the integrated mixed species multi-gear groundfish fishery under the Integrated Fisheries Management Plan (IFMP). Commercial TACs and landings for 2019 are provided in Appendix 2. To support groundfish research and account for unavoidable mortality incurred during the 2019 Groundfish surveys, research catches are allocated before defining the TAC. See Appendix 2 for details.

F. Pacific Whiting (Hake)

1. Research

There are two commercially harvested and managed stocks of Pacific hake. The offshore stock is the principal target of the commercial fishery comprising the bulk of landings year over year. A smaller and discrete stock residing within the Strait of Georgia is targeted episodically when market demand is sufficient, and the available fish are large enough for processing. Biological data on Pacific Hake (age samples and length-sex frequency data) are collected from the commercial fishery through the at-sea observer and dockside monitoring programs.

Triennial (until 2001), then biennial acoustic surveys, covering the known extent of the Pacific hake stock have been run since 1995. An acoustic survey, ranging from California to northern British Columbia is currently run in odd-numbered years, to continue the biennial time series. The biomass estimate generated from the 2019 survey was 1.723 million t. In addition, there has been a biennial acoustic survey for Pacific hake in the Strait of Georgia since 2011. Methods are currently being developed to calculate a biomass estimate for the Strait of Georgia surveys, which will then be used as the primary index of abundance for a Strait of Georgia stock assessment. There was no survey in the Strait of Georgia in 2018 – 2020 due to restrictions in chartering as a result of the decommissioning of the W.E. Ricker in 2016, but there is a plan to continue the time series in 2021 with the new Offshore Fisheries Science Vessel CCGS Sir John Franklin.

2. Assessment

As in previous years, and as required by the Agreement Between the Government of Canada and the Government of the United States of America on Pacific hake/Whiting (the Pacific Whiting treaty), the 2019 harvest advice was prepared jointly by Canadian and U.S. scientists working together, collectively called the Joint Technical Committee (JTC) as stated in the treaty. The assessment model used was Stock Synthesis 3 (SS3). The 2019 model had almost the same model structure used in 2018, with updates to catch and age compositions. Standard sensitivities requested by the Scientific Review Group showed little difference when compared with the base model. The largest cohort caught in the fishery was age-4's, followed by age 2's. The three cohorts currently sustaining the fishery were born in 2010, 2014, and 2016. There has not been an assessment of Pacific hake in the Strait of Georgia.

3. Management

The coastwide TAC for 2019 was set at 597,500 t with Canada receiving 26.12% and the US receiving 73.88% as agreed upon in the hake treaty. Canadian commercial TACs and landings for 2019 are provided in Appendix 2. To support groundfish research and account for unavoidable mortality incurred during the 2019 Groundfish surveys, research catches are allocated before defining the TAC. See Appendix 2 for details.

G. Grenadiers

1. Research

There is no directed work conducted on Grenadiers. Opportunistic sampling occurs on groundfish trawl surveys, but no Grenadiers were encountered in 2019.

2. Assessment

Grenadiers are not commercially harvested in BC and are rarely encountered during commercial fisheries. Consequently, there are no assessment activities planned for these species.

3. Management

There are no management objectives or tactics established for these species. These species are caught incidentally in the deep-water rockfish (Rougheye/Shortraker/Thornyhead) and Dover Sole fisheries and in the Sablefish trap fishery. 100% of the catch is discarded.

H. Rockfish

1. Research

Biological samples are collected on an ongoing basis from annual trawl, longline, and trap surveys, and from the commercial trawl fishery via the at-sea observer program.

i) Inshore Rockfish

Dr. Dana Haggarty is collaborating with Dr. Sarah Dudas and Dr. Stephanie Archer on a project funded by DFO's SPERA (Strategic Program for Ecosystem Based Research and Advice) to develop the novel method of passive acoustic monitoring (PAM) for fishes. Species of interest for this project include Pacific Herring and three rockfish species: Copper, Yelloweye, and Quillback Rockfishes. Most of the field work has now been done using paired visual (diver and drop camera) and audio surveys (soundtraps). They are testing the PAM methods by assessing temporal patterns in habitat use by deploying hydrophones in and adjacent to the Northumberland Channel RCA for one year. This project will also evaluate the impact of ship noise on the sensitivity of PAM. Although Dr. Archer has left DFO, she remains involved in the project and Dr. Philina English has been hired as a term research scientist to lead the project. Collaborators at the University of Victoria (UVic), Dr. Francis Juanes and graduate student Xavier Mouy have been making good progress in describing rockfish sounds and developing an automatic fish detector for the acoustic data to facilitate data processing. This project is due to be completed by the end of 2020-21.

Dr. Haggarty is also collaborating with colleagues at UVic and Ballstate University as well as industry (Angler's Atlas) to improve and monitor compliance in Rockfish Conservation Areas (RCAs) and Marine Protected Areas (MPAs). Angler's Atlas has already upgraded their smart phone App, MyCatch, to include the location of all RCAs and to provide users with warnings when they are in an RCA. The app works employs the cell phone's internal GPS and with downloaded maps, so users do not need to be on cell networks for it to function. There is also a function to collect data on the use of descending devices for rockfishes and an outreach program associated with this. This project was funded by the BC Salmon Restoration and Innovation Fund (BCSRIF) until the end of 2022-23.

ii) Offshore Rockfish

The Offshore Rockfish program has only one DFO person available; therefore, all efforts are devoted to stock assessment in collaboration with an industry-sponsored scientist. To facilitate stock assessment, the Offshore Rockfish program maintains a suite of PBS R software packages (https://github.com/pbs-software). The Groundfish Surveys program coordinates all sample collections (otoliths, genetic tissues, morphology measurements, etc.) and the Sclerochronology Lab researches ageing protocols and methods.

2. Assessment

i) Inshore Rockfish

British Columbia (BC) "Inside" stocks are generally those occurring in Area 4B (Queen Charlotte Strait, Strait of Georgia, and Strait of Juan de Fuca), while "Outside" stocks occur outside Area 4B (West Coast Vancouver Island, West Coast Haida Gwaii, Queen Charlotte Sound, Hecate Strait, Dixon Entrance).

Outside Yelloweye Rockfish

The Outside population of Yelloweye Rockfish was designated as Special Concern in 2008 by the Committee On the Status of Endangered Wildlife In Canada (COSEWIC).

In 2019, DFO collaborated with Industry (the Pacific Halibut Management Association, PHMA) on a closed-loop simulation modelling to test performance of a set of candidate management procedures (MPs) against specific quantitative objectives. The outside stock was split into two different regions representing the North and Southern parts of the province. Alternative data scenarios produced a wide range of estimated stock status, as well as biological and management parameters, from which 4 representative OMs (using a 1960 or 1918 start year and alternative catch scenarios) were selected for simulation testing MPs. The 4 OMs ranged in current biomass from approximately 2,600 to 8,200 t in the North (groundfish management areas 5BCDE) and 1,900 to 4,400 t in the South (groundfish management areas 3CD5A). This range is considerably wider than the statistical uncertainty within any particular OM. No single factor clearly explains the range of biomasses because natural mortality, absolute catch levels, and historical recruitments all affect biomass and recruitment estimates either directly or indirectly. None of the 4 OMs indicate that either OYE stock area has been fished to less than 20% of the unfished level or below 40% of BMSY, as inferred in previous assessments. Model estimates of spawning biomass depletion relative to unfished levels range from 29-51% in the North, 21-43% in the South, and 27-48% coastwide. These correspond to 111-185% of BMSY in the North, 75-154% in the South, and 96-173% coastwide.

The candidate MPs evaluated included three different assessment methods: i) a catch-at-age (CAA) assessment model, a surplus production (SP) assessment model, and an empirical rule (IDX) using survey index trends. The three assessment methods were used in combination with different harvest control rules or implementation error scenarios to create a set of candidate MPs that were simulation tested for each of the 4 OMs for North and South areas independently. Performance statistics were evaluated using combined outputs across OMs via a 50%-16.67%-16.67%-16.67% weighting scheme. Simulations of MP performance for setting future OYE TACs generally showed robust, or potentially robust, performance to a wide range of OM scenarios. The CAA MPs were tuned to achieve a target fishing mortality rate that would provide relatively stable OYE biomass over the projection period and biomass in both the North and South responded accordingly. Management procedures based on SP models or survey index trends (IDX) produced a range of increases or stable trends in future OYE biomass. The IDX MPs were tuned to avoid biomass declines in the first 10 years, which produced long-term increases or stable trends in biomass with high inter-annual catch variability. Although the SP models generally led to biomass increases, they did so because of under-estimation biases and often showed erratic patterns in TACs. It is likely that undesirable properties of IDX and SP MPs could be improved via further tuning.

Cox, S.P., Doherty, B., Benson, A.J., Johnson, S.D., and Haggarty, D. 2020. Evaluation of potential rebuilding strategies for Outside Yelloweye Rockfish in British Columbia. DFO Can. Sci. Advis. Sec. Res. Doc. 2019/041.

Inside Yelloweye Rockfish

The inside stock of Yelloweye Rockfish is a data-limited stock, occurring in Groundfish Management Area 4B (Queen Charlotte Strait, Strait of Georgia, and Strait of Juan de Fuca) in British Columbia (BC). The stock was designated as Special Concern by COSEWIC in 2008.

The stock was assessed as being below the LRP in 2010, resulting in a published rebuilding plan. DFO is currently working on an evaluation of the rebuilding plan using a closed-loop simulation model similar to the work that was done for Outside Yelloweye Rockfish. The working paper will be presented at CSAS in June 2020.

Quillback Rockfish

The Inside and Outside management units of Quillback Rockfish were last assessed in 2010 after the Committee On the Status of Endangered Wildlife In Canada (COSEWIC) designated them as threatened in November 2009. A Bayesian state space surplus production model was used in the stock assessment for the two management units. The model required fishery catch reconstructions to provide catch series from 1918 to 2010, as well as, abundance trends for the two management units. Reference Case model runs provided median biomass estimates for 2011 of 6,480 tonnes (CV 1.21) for the outside management unit and 2,668 tonnes (CV 0.60) for the inside management unit. B2010/Bmsy for the outside and inside is 0.736 (95%CI is 0.266 to 1.814) and 0.493 (95% CI is 0.252 to 0.945), respectively. The probability that the biomass of the outside Quillback Rockfish is above 0.4 Bmsy is 81.2 % and above 0.8 Bmsy is 45.6%. The probability that the biomass of the inside Quillback Rockfish is above 0.4 Bmsy is 70.2% and above 0.8 Bmsy is 11.5%. Stocks in both management areas appear to be within the cautious zone. Quillback is due to being reassessed in 2021 in advance of a COSEWIC reassessment..

Yamanaka, K.L., McAllister, M.K., Etienne, M.-P., and Flemming, R. 2011a. Stock assessment and recovery potential assessment for Quillback Rockfish (*Sebastes maliger*) on the Pacific coast of Canada. DFO Can. Sci. Advis. Sec. Res. Doc. 2011/135: vii + 151 p.

Other Inshore Rockfish Species (Copper, China, Tiger, Brown, Black, Deacon Rockfishes).

Inshore Rockfishes were assessed as a group in 2001, but none of these other inshore species have been assessed individually by DFO.

ii) Offshore Rockfish

Bocaccio

Bocaccio were designated as endangered by COSEWIC in 2013. However, a strong cohort was born in 2016, and subsequently starting appearing in increasing numbers in survey catches and commercial fisheries coastwide.

Bocaccio rockfish (BOR) along the BC coast was assessed in 2019 using an annual catch-at-age model tuned to six fishery-independent trawl survey series, a truncated bottom trawl CPUE series, annual estimates of commercial catch since 1935, and age composition data from survey series (31 years of data from four surveys) and the commercial fishery (12 years of data). The model started from an assumed equilibrium state in 1935, and the survey data covered the period 1967 to 2019 (although not all years were represented). Two fisheries were modelled: one a combined bottom and midwater trawl fishery and an ‘other’ fishery, which combined halibut longline, sablefish trap, salmon troll, rockfish hook and line, etc. The second fishery was a compromise that acknowledged other methods capturing this species while keeping the complexity to a minimum, given the lack of good information from these additional fisheries.

Three base runs using a two-sex model were implemented in a Bayesian framework (using the Markov Chain Monte Carlo procedure) under a scenario that fixed natural mortality to three levels (0.07, 0.08, 0.09) while estimating steepness of the stock-recruit function, catchability for the surveys and CPUE, and selectivity for four of the six surveys and the commercial trawl fleet. These three runs were combined into a composite base case which explored the major axis of parameter uncertainty in this stock assessment (Figure 6). Nine sensitivity analyses were performed to test the effect of alternative model assumptions (Figure 7).

The composite base case suggested that the BOR spawning population was in the Critical Zone (with a probability >0.99), as did the three component runs. This was in spite of the stock being moderately productive and exploitation rates being uniformly low. For instance, the median exploitation by the trawl fishery, which accounted for 95% of the catch, in the final year was estimated to be 0.025 (0.012-0.044) even at the very low biomass levels. A strong cohort, estimated at 44 times the long term average recruitment (range: 30-58), was born in 2016 and was projected to bring this stock out of the Critical Zone by the beginning of 2023 and would have a better than 50% probability of being in the Healthy Zone in that same year.

These predictions were entirely dependent on the assessed size of the 2016 year class, which was highly uncertain. However, there was evidence, beginning in 2017, that this cohort was large and dominated the available data. Three of the synoptic surveys, particularly the Queen Charlotte Sound survey in 2019, showed strong quantitative increases in abundance and in distribution. This cohort dominated the age and length frequencies in the commercial trawl, beginning in 2018. Similar strong recruitment (in 2010 and 2013) in the US BOR population, located south of Monterey, had lifted that stock out of an ‘overfished’ designation and was assessed in 2017 to be approaching 0.5B0. The BC authors suggested that the demonstrable capacity of the four active synoptic surveys plus the high quality monitoring of the trawl fishery catches and discards will verify the future progress of the strong 2016 cohort as it recruits to the fishery.

Starr, P. J. and Haigh, R. in press. Bocaccio (*Sebastes paucispinis*) stock assessment for British Columbia in 2019, including guidance for rebuilding plans. DFO Can. Sci. Advis. Sec. Res. Doc. 2019/nnn: iii + xxx p.

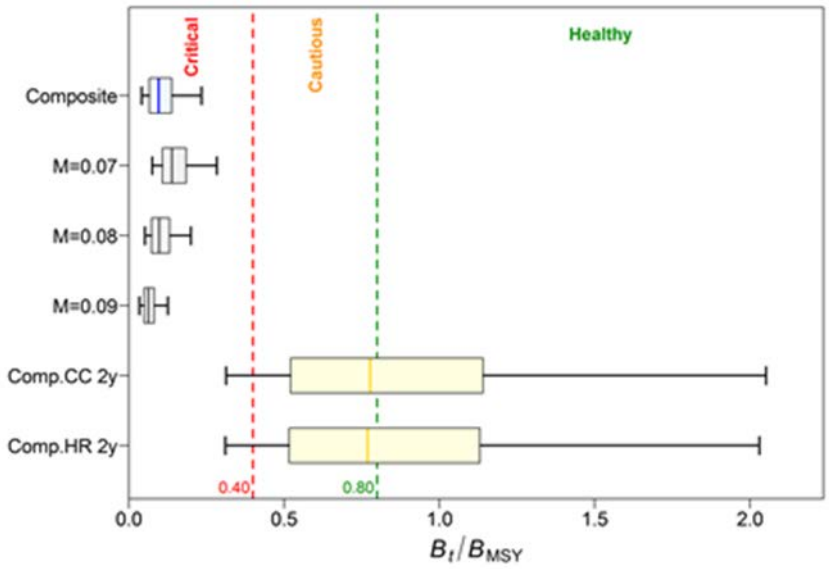

Figure 6. Status of the coastal BOR stock relative to the DFO PA provisional reference points of 0.4BMSY and 0.8BMSY for the t=2020 composite base case and the component base runs that are pooled to form the composite base case. Also shown are projected stock status for the composite base case at the beginning of 2022 after fishing at a constant catch=200 tonnes/year or a constant exploitation rate of 0.04/year. Model year 2022 is the second year that the 2016 cohort is assumed to contribute to the spawning population. Boxplots show the 0.05, 0.25, 0.5, 0.75 and 0.95 quantiles from the MCMC posterior.

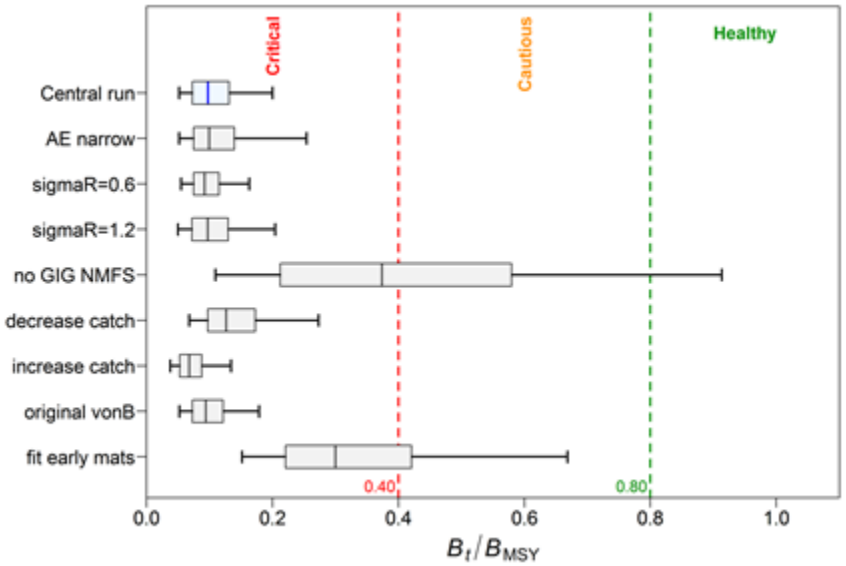

Figure 7. Stock status at beginning of 2020 of the BOR stock relative to the DFO PA provisional reference points of 0.4BMSY and 0.8BMSY for the central run of the composite base case and eight sensitivity runs (see y-axis notation and sensitivity descriptions in the main text). Boxplots show the 0.05, 0.25, 0.5, 0.75 and 0.95 quantiles from the MCMC posterior. See CSAS research document for details of the sensitivity runs

Pacific Ocean Perch

The most recent stock assessment (2017) is publicly available on the CSAS website (Research Document 2018/031).

Redstripe Rockfish

The most recent stock assessment (2017) is still awaiting translation; however, a summary report is available (Science Advisory Report 2018/049).

Rougheye/Blackspotted Rockfish

The Rougheye/ Blackspotted (REBS) complex, called Rougheye Rockfish Type I and Type II by COSEWIC was designated as Special Concern in 2007. A COSEWIC re-assessment is anticipated, but has been postponed until after the next stock assessment is completed.

Preliminary stock assessment work was attempted in 2019 for the Rougheye/ Blackspotted (REBS) complex by a student at Simon Fraser University (SFU) but difficulties arose when the student transferred to the University of British Columbia (UBC). The Offshore Rockfish program has taken over the stock assessment for delivery in May 2020.

Widow Rockfish

Widow Rockfish (WWR) along the BC coast was assessed in 2019 using a catch-at-age model tuned to five fishery-independent trawl survey series, one bottom trawl CPUE series, annual estimates of commercial catch since 1940, and age composition data from survey series (five years of data from four surveys) and the commercial fishery (30 years of data). The model starts from an assumed equilibrium state in 1940, and the survey data cover the period 1967 to 2018 (although not all years are represented). Nine base runs using a two-sex model were implemented in a Bayesian framework (using the Markov Chain Monte Carlo procedure) under a scenario that fixed natural mortality to three levels (0.07, 0.08, 0.09) and set the accumulator age to three values (40, 45, 50 y) while estimating steepness of the stock-recruit function, catchability for surveys and CPUE, and selectivity for surveys and the commercial trawl fleet. These nine runs were combined into a composite base case which explored the major axes of uncertainty in this stock assessment (Figure 8). Twelve sensitivity analyses were performed to test the effect of alternative model assumptions (Figure 9).

The composite base case suggested that low exploitation in the early years, including that by foreign fleets, coupled with several strong recruitment events (in 1961 and 1990) have sustained the population to the present. Exploitation rates were high during a period of heavy fishing by the domestic fleet extending from the mid-1980s to the mid-1990s, causing the stock size to diminish. Exploitation rates dropped with the implementation of 100% observer coverage in 1996 and the introduction of catch limits coupled with IVQs in 1997.

The spawning biomass (mature females only) at the beginning of 2019 was estimated to be 0.37 (0.26, 0.54) of unfished biomass (median and 5th and 95th quantiles of the Bayesian posterior distribution). This biomass was estimated to be 1.51 (0.92, 2.61) of the spawning biomass at maximum sustainable yield, BMSY.

Advice to managers was presented as decision tables that provided probabilities of exceeding limit and upper stock reference points for five-year projections across a range of constant catches. The DFO provisional ‘Precautionary Approach compliant’ reference points were used, which specify a ‘limit reference point’ (LRP) of 0.4BMSY and an ‘upper stock reference point’ (USR) of 0.8BMSY. The estimated spawning biomass at the beginning of 2019 had a probability of 1 of being above the LRP, and a probability of 0.98 of being above the USR. Five-year projections using a constant catch of 2000 t/y indicated that, in 2024, the spawning biomass had probabilities of 0.99 of remaining above the LRP, and 0.91 of remaining above the USR. Catches greater than 2250 t/y will cause u2024 to exceed the uMSY reference point with a probability of greater than 0.5.

Starr, P. J. and Haigh, R. in press. Widow Rockfish (*Sebastes entomelas*) stock assessment for British Columbia in 2019. DFO Can. Sci. Advis. Sec. Res. Doc. 2019/nnn: iii + xxx p.

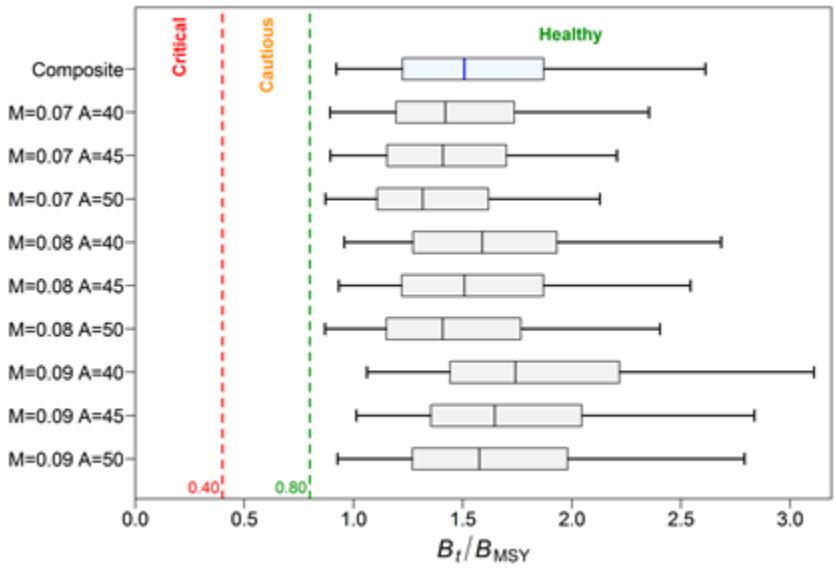

Figure 8. Status of the coastal WWR stock relative to the DFO PA provisional reference points of 0.4BMSY and 0.8BMSY for the t=2019 composite base case and the component base runs that are pooled to form the composite base case. Boxplots show the 0.05, 0.25, 0.5, 0.75 and 0.95 quantiles from the MCMC posterior.

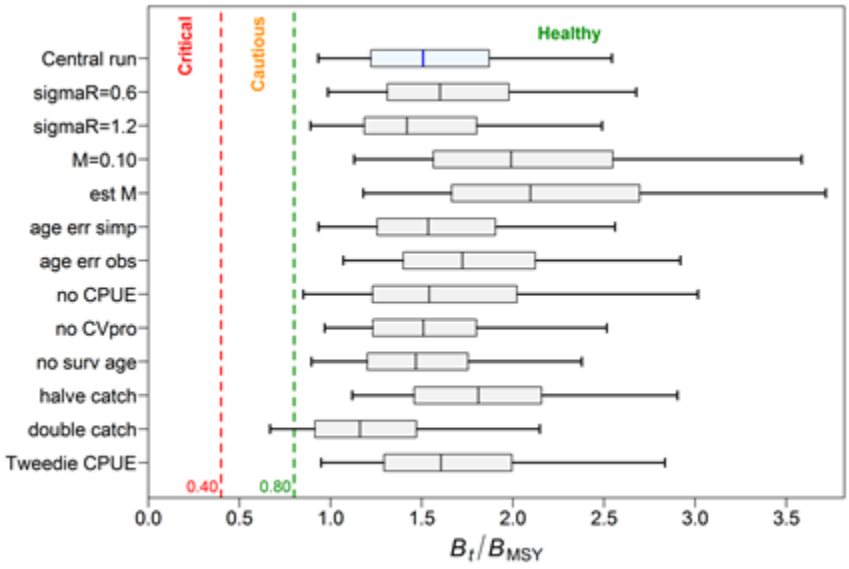

Figure 9. Stock status at beginning of 2019 of the WWR stock relative to the DFO PA provisional reference points of 0.4BMSY and 0.8BMSY for the central run of the composite base case and twelve sensitivity runs (see y-axis notation and sensitivity descriptions in the main text). Boxplots show the 0.05, 0.25, 0.5, 0.75 and 0.95 quantiles from the MCMC posterior. See CSAS research document for details of the sensitivity runs.

Yellowtail Rockfish

Yellowtail Rockfish were last assessed in 2014. The Science Advisory Report (SAR 2015/010) is available at https://waves-vagues.dfo-mpo.gc.ca/Library/364528.pdf.

Canary Rockfish

In 2007, Canary Rockfish along the Pacific coast of Canada was designated as Threatened by the Committee on the Status of Endangered Wildlife in Canada, with commercial fishing identified as the primary threat. This designation means that Fisheries and Oceans Canada, as the responsible jurisdiction under the Canadian Species at Risk Act, is required to undertake a number of actions. Many of these actions require scientific information on the current status of the species, threats to its survival and recovery, and the feasibility of its recovery.

The Canary Rockfish stock assessment was last updated in 2009. In 2017, DFO prepared a summary of available information on Canary Rockfish in preparation for a re-assessment by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC); the pre-COSEWIC assessment is awaiting translation before appearing on the CSAS website. A new full stock assessment by DFO is planned for 2021.

Silvergray Rockfish

Silvergray Rockfish were last assessed in 2014. The Research Document (2016/042) and Science Advisory Report (SAR 2014/028) are available at http://www.dfo-mpo.gc.ca/csas-sccs/Publications/ResDocs-DocRech/2016/2016_042-eng.html and https://waves-vagues.dfo-mpo.gc.ca/Library/364111.pdf.

Yellowmouth Rockfish

In 2010, Yellowmouth Rockfish along the Pacific coast of Canada was designated as Threatened by COSEWIC, with commercial fishing identified as the primary threat. This designation means that Fisheries and Oceans Canada, as the responsible jurisdiction under the Canadian Species at Risk Act, is required to undertake a number of actions. Many of these actions require scientific information on the current status of the species, threats to its survival and recovery, and the feasibility of its recovery.

In 2011 – 2012, DFO completed a Stock Assessment and Recovery Potential Assessment. The Research Document (2012/095) and Science Advisory Report (SAR 2011/060) are available at https://waves-vagues.dfo-mpo.gc.ca/Library/347270.pdf and https://waves-vagues.dfo-mpo.gc.ca/Library/345104.pdf.

The next assessment is planned for fall 2020.

Shortraker Rockfish

Shortraker Rockfish were last assessed in 1998. There is currently no new assessment planned.

Redbanded Rockfish

The last assessment for Redbanded Rockfish was attempted in 2014; however, no model was found that was able to produce reliable results, so researchers were unable to provide specific quantitative advice to fisheries management. The Research Document (2017/058) is available at http://www.dfo-mpo.gc.ca/csas-sccs/Publications/ResDocs-DocRech/2017/2017_058-eng.html.

Darkblotched Rockfish

In 2009, Darkblotched Rockfish along the Pacific coast of Canada was designated as Special Concern by COSEWIC. There is currently no stock assessment planned.

3. Management

i) Inshore Rockfish

Inside and Outside Yelloweye Rockfish still fall under a rebuilding plan that is documented in Appendix 9 of the 2019 IFMP (https://waves-vagues.dfo-mpo.gc.ca/Library/40765167.pdf). Most inshore rockfish are managed with Total Allowable Catches under the Individual Transferable Quota system.

Commercial TACs and landings for 2019 are provided in Appendix 2. To support groundfish research and account for unavoidable mortality incurred during the 2019 Groundfish surveys, research catches are allocated before defining the TAC. See Appendix 2 for details.

Recreationally, the retention of Yelloweye Rockfish in inside and outside waters is prohibited. In outside waters, recreational fishers are limited to 3 rockfishes daily, only 1 of which may be a China, Tiger or Quillback Rockfish; possession limits are twice the daily limits, and the season runs from April 1 – November 15. In inside waters (4B), recreational fishers can take 1 rockfish daily, possession limits are twice the daily limit and the season runs from May 1 – October 1. A condition of the recreational license is that: “Anglers in vessels shall immediately return all rockfish that are not being retained to the water and to a similar depth from which they were caught by use of an inverted weighted barbless hook or other purpose-built descender device.”

ii) Offshore Rockfish

Commercial TACs and landings for 2019 are provided in Appendix 2. To support groundfish research and account for unavoidable mortality incurred during the 2019 Groundfish surveys, research catches are allocated before defining the TAC. See Appendix 2 for details.

I. Thornyheads

1. Research

Data collection continued in 2019 through trawl and longline surveys and at-sea observer sampling of the trawl fishery.

2. Assessment

Longspine Thornyhead was designated “Special Concern” by COSEWIC in 2007. An assessment has been requested but not yet scheduled.

Shortspine Thornyheads were assessed in 2015. The Research Document (2017/015) and Science Advisory Report (SAR 2016/016) are available at http://www.dfo-mpo.gc.ca/csas-sccs/Publications/ResDocs-DocRech/2017/2017_015-eng.html and https://waves-vagues.dfo-mpo.gc.ca/Library/365535.pdf.

3. Management

Longspine and Shortspine Thornyhead are both IVQ species. Commercial TACs and landings for 2019 are provided in Appendix 2. To support groundfish research and account for unavoidable mortality incurred during the 2019 Groundfish surveys, research catches are allocated before defining the TAC. See Appendix 2 for details.

J. Sablefish

The Sablefish management system in British Columbia is an adaptive ecosystem-based approach in which three pillars of science – hypotheses, empirical data, and simulation - play a central role in defining management objectives and in assessing management performance relative to those objectives via Management Strategy Evaluation (MSE). Objectives relate to outcomes for three categories of ecosystem resources: target species, non-target species, and Sensitive Benthic Areas.

The MSE process is used to provide management advice each year that supplements the stock assessment process by providing a way to explicitly evaluate harvest strategies given a set of stock and fishery objectives and uncertainties/hypotheses about Sablefish fishery and resource dynamics. Fisheries and Oceans Canada (DFO) and Wild Canadian Sablefish Ltd. have collaborated for many years on fisheries management and scientific research with the aim of further supporting effective assessment and co-management of the Sablefish stock and the fishery in Canadian Pacific waters.

1. Research

In addition to the annual Sablefish Research and Assessment Survey (see Appendix 1 for details), research activities in 2019 included the continuation of an informal collaboration among Sablefish scientists from DFO, NOAA, ADFG and academia on range-wide Sablefish ecology and management. The overarching goal of the collaboration is to develop a range-wide, spatially explicit population dynamics model for Sablefish that can be used to explore questions of biological and management relevance across the eastern North Pacific. In 2019 primary research activities towards this goal included initiating a synthesis of life history characteristics across the Sablefish range, analyses to identify and develop range-wide indices of abundance and the evaluation of time- and size-varying movement within and among regions (e.g., Alaska, British Columbia and the US West Coast).

2. Assessment

Sablefish stock status is regularly evaluated via the MSE process. An operating model (i.e., representation of alternative hypotheses about ‘true’ Sablefish population dynamics) is used to simulate data for prospective testing of management procedure performance relative to stock and fishery objectives. The current Sablefish operating model (OM) was revised in 2015/16 to account for potential structural model misspecification and lack-of-fit to key observations recognized in previous models (DFO 2016). Specific modifications included: (i) changing from an age-/growth- group operating model to a two-sex/age-structured model to account for differences in growth, mortality, and maturation of male and female Sablefish, (ii) adjusting

model age- proportions via an ageing error matrix, (iii) testing time-varying selectivity models, and (iv) revising the multivariate-logistic age composition likelihood to reduce model sensitivity to small age proportions. These structural revisions to the operating model improved fits to age-composition and at-sea release data that were not well-fit by the previous operating model. Accounting for ageing errors improved the time-series estimates of age-1 Sablefish recruitment by reducing the unrealistic auto-correlation present in the previous model results. The resulting estimates clearly indicate strong year classes of Sablefish that are similar in timing and magnitude to estimates for the Gulf of Alaska. Two unanticipated results were that (i) time-varying selectivity parameters were not estimable (or necessarily helpful) despite informative prior information from tagging and (ii) improved recruitment estimates helped to explain the scale and temporal pattern of at-sea release in the trawl fishery. The latter finding represents a major improvement in the ability to assess regulations (e.g., size limits) and incentives aimed at reducing at-sea releases in all fisheries.

The status of the Sablefish stock is judged on the scale of the OM which was last updated in 2019 (DFO 2019). Based on the 2019 assessment, the current point estimate of Sablefish spawning stock biomass in Canada is 16,300 t. This spawning biomass is at the transition from the Cautious to Healthy zones under the DFO FPA Framework (i.e., B2018/BMSY = 0.8). The updated stock status of Canadian Sablefish depended on the absolute size of the 2015-year class the raw estimate of this which was about eight times the historical average. This created the impression of the largest recorded recruitment from one of the lowest spawning biomasses ever observed in Canada. However, this estimated recruitment is highly uncertain, and both the timing and magnitude of the year-class size should be better estimated as several more years of fishery and survey data accumulate.

In 2019 the updated operating model was used to generate simulated data to test the current and alternative management procedures (MPs). The joint posterior distribution of spawning biomass and stock-recruitment steepness was used to generate five scenarios that captured a range of hypotheses related to current spawning biomass and productivity. These feedback simulations showed that the current MP (no limits on at-sea releases) meets biological objectives but ranked near the bottom in terms of catch performance and revenues compared to MPs with at-sea release management measures. A no size limit (i.e., full retention) MP performed best for both biological and fishery objectives, followed by MPs that included caps on sub-legal releases. These simulations also showed that the largest conservation risk is tuning the maximum target harvest rate in MPs assuming large 2015 recruitment, but then it fails to materialize.

The revised operating model continues to assume that the BC Sablefish stock is a closed population, despite evidence of movements among Sablefish stocks in Alaska and US waters south of BC (Hanselmen et al. 2014) and little genetic evidence of population structure across these management regions (Jasonowicz et al. 2017) . These movements may have implications for the assumptions made about Sablefish stock dynamics in BC (i.e., recruitment, productivity) that are not currently captured by the revised OM or reflected in MP performance evaluations. The collaboration between DFO, NOAA and ADFG identified above in the research section is working towards the development of a coastwide Sablefish OM to understand the potential consequences of the mismatch between Sablefish stock structure and management by simulation testing current, and potential future, MPs to quantify their performance against a range of conservation and fishery objectives.

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3. Management

The MP that is currently in place for the Canadian Sablefish fishery was last evaluated in 2019 through the Sablefish MSE (see Assessment section above). This MP is based on a surplus production model fit to time-series observations of total landed catch, and the fishery independent survey CPUE, to forecast Sablefish biomass for the coming year. The surplus production model outputs are then inputs to a harvest control rule to calculate the recommended catch of legal Sablefish in a given year. This MP includes a 3-year phased-in period to a new maximum target harvest rate of 5.5% in 2022.

Commercial TACs and landings for 2019 are provided in Appendix 2. To support groundfish research and account for unavoidable mortality incurred during the 2019 Groundfish surveys, research catches are allocated before defining the TAC. See Appendix 2 for details.

K. Lingcod

1. Research

Ongoing data collection continued in 2019 through surveys, port sampling, at-sea observer sampling, and recreational creel surveys. Additional biological samples (length, weight, sex, maturity and fins for ageing) were collected on the Inside HBLL N and the Outside HBLL N, and the Queen Charlotte Strait and Hecate Strait Synoptic Trawl Surveys.

2. Assessment

Inside, the waters within the Strait of Georgia, and Outside, the rest of the BC Coast, Lingcod populations are assessed and managed as separate units. Outside Lingcod were scheduled to be assessed in the spring of 2019; however, the assessment has been pushed back due to other program demands as well as the desire to have some age-data to inform the catchability of the longline surveys. Fins collected on the IPHC, trawl surveys and Outside HBLL surveys are currently being processed. Inside Lingcod were last assessed in 2014.

3. Management

Commercial TACs and landings for 2019 are provided in Appendix 2. To support groundfish research and account for unavoidable mortality incurred during the 2019 Groundfish surveys, research catches are allocated before defining the TAC. See Appendix 2 for details.

L. Atka Mackerel

The distribution of Atka mackerel does not extend into the Canadian zone.

M. Flatfish

1. Research

Ongoing data collection in support of the flatfish research program, inclusive of Arrowtooth Flounder, Petrale Sole, Southern Rock Sole, Dover Sole, and English Sole continued in 2019 through surveys and at-sea observer sampling.

2. Assessment

Arrowtooth Flounder

Arrowtooth Flounder was last assessed in 2016. The final assessment was finalized and published through the Canadian Science Advice Secretariat (CSAS) in 2017. The research document and science advisory report are available at http://www.dfo-mpo.gc.ca/csas-sccs/Publications/ResDocs-DocRech/2017/2017_025-eng.html and https://waves-vagues.dfo-mpo.gc.ca/Library/365131.pdf.

Concerns expressed by industry participants regarding localized depletion on several the historic fishing grounds have led to a request from fisheries management for an updated assessment. Efforts are underway to deliver that assessment by the fall of 2020.

Petrale Sole

Petrale sole was last assessed in 2007. In response to a request for updated harvest advice from fishery managers, aging of otoliths was completed in 2018. Planning is currently underway to deliver an updated assessment in 2020/21.

Southern Rock Sole

Southern Rock sole was last assessed in 2013. No request for updated advice has been received, but aging of otoliths was undertaken in 2019 in anticipation of an updated assessment sometime in 2021/22.

Dover Sole

Dover sole was last assessed in 1999. Aging of otoliths is currently underway in anticipation of an updated assessment in 2020.

English Sole

English sole was also last assessed in 2007. No request for updated advice has been received, but aging of otoliths was undertaken in 2019 in anticipation of an updated assessment sometime in 2020/21.

3. Management

Arrowtooth Flounder, Petrale Sole, Southern Rock Sole, Dover sole, and English Sole are all managed by annual coastwide or area specific TACs and harvested primarily by the IVQ multi-species bottom trawl fishery. Commercial TACs and landings for 2019 are provided in Appendix 2. To support groundfish research and account for unavoidable mortality incurred during the 2019 Groundfish surveys, research catches are allocated before defining the TAC. See Appendix 2 for details.

Pacific Halibut & IPHC Activities

Pacific halibut caught incidentally by Canadian groundfish trawlers are measured and assessed for condition prior to being released. Summaries of these length data are supplied annually to the IPHC. In addition, summaries of live and dead releases (based on condition) from both the trawl and line fisheries in British Columbia are provided.

Commercial TACs and landings for 2019 are provided in Appendix 2.

N. Other Groundfish Species

Nothing to report at this time.

V. Ecosystem Studies

A. Data-limited Species

The Fisheries and Oceans Canada (DFO) Sustainable Fisheries Framework (DFO 2009) lays the foundation for an ecosystem-based and precautionary approach to fisheries management that enables continued productivity of Canada's fisheries.

In recent decades, DFO groundfish stock assessments have focused on data-rich species, resulting in a subset of stocks with full stock assessments, while many stocks with less informative data remain unassessed. Consequently, quotas assigned to rarely assessed or unassessed stocks may result in catch rates that are too high, may restrict harvesting opportunities to catch target species, or may result in failure for fisheries to meet seafood certification standards.

Starting in 2015, work was initiated to address this gap. Instead of a tiered approach as is used in other jurisdictions around the world, the approach eventually adopted for BC groundfish stocks considers data-richness on a continuous scale and focuses on simulation testing multiple

management procedures on a stock-by-stock basis to choose an approach that best meets fisheries risk objectives.

Groundfish Data Synopsis

The first phase consisted of a groundfish data synopsis, as described in the 2019 TSC report. The synopsis provides a visual snapshot of temporal trends and spatial distributions of commercial catches and survey indices, growth and maturity characteristics, and data availability for over 100 BC groundfish stocks. The synopsis was peer reviewed through a Canadian Science Advisory Secretariat (CSAS) Regional Peer Review (RPR) process in 2018 and published in 2019 as a Research Document (Anderson et al. 2019). An article describing the approach will be featured in 2020 in the AFS Fisheries Magazine (Anderson et al. in press).

Management Procedure Framework

The second phase is the development of a framework for applying a management-procedure (MP) approach to data-limited groundfish stocks in British Columbia. (Data-limited stocks are defined here as those with insufficient data to reliably estimate stock status or estimate abundance or productivity with conventional stock assessment methods such as statistical catch-at-age models.) The MP framework will be reviewed through a CSAS RPR process in June 2020. Specifically, the MP framework tests the performance of a suite of data-limited management procedures against conservation and fishery objectives. This is done using an existing closed-loop simulation framework that includes building appropriate operating models, testing suites of management procedures, and determining management procedures that best meet conservation and fishery objectives for one or more case-study stocks. The framework uses the open source R package DLMtool (Carruthers and Hordyk 2018), developed at the University of British Columbia, in partial partnership with DFO.

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VI. Other related studies

Nothing to report at this time.

VII. Publications

A. Primary Publications

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Appendix 1: Details of Fisheries and Oceans, Canada Pacific Region Groundfish Surveys in 2019

Overview

The Fisheries and Oceans, Canada (DFO) Groundfish section of the Stock Assessment and Research Division includes a surveys program. The program includes a suite of fishing surveys using bottom trawl, longline hook, and longline trap gear that, in aggregate, provide comprehensive coverage for all offshore waters of Canada's Pacific Coast (Figure 1). All the surveys follow random depth-stratified designs and have in common full enumeration of the catches (all catch sorted to the lowest taxon possible), size composition sampling for most species, and more detailed biological sampling of selected species. Most of the surveys are conducted in collaboration with the commercial fishing industry under the authorities of various Collaborative Agreements. In addition to these randomized surveys, a fixed-station longline hook survey targeting North Pacific Spiny Dogfish in the Strait of Georgia is completed every three years. The Groundfish section also routinely participates in the Canadian portion of the Joint Canada US Hake Acoustic Survey, collects groundfish information from a DFO Small-Mesh Bottom Trawl Survey, and funds an additional technician during the International Pacific Halibut Commission (IPHC) Setline Survey (Figure 2).

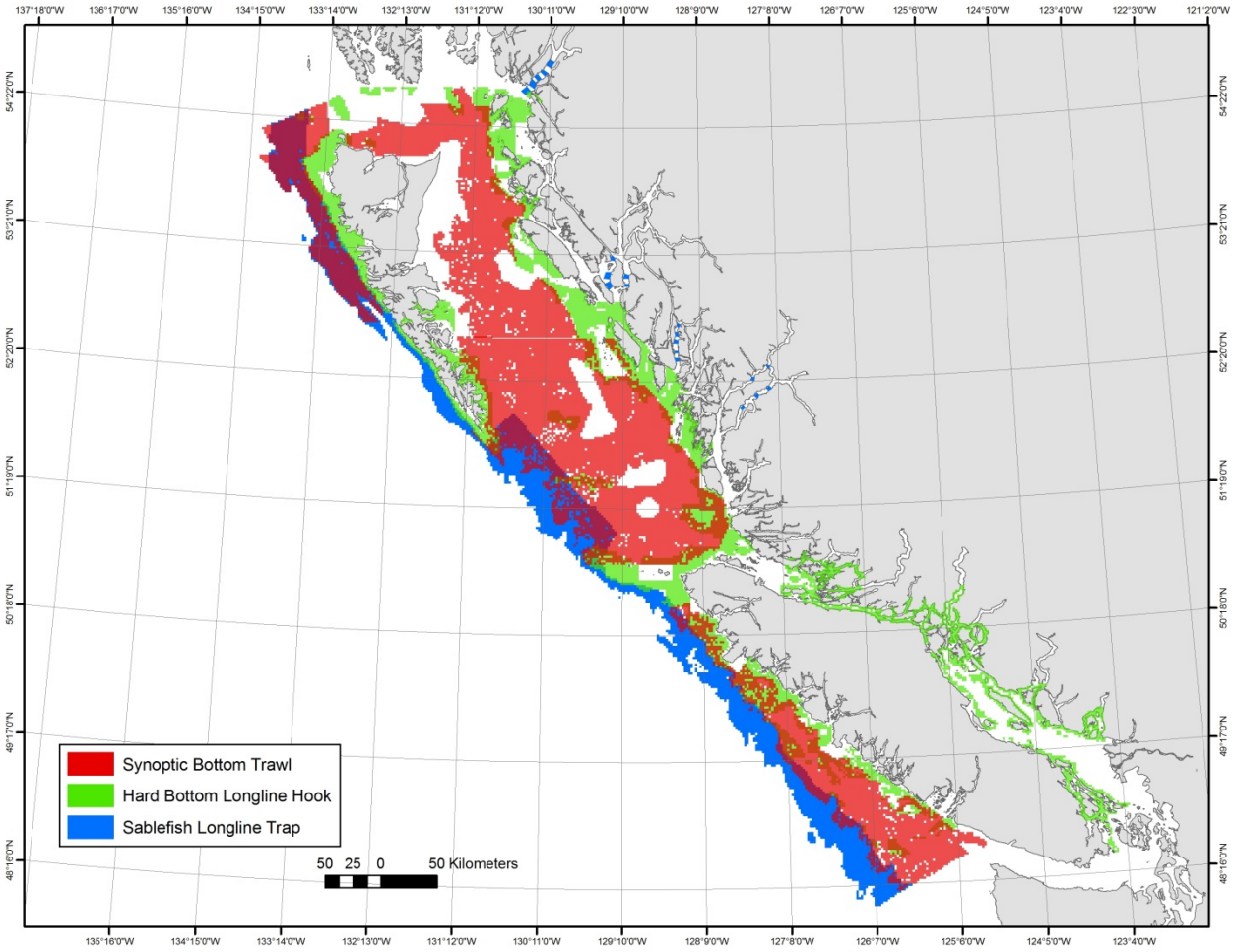

Figure 10. Random depth-stratified survey coverage.

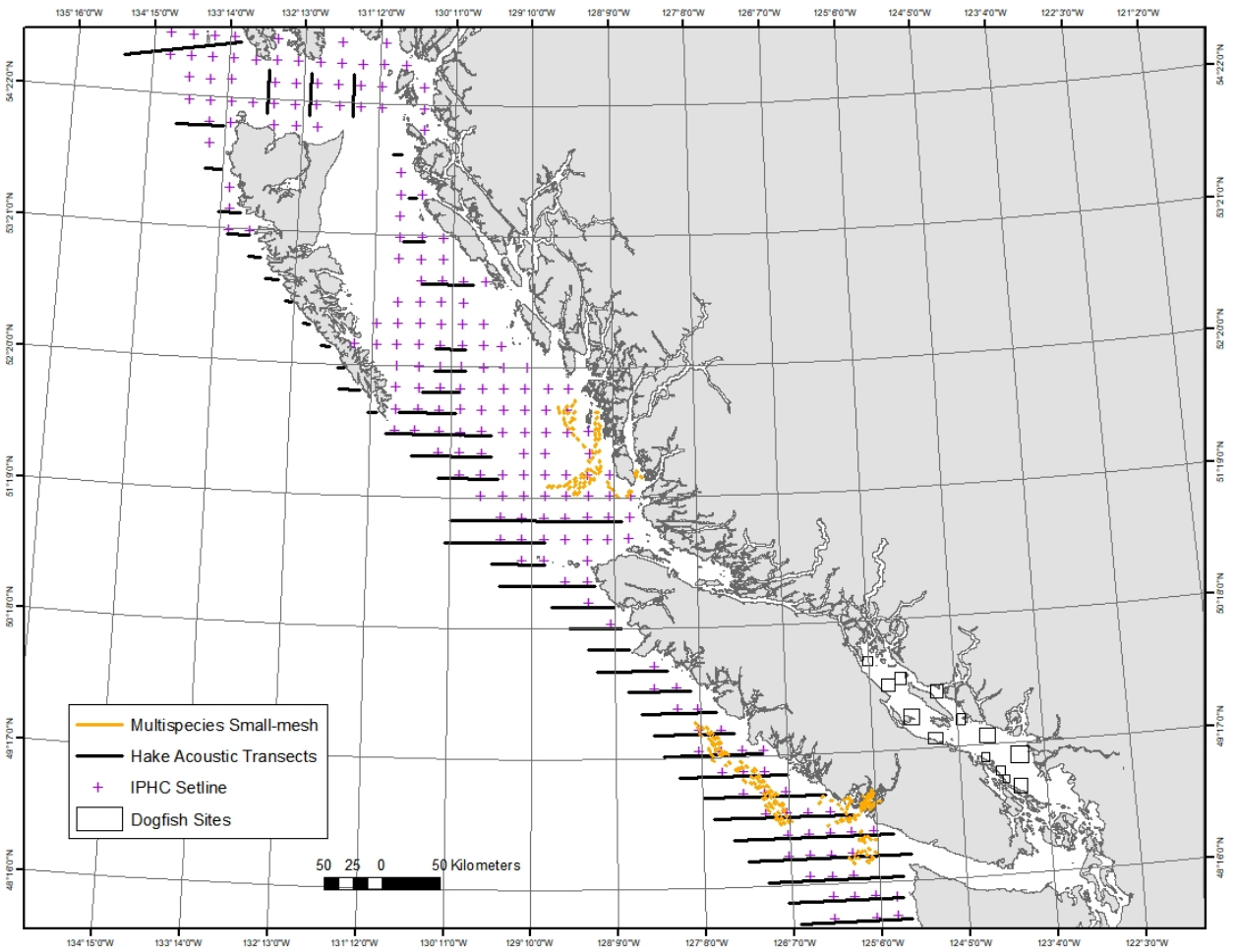

Figure 11. Non-random depth-stratified surveys that form part of the Groundfish surveys program including the Multi-species Small-mesh Bottom Trawl Survey, the Pacific Hake Acoustic Survey, and the International Pacific Halibut Commission (IPHC) Setline Survey.

Each year, two or three area-specific random depth-stratified bottom trawl surveys known as Multi-species Synoptic Bottom Trawl Surveys are conducted. The commercial trawl industry provides the vessel for one survey while the other survey is conducted onboard a Canadian Coast Guard research trawler. Surveys are conducted with a combination of DFO staff and industry-hired sea-going technicians. These bottom trawl surveys provide coast-wide coverage of most of the trawlable habitat between 50 and 500 meters depth.

Each year, in addition to the annual bottom trawl surveys, two area-specific random depth-stratified longline hook surveys known as Hard Bottom Longline Hook (HBLL) Surveys are conducted. The commercial longline hook industry contracts vessels and sea-going technicians for a survey of “outside” waters (not between Vancouver Island and the mainland) while a separate longline hook survey of “inside” waters (between Vancouver Island and the mainland) is conducted by DFO staff onboard a Canadian Coast Guard research vessel. These longline hook surveys provide coast-wide coverage of most of the non-trawlable habitat between 20 and 220 meters depth that is not covered by the bottom trawl surveys.

In addition to the bottom trawl and hook and line surveys, an annual, coast-wide longline trap survey targeting sablefish, known as the Sablefish Research and Assessment Survey, is also

conducted. The commercial sablefish industry supplies the chartered commercial fishing vessel and the survey is conducted with a combination of DFO staff and industry-hired sea-going technicians. This survey covers the depth range of 150 m to 1500 m for the entire outer BC coast as well as a number of central coast inlets.

In addition to the bottom trawl, hook and line, and trap surveys, a longline hook survey targeting North Pacific Spiny Dogfish is conducted every three years and an annual Hake Acoustic Survey is conducted for Pacific Hake. The Strait of Georgia Dogfish Longline Hook Survey follows a fixed-station design and is intended to provide biological, catch, and effort data. The Hake Acoustic Survey is conducted as part of the Pacific Whiting Treaty and typically alternates year to year between research and assessment activities. Both of these surveys are conducted aboard the Canadian Coast Guard research vessels by DFO staff.

Each year, Groundfish section staff also participate in the Multi-species Small-mesh Bottom Trawl Survey onboard the Canadian Coast Guard research trawler. This survey follows a fixed-station design and visits commercially important shrimp grounds off the west coast of Vancouver Island and in eastern Queen Charlotte Sound. Groundfish program staff participate in the survey to provide assistance in enumerating the catch while also collecting biological samples from selected fish species.

During their annual survey, the International Pacific Halibut Commission (IPHC) only fully enumerates the catch for, and collects biological samples from, Pacific Halibut. In an effort to acquire more data on groundfish species intercepted by this survey, particularly rockfish, the commercial longline fishing industry provides an additional technician aboard each of the IPHC chartered survey vessels. The extra technician fully enumerates the catch of all species and collects biological samples from selected inshore species of rockfish as well as Lingcod.

This report summarizes all the 2019 surveys (Figure 3) including the Multi-species Synoptic Bottom Trawl surveys conducted in Hecate Strait and Queen Charlotte Sound, the Hard Bottom Longline Hook Survey conducted in the northern part of “outside” waters and both the northern and southern parts of “inside waters”, the coast-wide Sablefish Research and Assessment Survey, the Multi-species Small-mesh Bottom Trawl Survey off the west coast of Vancouver Island, and the IPHC setline survey. Unfortunately, at the time of writing, the data from the Hard Bottom Longline Hook Survey of “outside” waters and the IPHC setline survey are not yet finalized so have not been included. The results of the Pacific Hake Acoustic Survey are also not included in this report.

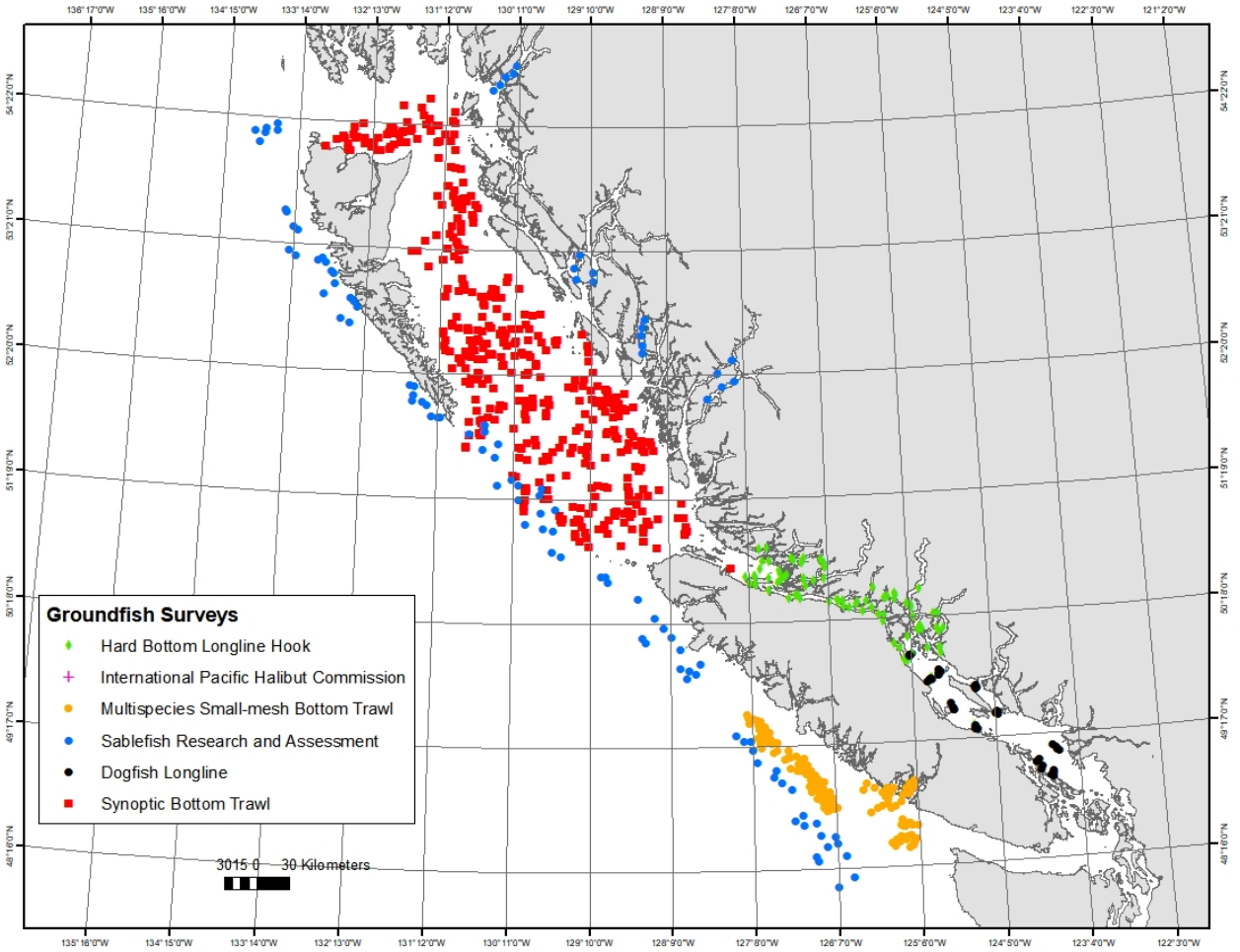

Figure 12. Fishing locations of the 2019 Groundfish surveys.

Multi-species Synoptic Bottom Trawl Surveys

Fisheries and Oceans, Canada (DFO) together with the Canadian Groundfish Research and Conservation Society (CGRCS) have implemented a comprehensive multi-species bottom trawl survey strategy that covers most of the BC coast. The objectives of these surveys are to provide fishery independent abundance indices of as many benthic and near-benthic fish species available to bottom trawling as is reasonable while obtaining supporting biological samples from selected species. The abundance indices and biological information are incorporated into stock assessments, status reports, and research publications.

All of the synoptic bottom trawl surveys along the British Columbia coast have followed the same random depth-stratified design. Each survey area is divided into 2 km by 2 km blocks and each block is assigned one of four depth strata based on the average bottom depth in the block. The four depth strata vary between areas. For each survey and in each year, blocks are randomly selected within each depth stratum. If a survey block is not fishable for any reason it will be abandoned and the vessel will proceed to the next block.

There are four core synoptic bottom trawl surveys, two of which are conducted each year. The Hecate Strait survey and the Queen Charlotte Sound survey are conducted in odd-numbered

years while the West Coast Vancouver Island survey and the West Coast Haida Gwaii (formerly Queen Charlotte Islands) survey are conducted in even-numbered years (Figure 4).

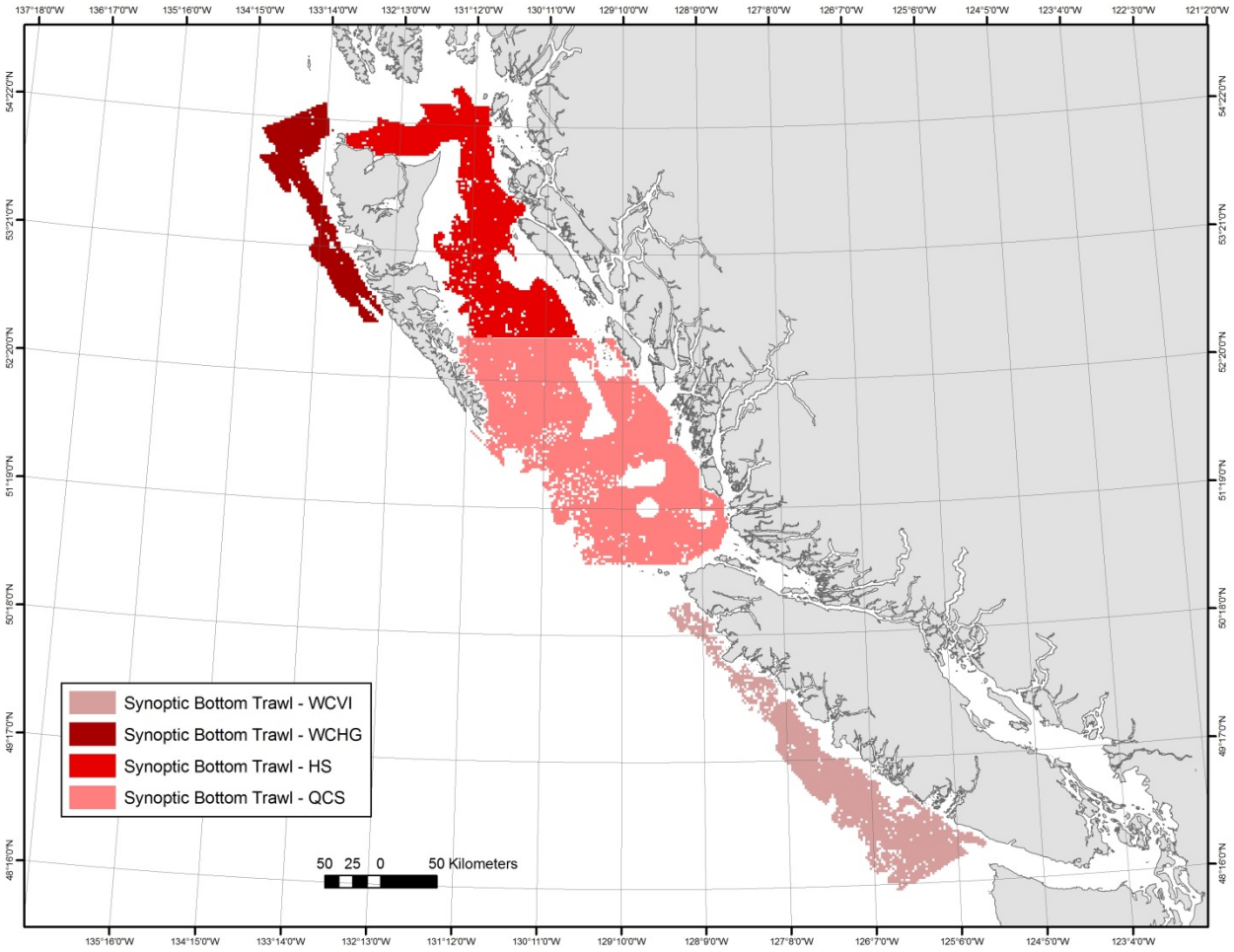

Figure 13. Multi-species Synoptic Bottom Trawl Survey coverage.

In addition to the four core surveys, a Strait of Georgia survey was initiated in 2012 with the intention of repeating the survey every 3 years. The first scheduled repeat of the survey was in 2015 but it was not possible to conduct the survey during March. Nonetheless, research vessel time was available during May and it appeared that the time period would remain available in future years. However, due to changes in department priorities, the May time period was actually not available in subsequent years. As such, the plan in 2017 was to revert back to the original time frame for the Strait of Georgia survey and complete a survey in March. The survey would continue biennially, in odd numbered years. Unfortunately the research vessel was not operational in 2017 so no survey was completed and the survey is now on hiatus due to staffing constraints.

The synoptic bottom trawl surveys are conducted on both chartered commercial vessels and government research vessels. The Hecate Strait survey, the West Coast Vancouver Island survey, and the Strait of Georgia survey are all conducted on a Canadian Coast Guard research

trawler while the Queen Charlotte Sound survey and the West Coast Haida Gwaii are conducted on chartered commercial fishing vessels.

The four core synoptic surveys (Hecate Strait, Queen Charlotte Sound, West Coast Vancouver Island, and West Coast Haida Gwaii) are all fished using an Atlantic Western IIA bottom trawl. In contrast, the Strait of Georgia survey is fished using a much smaller Yankee 36 bottom trawl. The decision to use the smaller trawl makes direct comparisons between the areas difficult but allowed us to cover the survey area in the available days. The use of the smaller trawl allows more blocks to be fished each day as the net is faster to deploy and retrieve and catches tend to be smaller.

In 2019 the Hecate Strait and Queen Charlotte Sound surveys were conducted. Both surveys were conducted on a chartered commercial vessel because the Canadian Coast Guard research trawler was not operational.

Hecate Strait Multi-species Synoptic Bottom Trawl Survey

The Hecate Strait Multi-species Synoptic Bottom Trawl Survey was conducted on the F/V Nordic Pearl between May 16 and June 12, 2019. We assessed a total of 196 blocks (Table 1, Figure 5). Of the 147 total tows conducted, one was a test tow that was completed outside of the survey area, 136 were successful survey tows, and 10 were failures due to hang ups or insufficient bottom time. Note that some blocks are only successfully fished following more than one attempt.

The total catch weight of all species was 49,992 kg. The mean catch per tow was 340 kg, averaging 22 different species of fish and invertebrates in each. The most abundant fish species encountered were Spotted Ratfish (*Hydrolagus colliei*), Arrowtooth Flounder (*Atheresthes stomias*), Rex Sole (*Glyptocephalus zachirus*), Dover Sole (*Microstomus pacificus*), and English Sole (*Parophrys vetulus*). The number of tows where the species was captured and total catch weight from usable tows as well as the estimated biomass and relative survey error for the 25 most abundant species are shown in Table 2. Biological data, including individual length, weight, sex, maturity, and age structure were collected from a total of 21,731 individual fish of 45 different species (Table 3).

Table 1. 2019 Hecate Strait Multi-species Synoptic Bottom Trawl Survey final block summary showing the number of blocks rejected based on fishing master's knowledge or by on-ground inspection, number of failed blocks (due to hang-ups or insufficient bottom time), number of successful tows, and number of un-fished blocks (due to other reasons such as tide, weather, or other vessels in the area) by stratum.

Depth Stratum (m)	Rejected Prior	Rejected Inspected	Failed	Success	Not Assessed	Total
10 to 70	4	32	3	41	0	83
70 to 130	0	6	1	44	0	51
130 to 220	0	7	1	37	0	45
220 to 500		3	0	14	0	17
Total	**4**	**48**	**5**	**136**	**0**	**196**

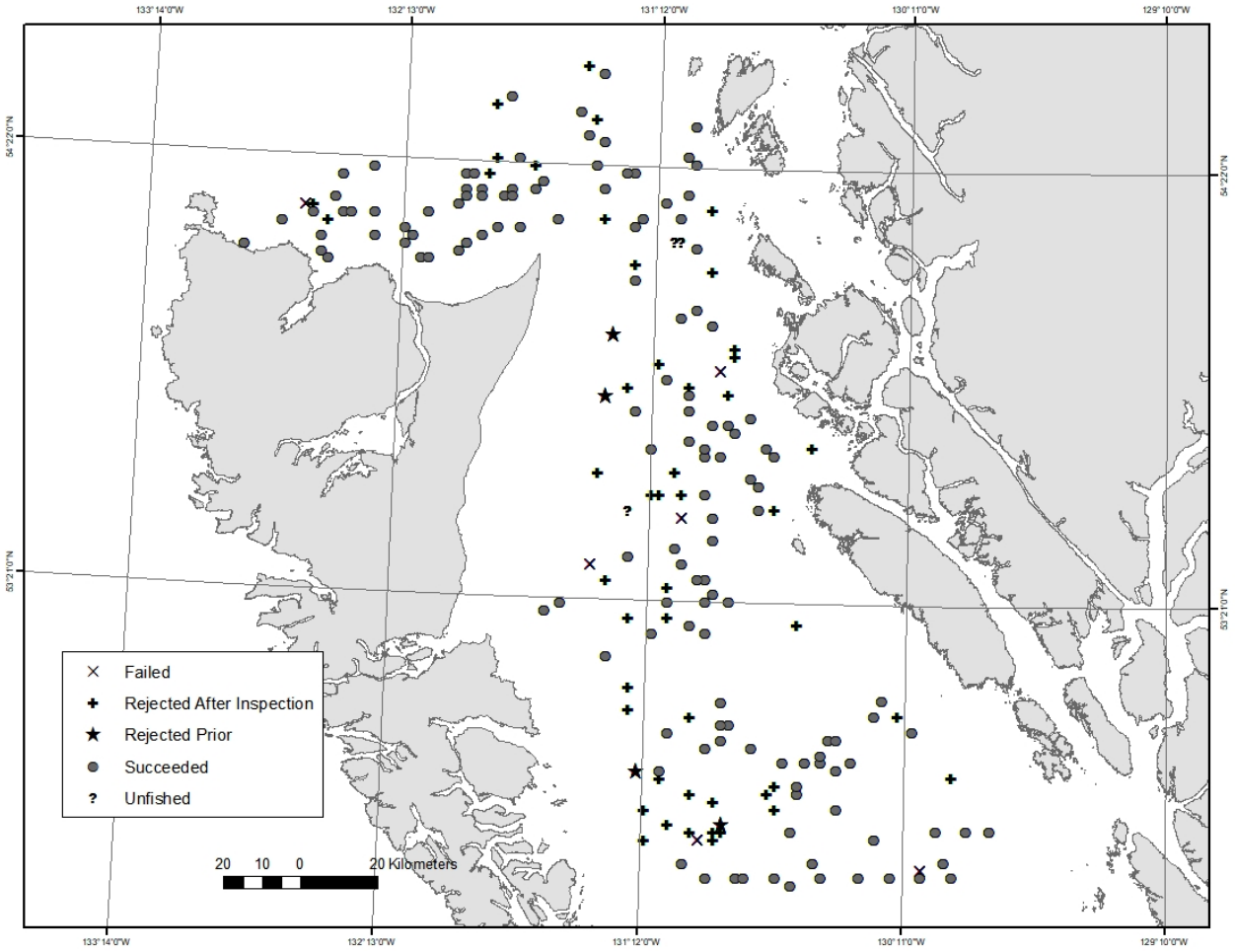

Figure 14. Final status of the allocated blocks for the 2019 Hecate Strait Multi-species Synoptic Bottom Trawl Survey.

Table 2. Number of catches and total catch weight from usable tows, estimated biomass, and relative survey error for the top 25 species (by weight) captured in the 2019 Hecate Strait Multi-species Synoptic Bottom Trawl Survey.

Species	Scientific Name	Number of Tows	Catch (kg)	Biomass (t)	Relative Error
Spotted Ratfish	*Hydrolagus colliei*	130	10004	8883	0.25
Arrowtooth Flounder	*Atheresthes stomias*	107	6684	4392	0.11
Rex Sole	*Glyptocephalus zachirus*	111	4752	3015	0.16
Dover Sole	*Microstomus pacificus*	97	4131	2801	0.26
English Sole	*Parophrys vetulus*	86	3033	3365	0.22
Pacific Ocean Perch	*Sebastes alutus*	49	2594	1512	0.45
Walleye Pollock	*Gadus chalcogrammus*	98	2534	1573	0.32
Pacific Cod	*Gadus macrocephalus*	102	1720	1752	0.37
Sablefish	*Anoplopoma fimbria*	77	1656	1056	0.36
Pacific Halibut	*Hippoglossus stenolepis*	84	1279	1298	0.15
Silvergray Rockfish	*Sebastes brevispinis*	40	1073	653	0.55
Southern Rock Sole	*Lepidopsetta bilineata*	56	1051	1544	0.22
Flathead Sole	*Hippoglossoides elassodon*	58	1045	650	0.25
North Pacific Spiny Dogfish	*Squalus suckleyi*	72	1036	725	0.59
Yellowtail Rockfish	*Sebastes flavidus*	31	642	385	0.48
Pacific Sanddab	*Citharichthys sordidus*	59	565	667	0.36
Big Skate	*Beringraja binoculata*	23	565	668	0.38
Petrale Sole	*Eopsetta jordani*	76	501	329	0.16
Redbanded Rockfish	*Sebastes babcocki*	33	344	242	0.19
Longnose Skate	*Raja rhina*	45	296	226	0.19
Shortspine Thornyhead	*Sebastolobus alascanus*	30	265	224	0.24
Lingcod	*Ophiodon elongatus*	38	245	240	0.38
Quillback Rockfish	*Sebastes maliger*	35	243	227	0.31
Starry Flounder	*Platichthys stellatus*	11	221	312	0.64
Copper Rockfish	*Sebastes caurinus*	14	202	341	0.57

Table 3. Number of fish sampled for biological data during the 2019 Hecate Strait Multi-species Synoptic Bottom Trawl Survey showing the number of lengths, age structures, and DNA tissue samples that were collected by species.

Species	Scientific Name	Lengths Collected	Age Structures Collected	DNA Tissue Collected
Aleutian Skate	*Bathyraja aleutica*	10	0	0
Arrowtooth Flounder	*Atheresthes stomias*	2095	685	0
Big Skate	*Beringraja binoculata*	53	0	0
Bocaccio	*Sebastes paucispinis*	58	56	54
Butter Sole	*Isopsetta isolepis*	194	0	0
Canary Rockfish	*Sebastes pinniger*	127	88	0
Copper Rockfish	*Sebastes caurinus*	114	84	0
Curlfin Sole	*Pleuronichthys decurrens*	121	105	0
Dover Sole	*Microstomus pacificus*	1437	831	0
English Sole	*Parophrys vetulus*	1671	912	0
Eulachon	*Thaleichthys pacificus*	459	0	70
Flathead Sole	*Hippoglossoides elassodon*	752	0	0
Greenstriped Rockfish	*Sebastes elongatus*	74	52	0
Kelp Greenling	*Hexagrammos decagrammus*	51	0	0
Lingcod	*Ophiodon elongatus*	94	57	0
Longnose Skate	*Raja rhina*	82	0	0
North Pacific Spiny Dogfish	*Squalus suckleyi*	101	0	0
Pacific Cod	*Gadus macrocephalus*	889	671	0
Pacific Hake	*Merluccius productus*	26	0	0
Pacific Halibut	*Hippoglossus stenolepis*	319	0	0
Pacific Ocean Perch	*Sebastes alutus*	660	426	0
Pacific Sanddab	*Citharichthys sordidus*	1077	0	0
Pacific Tomcod	*Microgadus proximus*	479	0	0
Petrale Sole	*Eopsetta jordani*	609	405	0
Puget Sound Rockfish	*Sebastes emphaeus*	11	0	0
Pygmy Rockfish	*Sebastes wilsoni*	55	0	0
Quillback Rockfish	*Sebastes maliger*	261	244	0
Redbanded Rockfish	*Sebastes babcocki*	176	172	0
Redstripe Rockfish	*Sebastes proriger*	70	54	0
Rex Sole	*Glyptocephalus zachirus*	2469	936	0
Rougheye/Blackspotted Rockfish Complex	*Sebastes aleutianus/melanostictus* complex	46	46	46
Sablefish	*Anoplopoma fimbria*	542	228	0
Sand Sole	*Psettichthys melanostictus*	209	0	0
Sandpaper Skate	*Bathyraja interrupta*	23	0	0
Sharpchin Rockfish	*Sebastes zacentrus*	67	0	0
Shortspine Thornyhead	*Sebastolobus alascanus*	341	136	0
Silvergray Rockfish	*Sebastes brevispinis*	218	161	0
Slender Sole	*Lyopsetta exilis*	546	0	0
Southern Rock Sole	*Lepidopsetta bilineata*	1142	589	0
Spotted Ratfish	*Hydrolagus colliei*	2485	0	0
Starry Flounder	*Platichthys stellatus*	62	0	0
Walleye Pollock	*Gadus chalcogrammus*	1218	0	0
Yelloweye Rockfish	*Sebastes ruberrimus*	1	1	1
Yellowmouth Rockfish	*Sebastes reedi*	40	38	0
Yellowtail Rockfish	*Sebastes flavidus*	197	118	0

Queen Charlotte Sound Multi-species Synoptic Bottom Trawl Survey

The Queen Charlotte Sound Multi-species Synoptic Bottom Trawl Survey was conducted on the F/V Nordic Pearl between July 16 and August 13, 2018. We assessed a total of 290 blocks (Table 4, Figure 6). Four of the randomly selected blocks fell within the Gwaii Haanas National Marine Conservation Area and at the time of the survey, no decisions had been made as to whether or not research trawl surveys will be permitted to continue in the reserve. As such, we decided to treat these blocks as temporarily unfishable and they were left unassessed at the end of the survey. Of the 274 total tows conducted, 242 were successful and 32 were failures due to hang ups or insufficient bottom time. Note that some blocks are only successfully fished following more than one attempt.

The total catch weight of all species was 154,899 kg. The mean catch per tow was 567 kg, averaging 24 different species of fish and invertebrates in each. The most abundant fish species encountered were Sablefish (*Anoplopoma fimbria*), Pacific Ocean Perch, (*Sebastes alutus*), Arrowtooth Flounder (*Atheresthes stomias*), Silvergray Rockfish (*Sebastes brevispinis*), Pacific Hake (*Merluccius productus*), Yellowmouth Rockfish (*Sebastes reedi*), and North Pacific Spiny Dogfish (*Squalus suckleyi*). The number of tows where the species was captured and total catch weight from usable tows as well as the estimated biomass and relative survey error for the 25 most abundant species are shown in Table 5. Biological data, including individual length, weight, sex, maturity, and age structure were collected from a total of 40,109 individual fish of 48 different species (Table 6). Oceanographic data, including water temperature, depth, salinity, and dissolved oxygen were also recorded for most tows.

Table 4. 2019 Queen Charlotte Sound Multi-species Synoptic Bottom Trawl Survey final block summary showing the number of blocks rejected based on fishing master's knowledge or by on-ground inspection, number of failed blocks (due to hang-ups or insufficient bottom time), number of successful tows, and number of un-fished blocks (due to other reasons such as tide, weather, or other vessels in the area) by stratum.

Depth Stratum (m)	Rejected Prior	Rejected Inspected	Failed	Success	Not Assessed	Total
South 50 to 125 m	1	1	2	35	0	39
South 125 to 200 m	0	6	5	62	0	73
South 200 to 330 m	0	5	2	26	0	33
South 330 to 500 m	0	1	0	9	0	10
North 50 to 125 m	0	4	1	15	1	21
North 125 to 200 m	0	5	3	52	2	62
North 200 to 330 m	4	4	4	35	1	48
North 330 to 500 m	0	0	0	8	0	8
Total	**5**	**26**	**17**	**242**	**4**	**294**

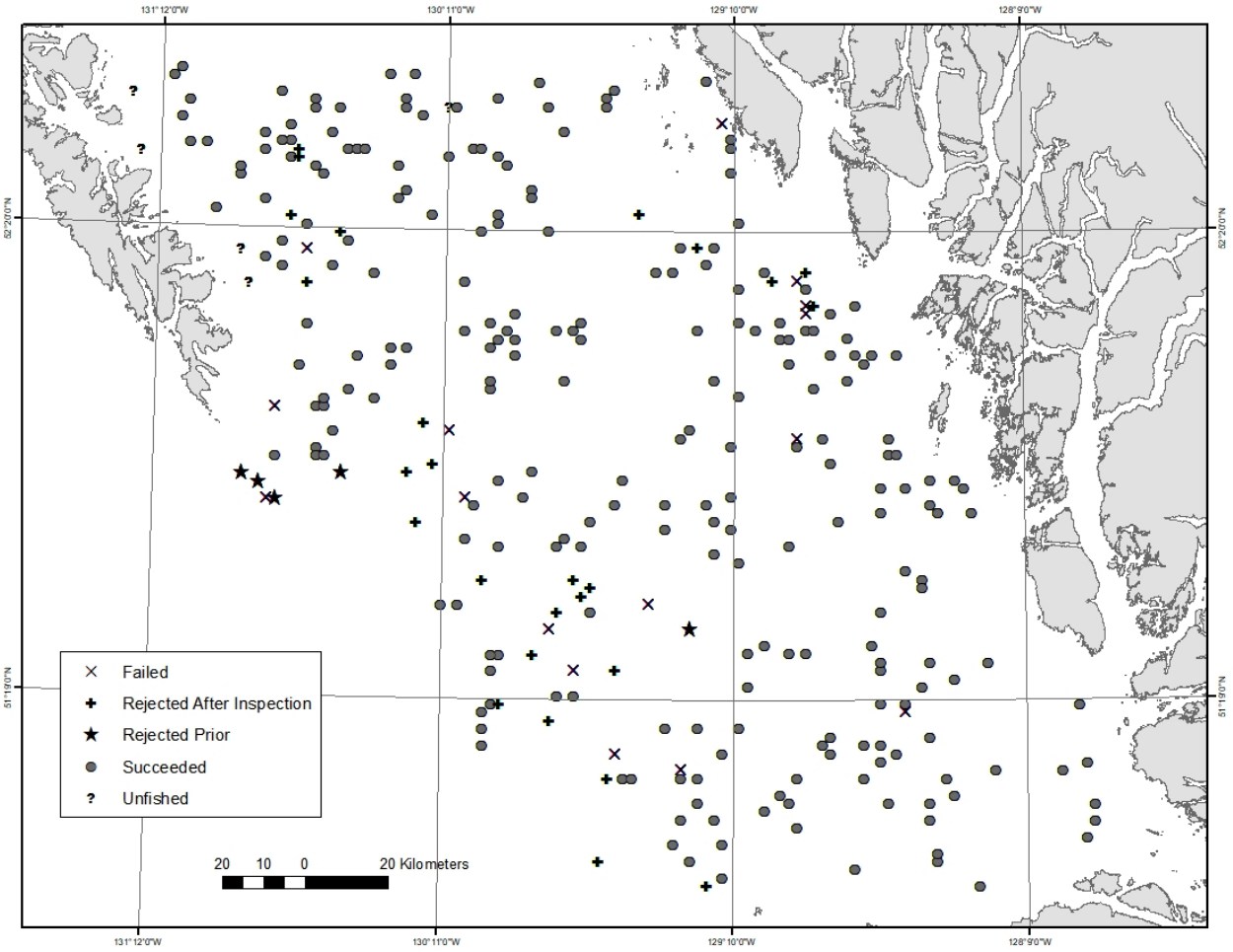

Figure 15. Final status of the allocated blocks for the 2019 Queen Charlotte Sound Multi-species Synoptic Bottom Trawl Survey.

Table 5. Number of catches and total catch weight from usable tows, estimated biomass, and relative survey error for the top 25 species (by weight) captured in the 2019 Queen Charlotte Sound Multi-species Synoptic Bottom Trawl Survey.

Species	Scientific Name	Number of Tows	Catch (kg)	Biomass (t)	Relative Error
Sablefish	*Anoplopoma fimbria*	178	20610	15233	0.28
Pacific Ocean Perch	*Sebastes alutus*	163	18949	15111	0.16
Arrowtooth Flounder	*Atheresthes stomias*	215	16018	12167	0.15
Silvergray Rockfish	*Sebastes brevispinis*	166	12877	10192	0.18
Pacific Hake	*Merluccius productus*	124	11761	9264	0.22
Yellowmouth Rockfish	*Sebastes reedi*	62	7146	5401	0.69
North Pacific Spiny Dogfish	*Squalus suckleyi*	99	7122	12167	0.91
Redstripe Rockfish	*Sebastes proriger*	68	4828	3482	0.23
Splitnose Rockfish	*Sebastes diploproa*	44	4524	3376	0.46
Rex Sole	*Glyptocephalus zachirus*	219	4430	3494	0.1
Canary Rockfish	*Sebastes pinniger*	52	3784	2924	0.53
Walleye Pollock	*Gadus chalcogrammus*	156	3610	2959	0.26
Yellowtail Rockfish	*Sebastes flavidus*	67	3471	2407	0.38
Redbanded Rockfish	*Sebastes babcocki*	113	3206	2531	0.48
Dover Sole	*Microstomus pacificus*	201	2843	2188	0.12
Bocaccio	*Sebastes paucispinis*	107	2412	1671	0.4
English Sole	*Parophrys vetulus*	117	2288	2306	0.2
Flathead Sole	*Hippoglossoides elassodon*	136	2137	1737	0.16
Shortspine Thornyhead	*Sebastolobus alascanus*	75	1606	1250	0.12
Spotted Ratfish	*Hydrolagus colliei*	229	1556	1352	0.12
Petrale Sole	*Eopsetta jordani*	134	1306	1082	0.14
Pacific Cod	*Gadus macrocephalus*	113	1300	1004	0.13
Lingcod	*Ophiodon elongatus*	126	1298	1128	0.15
Shortbelly Rockfish	*Sebastes jordani*	42	1220	1315	0.53
Rougheye/Blackspotted Rockfish Complex	*Sebastes aleutianus/melanostictus* complex	64	1160	733	0.24

Table 6. Number of fish sampled for biological data during the 2019 Queen Charlotte Sound Multi-species Synoptic Bottom Trawl Survey showing the number of lengths and age structures that were collected by species.

Species	Scientific Name	Lengths Collected	Age Structures Collected	DNA Tissue Collected
Alaska Skate	*Bathyraja parmifera*	1	0	0
Arrowtooth Flounder	*Atheresthes stomias*	3991	657	0
Big Skate	*Beringraja binoculata*	33	0	0
Bocaccio	*Sebastes paucispinis*	830	720	270
Brown Cat Shark	*Apristurus brunneus*	8	0	0
Canary Rockfish	*Sebastes pinniger*	492	313	0
Curlfin Sole	*Pleuronichthys decurrens*	190	160	0
Darkblotched Rockfish	*Sebastes crameri*	157	0	0
Dover Sole	*Microstomus pacificus*	2073	527	0
English Sole	*Parophrys vetulus*	1289	550	0
Eulachon	*Thaleichthys pacificus*	415	0	75
Flathead Sole	*Hippoglossoides elassodon*	1675	0	0
Greenstriped Rockfish	*Sebastes elongatus*	525	196	0
Lingcod	*Ophiodon elongatus*	603	445	0
Longnose Skate	*Raja rhina*	154	0	0
Longspine Thornyhead	*Sebastolobus altivelis*	144	109	0
North Pacific Spiny Dogfish	*Squalus suckleyi*	210	0	0
Pacific Cod	*Gadus macrocephalus*	943	639	0
Pacific Hake	*Merluccius productus*	1748	464	0
Pacific Halibut	*Hippoglossus stenolepis*	209	0	0
Pacific Ocean Perch	*Sebastes alutus*	3176	1236	0
Pacific Sanddab	*Citharichthys sordidus*	1069	0	0
Pacific Tomcod	*Microgadus proximus*	99	0	0
Petrale Sole	*Eopsetta jordani*	1145	638	0
Pygmy Rockfish	*Sebastes wilsoni*	24	0	0
Quillback Rockfish	*Sebastes maliger*	177	99	0
Redbanded Rockfish	*Sebastes babcocki*	790	583	0
Redstripe Rockfish	*Sebastes proriger*	1475	545	0
Rex Sole	*Glyptocephalus zachirus*	4067	158	0
Rosethorn Rockfish	*Sebastes helvomaculatus*	165	0	0
Rougheye/Blackspotted Rockfish Complex	*Sebastes aleutianus/melanostictus* complex	565	565	556
Roughtail Skate	*Bathyraja trachura*	1	0	0
Sablefish	*Anoplopoma fimbria*	2128	735	0
Sandpaper Skate	*Bathyraja interrupta*	52	0	0
Sharpchin Rockfish	*Sebastes zacentrus*	505	0	0
Shortbelly Rockfish	*Sebastes jordani*	297	125	0
Shortraker Rockfish	*Sebastes borealis*	26	26	0
Shortspine Thornyhead	*Sebastolobus alascanus*	1569	273	0
Silvergray Rockfish	*Sebastes brevispinis*	1932	1167	0
Slender Sole	*Lyopsetta exilis*	827	0	0
Southern Rock Sole	*Lepidopsetta bilineata*	690	397	0
Splitnose Rockfish	*Sebastes diploproa*	349	0	0
Spotted Ratfish	*Hydrolagus colliei*	742	0	0
Walleye Pollock	*Gadus chalcogrammus*	1296	0	0
Widow Rockfish	*Sebastes entomelas*	63	56	0
Yelloweye Rockfish	*Sebastes ruberrimus*	103	103	101
Yellowmouth Rockfish	*Sebastes reedi*	555	228	0
Yellowtail Rockfish	*Sebastes flavidus*	532	77	0

Hard Bottom Longline Hook Surveys

The Hard Bottom Longline Hook survey program is designed to provide hook by hook species composition and catch rates for all species available to longline hook gear from 20 to 260 m depth. The program is intended to cover areas that are not covered by the synoptic bottom trawl surveys with a focus on inshore rockfish species habitat. The goal of the survey is to provide relative abundance indices for commonly caught species, distributional and occurrence data for all other species, and detailed biological data for inshore rockfish population studies. These data are incorporated into stock assessments, status reports, and research publications.

The Hard Bottom Longline Hook program includes a survey of outside waters funded by the Pacific Halibut Management Association of BC (PHMA) and a survey of inside waters funded by DFO. Each year, approximately half of each survey area is covered and alternates between northern and southern regions year to year.

The “outside” area covers the entire British Columbia coast excluding inlets and the protected waters east of Vancouver Island. The “outside” area was intended to include “hard” bottom areas not covered by the synoptic bottom trawl surveys and was selected by including 95% of all Quillback and Yelloweye rockfish catches reported from the commercial Halibut and rockfish fisheries from 1996 to 2005. The northern region of the outside survey area includes the mainland coast north of Milbanke Sound, Dixon Entrance, and both sides of Haida Gwaii while the southern region includes the mainland coast south of Milbanke Sound, Queen Charlotte Sound, and the north and west coasts of Vancouver Island. The northern region of the outside area was surveyed during even numbered years from 2006 to 2012 and the southern region was surveyed in odd years from 2007 to 2011. The survey had a one year hiatus in 2013 but resumed in 2014 in the southern region. The current schedule is to survey the northern region in odd numbered years and the southern region in even numbered years.

The “inside” area includes waters east of Vancouver Island. The northern region of the inside area includes Johnstone Strait and the Broughton Archipelago while the southern region includes Desolation Sound, the Strait of Georgia and the southern Gulf Islands. The survey has been conducted annually since 2003 excluding 2006. Currently the northern region is surveyed in odd numbered years while the southern region is surveyed in even numbered years.

The Hard Bottom Longline Hook surveys follow a random depth-stratified design using standardized “snap and swivel” longline hook gear with prescribed fishing protocols including bait, soak time and set locations within the selected blocks. Hard bottom regions within each survey were identified through bathymetry analyses, inshore rockfish fishing records and fishermen consultations. Each survey area is divided into 2 km by 2 km blocks and each block is assigned a depth stratum based on the average bottom depth within the block. The three depth strata for the outside area are 20 to 70 meters, 71 to 150 meters, and 151 to 260 meters. Suitable hard bottom regions in the Strait of Georgia and Johnstone Strait are more limited so the depth strata for the inside area are 20 to 70 meters and 71 to 100 meters.

Both Hard Bottom Longline surveys include detailed hook by hook enumeration of the catch. Up until the 2018 survey, the DFO Inside survey also recorded catch weights. In 2019, the recording of catch weights was suspended in favour of more detailed biological sampling. The catch rate indices from both surveys are calculated using the hook by hook data only so not recording catch weights had no impact on the main goal of the survey. Further, by not spending

time and effort weighing the catch, it was possible to incorporate gut contents analysis as part of the biological sampling.

In 2019 the northern region of the outside area and the both the northern and part of the southern region of the inside area were surveyed.

Outside (Pacific Halibut Management Association, PHMA) Survey

The 2019 Outside Hard Bottom Longline Hook Survey was conducted in the northern region but at the time of writing, the data are not yet finalized and so have not been included in this report.

Inside (DFO) Survey

The Inside Hard Bottom Longline Hook Survey was conducted in both the northern and southern regions of the inside area on board the Canadian Coast Guard vessel Neocaligus from July 26 to August 26, 2019. The original schedule for this survey would have just been for the northern region. However, in 2018, we were not able to visit all the selected blocks due to crewing limitations and vessel mechanical issues. As a result, the 2019 survey included additional days to allow time to visit the sites that were missed in 2018. In addition, the 2019 survey included pilot work comparing the standard Hard Bottom Longline survey fishing gear with the standard Strait of Georgia Dogfish Longline survey fishing gear. For this report, which is focused on summarizing general survey activities, the results from all sets in all regions have been combined.

A total of 80 sets were completed including 9 random blocks in the southern region, 71 random blocks in the northern region, and 19 sets in the Strait of Georgia Dogfish Longline sites (Figure 7). The total catch of the survey was 8,234 pieces (Table 7), averaging four different species of fish and invertebrates per set. The most abundant fish species encountered were North Pacific Spiny Dogfish (*Squalus suckleyi*), Quillback Rockfish (*Sebastes maliger*), Yelloweye Rockfish (*Sebastes ruberrimus*), Spotted Ratfish (*Hydrolagus colliei*), and Lingcod (*Ophiodon elongatus*). The number of sets where the species was captured as well as the total catch count and proportion of the total catch of all fish species are shown in Table 8. An annual summary of catch by species in each region is shown in Table 9. Biological data, including individual length, weight, sex, maturity, and age structure were collected from a total of 7872 individual fish of 23 different species (Table 10). An annual summary of the number of fish sampled for biological data in each region is shown in Table 11.

One vertical CTD (conductivity, temperature, and depth recorder) cast was made at as many of the selected blocks as possible during the 2019 Inside Hard Bottom Longline Hook Survey. The CTD also included a dissolved oxygen sensor. In addition, temperature depth recorders were deployed at the start, middle, and end of every fishing set.

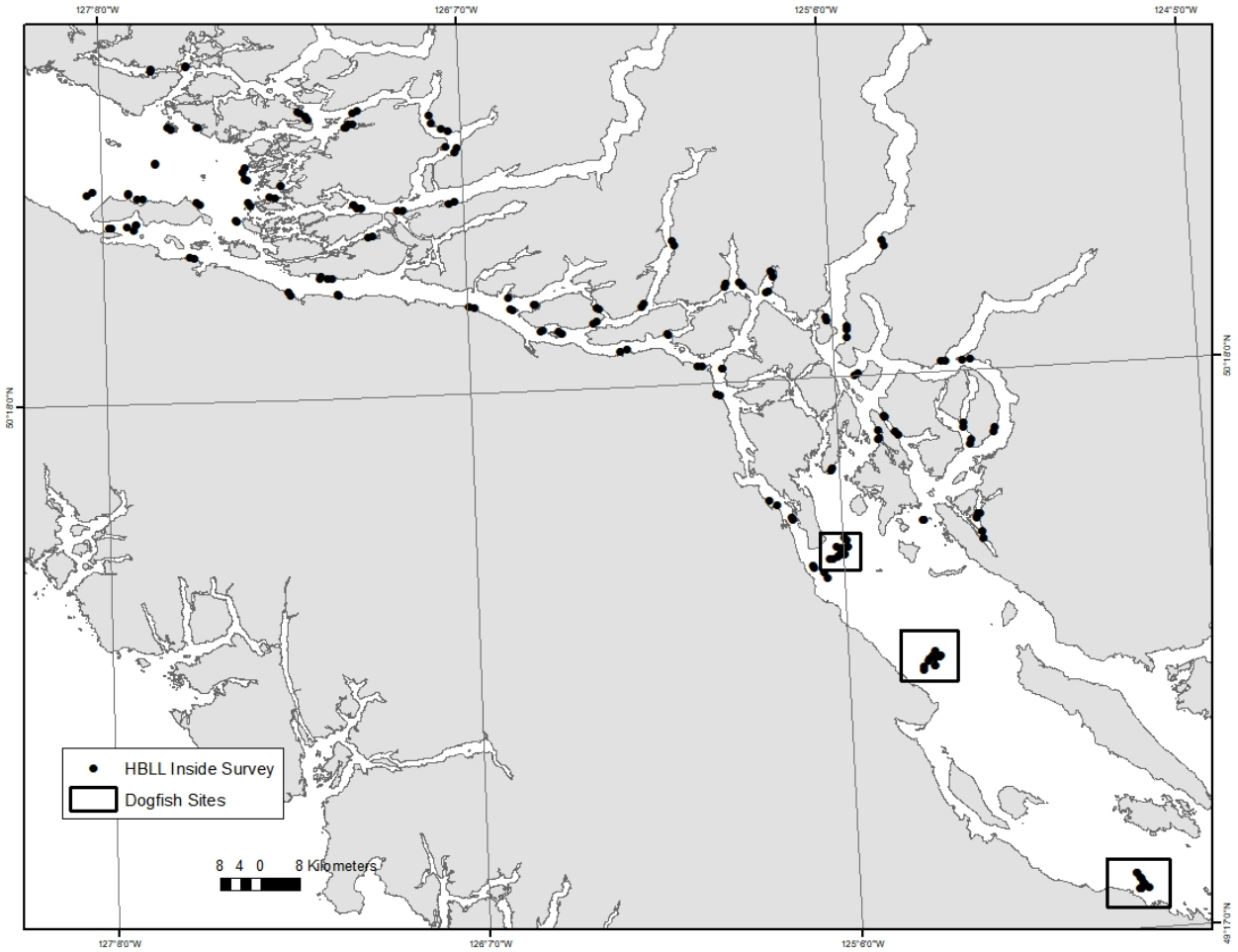

Figure 16. Longline set locations of the 2019 Inside Hard Bottom Longline Hook Survey. The boxes represent the Strait of Georgia Dogfish Longline survey sites that were visited as part of a pilot study to compare gear types and fishing protocols.

Table 7. Total catch, showing piece count by species for the 2019 Inside Hard Bottom Longline Hook Survey.

Species	Scientific Name	Total Catch (count)
North Pacific Spiny Dogfish	*Squalus suckleyi*	6994
Quillback Rockfish	*Sebastes maliger*	439
Yelloweye Rockfish	*Sebastes ruberrimus*	257
Spotted Ratfish	*Hydrolagus colliei*	84
Lingcod	*Ophiodon elongatus*	76
Sablefish	*Anoplopoma fimbria*	63
Longnose Skate	*Raja rhina*	43
Pacific Halibut	*Hippoglossus stenolepis*	28
Pacific Cod	*Gadus macrocephalus*	23
Cabezon	*Scorpaenichthys marmoratus*	22
Greenstriped Rockfish	*Sebastes elongatus*	11
Canary Rockfish	*Sebastes pinniger*	10
Copper Rockfish	*Sebastes caurinus*	10
Red Irish Lord	*Hemilepidotus hemilepidotus*	9
Big Skate	*Beringraja binoculata*	8
Pacific Sanddab	*Citharichthys sordidus*	3
Great Sculpin	*Myoxocephalus polyacanthocephalus*	2
Pacific Staghorn Sculpin	*Leptocottus armatus*	2
Tiger Rockfish	*Sebastes nigrocinctus*	2
Yellowtail Rockfish	*Sebastes flavidus*	2
Pacific Hake	*Merluccius productus*	2
Southern Rock Sole	*Lepidopsetta bilineata*	1
Flatfishes	Pleuronectiformes	1
Buffalo Sculpin	*Enophrys bison*	1
Brown Cat Shark	*Apristurus brunneus*	1
Sunflower Starfish	*Pycnopodia helianthoides*	31
Sponges	Porifera	21
Inanimate Object(s)	Inanimate object(s)	21
Tube Worms	Sedentaria	12
Red Rock Crab	*Cancer productus*	9
Fish-eating Star	*Stylasterias forreri*	6
Long-armed Sea Star	*Orthasterias koehleri*	5
Starfish	Asteroidea	4
Giant Pacific Octopus	*Enteroctopus dofleini*	3
Scallop	Pectinidae	3
	Luidia	3
Anemone	Actiniaria	3
	Solaster	2
Rose Starfish	*Crossaster papposus*	2
	Halipteris	2
Lampshells	Brachiopoda	2
Mussel	Anodonta	2
True Crabs	Brachyura	1
Box Crabs	Lopholithodes	1
Sea Urchins	Echinacea	1
Pink Short-spined Star	*Pisaster brevispinus*	1
	Evasterias	1
Sea Pen	*Ptilosarcus gurneyi*	1
Sea Whip	*Balticina septentrionalis*	1
	Ceriantharia	1
	Metridium	1

Table 8. Number of sets, catch (piece count), and proportion of the total fish catch for fish species caught during the 2019 DFO Hard Bottom Longline Hook Survey.

Species	Number of Sets	Catch (count)	Proportion of Total Catch (%)
North Pacific Spiny Dogfish	92	6994	86.41
Quillback Rockfish	63	439	5.42
Yelloweye Rockfish	38	257	3.18
Spotted Ratfish	30	84	1.04
Lingcod	33	76	0.94
Sablefish	12	63	0.78
Longnose Skate	23	43	0.53
Pacific Halibut	10	28	0.35
Pacific Cod	6	23	0.28
Cabezon	3	22	0.27
Greenstriped Rockfish	5	11	0.14
Copper Rockfish	6	10	0.12
Canary Rockfish	2	10	0.12
Red Irish Lord	4	9	0.11
Big Skate	3	8	0.10
Pacific Sanddab	2	3	0.04
Pacific Staghorn Sculpin	2	2	0.02
Pacific Hake	2	2	0.02
Great Sculpin	2	2	0.02
Yellowtail Rockfish	2	2	0.02
Tiger Rockfish	2	2	0.02
Southern Rock Sole	1	1	0.01
Flatfishes	1	1	0.01
Buffalo Sculpin	1	1	0.01
Brown Cat Shark	1	1	0.01

Table 9. Annual summary by region of the total catch (piece count) for the top 15 species (by total piece count over all years) for the Inside Hard Bottom Longline Survey.

Species	2003	2004	2005	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2019	Total
Northern Region																
North Pacific Spiny Dogfish	3858	3076	154	2803	1694		2716		2749		3004		2290		3921	26265
Quillback Rockfish	308	275	2	380	60		441		757		526		570		415	3734
Spotted Ratfish	395	336	0	462	8		267		353		142		242		82	2287
Yelloweye Rockfish	135	118	2	66	32		156		170		156		246		195	1276
Sablefish	77	37	0	20	0		26		47		14		137		59	417
Lingcod	22	16	0	20	3		65		75		45		90		71	407
Pacific Halibut	38	16	0	54	3		27		62		79		41		28	348
Pacific Cod	49	20	0	47	0		26		32		22		11		23	230
Longnose Skate	33	14	0	22	5		33		17		8		19		26	177
Greenstriped Rockfish	17	23	0	31	0		10		23		7		13		11	135
Red Irish Lord	2	13	0	66	2		7		25		3		0		9	127
Copper Rockfish	12	1	0	2	4		11		25		10		16		10	91
Pacific Sanddab	32	1	0	1	0		9		21		3		1		3	71
Canary Rockfish	2	6	0	2	1		0		8		17		7		10	53
Cabezon	2	0	0	0	0		2		5		7		0		22	38
Southern Region																
North Pacific Spiny Dogfish	203		8267		3320	2631		5744		5615		5283		5302	564	36929
Yelloweye Rockfish	1		144		127	10		266		223		209		55	47	1082
Quillback Rockfish	3		116		84	27		297		199		154		88	19	987
Copper Rockfish	0		22		34	11		21		21		64		37	0	210
Lingcod	0		36		24	2		17		22		28		60	5	194
Longnose Skate	0		9		10	2		17		13		48		53	0	152
Pacific Cod	0		2		15	8		33		17		33		6	0	114
Canary Rockfish	0		7		2	0		14		14		25		26	0	88
Big Skate	0		3		1	1		1		13		29		23	0	71
Spotted Ratfish	3		12		8	0		4		5		11		11	0	54
Pacific Sanddab	0		10		5	6		3		8		11		2	0	45
Greenstriped Rockfish	0		6		3	3		16		11		3		2	0	44
Southern Rock Sole	0		3		4	1		8		2		6		5	0	29
Cabezon	0		7		2	2		2		2		7		3	0	25
Red Irish Lord	0		2		0	1		1		7		6		0	0	17

Table 10. Number of fish sampled for biological data during the 2019 Inside Hard Bottom Longline Hook survey showing the number of lengths, age structures, and DNA tissue samples that were collected by species.

Species	Scientific Name	Lengths Collected	Age Structures Collected	DNA Tissue Collected
Big Skate	*Beringraja binoculata*	4	0	0
Brown Cat Shark	*Apristurus brunneus*	1	0	0
Buffalo Sculpin	*Enophrys bison*	1	0	0
Cabezon	*Scorpaenichthys marmoratus*	22	0	0
Canary Rockfish	*Sebastes pinniger*	10	0	10
Copper Rockfish	*Sebastes caurinus*	10	10	14
Great Sculpin	*Myoxocephalus polyacanthocephalus*	2	0	0
Greenstriped Rockfish	*Sebastes elongatus*	9	0	0
Lingcod	*Ophiodon elongatus*	64	64	0
Longnose Skate	*Raja rhina*	42	0	0
North Pacific Spiny Dogfish	*Squalus suckleyi*	6845	0	0
Pacific Cod	*Gadus macrocephalus*	20	0	0
Pacific Halibut	*Hippoglossus stenolepis*	23	0	0
Pacific Sanddab	*Citharichthys sordidus*	3	0	0
Pacific Staghorn Sculpin	*Leptocottus armatus*	1	0	0
Quillback Rockfish	*Sebastes maliger*	423	424	10
Red Irish Lord	*Hemilepidotus hemilepidotus*	9	0	0
Sablefish	*Anoplopoma fimbria*	52	28	0
Southern Rock Sole	*Lepidopsetta bilineata*	1	0	0
Spotted Ratfish	*Hydrolagus colliei*	71	0	0
Tiger Rockfish	*Sebastes nigrocinctus*	2	2	2
Yelloweye Rockfish	*Sebastes ruberrimus*	255	252	251
Yellowtail Rockfish	*Sebastes flavidus*	2	0	0

Table 11. Annual summary by region of the number of fish sampled for biological data during the Inside Hard Bottom Longline Survey.

Species	2003	2004	2005	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2018	2019	Total
Northern Region																
North Pacific Spiny Dogfish	3007	2068	89	2724	1686	0	2701	0	2747	0	3195	0	2289	0	3834	24340
Quillback Rockfish	295	264	2	372	61	0	438	0	744	0	520	0	568	0	399	3663
Spotted Ratfish	330	268	0	407	6	0	255	0	339	0	135	0	283	0	70	2093
Yelloweye Rockfish	133	117	2	65	31	0	153	0	169	0	156	0	235	0	193	1254
Sablefish	72	37	0	21	0	0	24	0	47	0	13	0	133	0	48	395
Lingcod	21	15	0	20	2	0	64	0	75	0	45	0	89	0	59	390
Pacific Halibut	32	13	0	1	2	0	26	0	62	0	79	0	37	0	23	275
Pacific Cod	32	16	0	42	0	0	25	0	27	0	18	0	9	0	20	189
Longnose Skate	30	9	0	12	0	0	33	0	15	0	8	0	18	0	26	151
Greenstriped Rockfish	15	19	0	27	0	0	9	0	18	0	7	0	13	0	9	117
Copper Rockfish	12	1	0	2	4	0	11	0	25	0	10	0	16	0	10	91
Pacific Sanddab	23	1	0	0	0	0	8	0	20	0	1	0	1	0	3	57
Canary Rockfish	2	6	0	2	1	0	0	0	8	0	17	0	7	0	10	53
Red Irish Lord	2	13	0	0	1	0	1	0	21	0	3	0	0	0	9	50
Cabezon	0	0	0	0	0	0	2	0	2	0	7	0	0	0	22	33
Arrowtooth Flounder	0	0	0	1	0	0	8	0	8	0	13	0	0	0	0	30
Big Skate	7	3	0	1	0	0	3	0	0	0	1	0	7	0	4	26
Tiger Rockfish	3	1	0	1	2	0	2	0	11	0	1	0	2	0	2	25
Yellowtail Rockfish	2	6	0	4	0	0	3	0	1	0	5	0	2	0	1	24
Southern Rock Sole	0	3	0	0	0	0	6	0	10	0	1	0	1	0	1	22
Great Sculpin	0	0	0	0	0	0	3	0	6	0	3	0	2	0	2	16
Kelp Greenling	0	1	0	1	0	0	3	0	4	0	0	0	6	0	0	15
Silvergray Rockfish	0	1	0	0	0	0	8	0	3	0	0	0	0	0	0	12
Pacific Staghorn Sculpin	0	0	0	0	0	0	1	0	2	0	1	0	1	0	1	6
Buffalo Sculpin	0	0	0	0	0	0	0	0	5	0	0	0	0	0	1	6
Brown Irish Lord	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Redstripe Rockfish	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	3
Northern Ronquil	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Sharpchin Rockfish	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Flathead Sole	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Petrale Sole	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1

Table 11. Continued.

Species	2003	2004	2005	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2018	2019	Total
Southern Region																
North Pacific Spiny Dogfish	136	0	4146	0	3303	1156	0	5720	0	5770	0	5274	0	5300	544	31349
Yelloweye Rockfish	1	0	138	0	127	10	0	264	0	222	0	205	0	55	47	1069
Quillback Rockfish	3	0	109	0	77	27	0	290	0	195	0	147	0	83	19	950
Copper Rockfish	0	0	22	0	32	10	0	19	0	20	0	64	0	30	0	197
Lingcod	0	0	33	0	23	2	0	17	0	20	0	28	0	60	5	188
Longnose Skate	0	0	7	0	0	1	0	16	0	13	0	47	0	52	0	136
Canary Rockfish	0	0	7	0	2	0	0	12	0	14	0	25	0	22	0	82
Pacific Cod	0	0	0	0	9	2	0	15	0	17	0	24	0	1	0	68
Big Skate	0	0	3	0	0	1	0	1	0	13	0	27	0	22	0	67
Spotted Ratfish	1	0	3	0	3	0	0	4	0	4	0	6	0	11	0	32
Greenstriped Rockfish	0	0	5	0	3	3	0	4	0	10	0	2	0	0	0	27
Southern Rock Sole	0	0	3	0	3	0	0	6	0	2	0	5	0	4	0	23
Cabezon	0	0	7	0	0	0	0	1	0	2	0	7	0	3	0	20
Pacific Sanddab	0	0	6	0	0	0	0	1	0	2	0	3	0	2	0	14
Red Irish Lord	0	0	2	0	0	0	0	0	0	5	0	6	0	0	0	13
Tiger Rockfish	0	0	7	0	0	0	0	1	0	0	0	0	0	0	0	8
Kelp Greenling	0	0	0	0	1	0	0	0	0	1	0	2	0	1	0	5
Pacific Halibut	0	0	0	0	0	0	0	0	0	3	0	2	0	0	0	5
Silvergray Rockfish	0	0	0	0	2	0	0	0	0	2	0	0	0	0	0	4
Walleye Pollock	0	0	0	0	0	0	0	1	0	0	0	2	0	0	0	3
Yellowtail Rockfish	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	3
Wolf Eel	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Vermilion Rockfish	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Petrale Sole	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Redstripe Rockfish	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Sablefish	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
Sandpaper Skate	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Sculpins	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1

Sablefish Research and Assessment Survey

Fisheries and Oceans Canada, in collaboration with the commercial sablefish industry, initiated an annual research and assessment survey of British Columbia Sablefish in 1988. Each year, fishing is conducted at selected localities using trap gear consistent with the commercial fishery. The fishing protocol was refined over the first few years of the survey and was standardized beginning in 1990. These standardized sets were intended to track trends in abundance and biological characteristics at the survey localities. We now refer to these sets as the “Traditional Standardized Program”. Sablefish from standardized sets were tagged and released beginning in 1991. Then, in 1994, sets with the sole purpose of capturing Sablefish for tag and release were added at the existing localities. We now refer to these sets as the “Traditional Tagging Program”. Also in 1994, sets were made in selected mainland inlet localities. In 1995, additional offshore localities were added specifically for tagging sets. The Traditional Tagging Program has not been conducted since 2007 and the Traditional Standardized Program has not been conducted since 2010.

A pilot stratified random design was introduced for the 2003 survey with the dual purposes of random release of tagged fish and development of a second stock abundance index. The offshore survey area was divided into five spatial strata (Figure 8). Each spatial stratum was further divided into 2 km by 2 km blocks and each block was assigned to one of three depth strata. Each year, blocks are randomly selected within each combination of spatial and depth strata. From 2003 through 2010, the selected blocks were allocated equally among the strata. An analysis was conducted for the 2011 survey to estimate the optimal allocation of blocks and that allocation was used in both 2011 and 2012. In 2013 the number of blocks in the survey was reduced in an effort to reduce the overall cost of the survey. The allocation from 2013 has been used for all subsequent surveys.

The 2019 Sablefish Research and Assessment Survey was comprised of two main components:

A **Randomized Tagging Program** that releases tagged Sablefish at randomly selected fishing locations in offshore waters. These sets also produce a time series of catch rate and biological data that can be used for assessing changes in stock abundance.

An **Inlets Program** that releases tagged Sablefish from fixed-stations at four mainland inlet localities (Figure 9). These sets also provide a time series of catch rate and biological data that can be used for assessing changes in stock abundance.

In addition to the main survey programs, the Sablefish Research and Assessment Survey included a Bottom Contact Research Project to investigate gear interaction with the substrate. Trap-mounted accelerometers recorded motion and orientation of the traps while oceanographic data from trap-mounted recorders collected temperature, depth, and salinity. The autonomous, trap-mounted cameras used in recent years were not deployed in 2019.

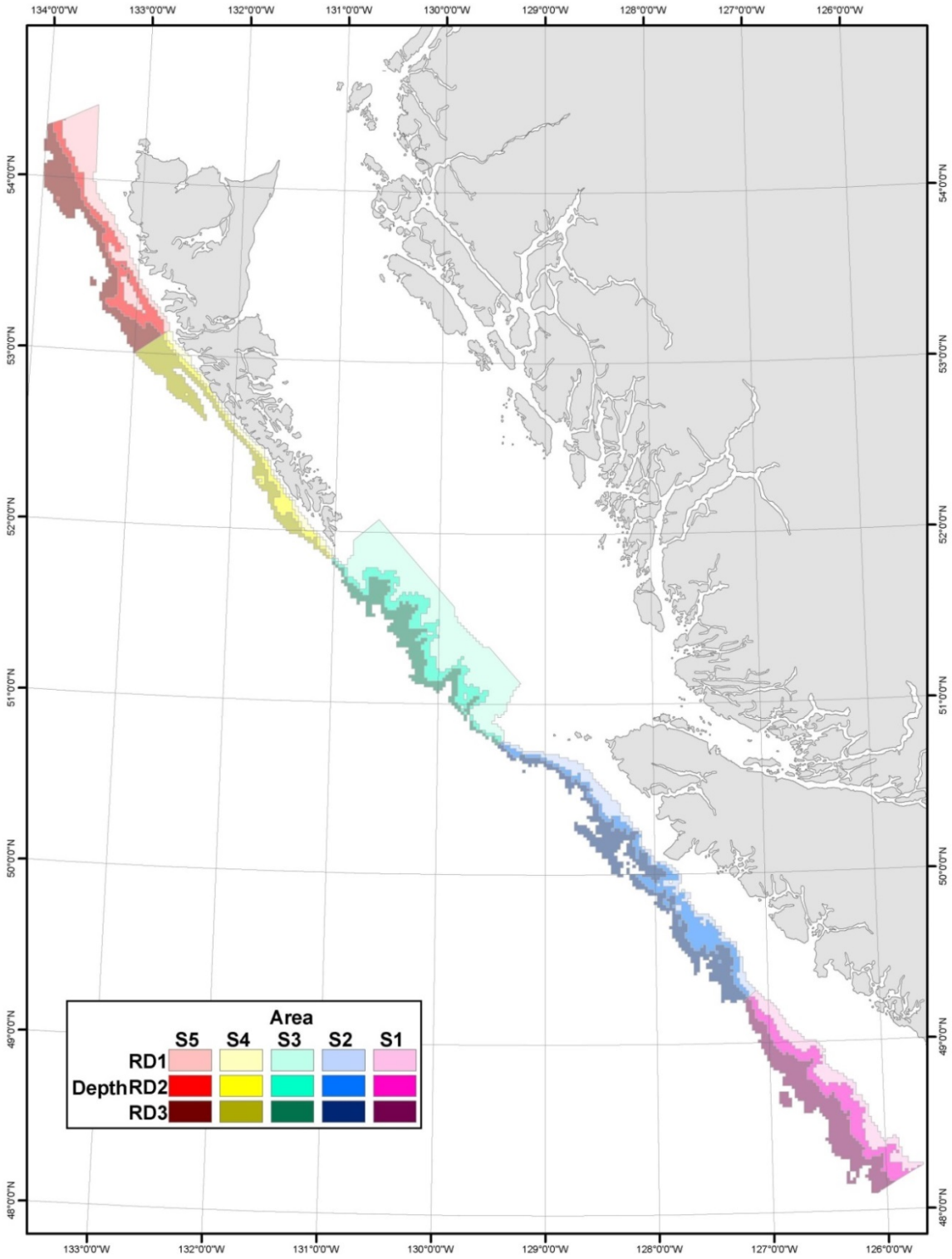

Figure 17. Sablefish Research and Assessment Survey randomized tagging program design showing the boundaries of each of the spatial and depth strata.

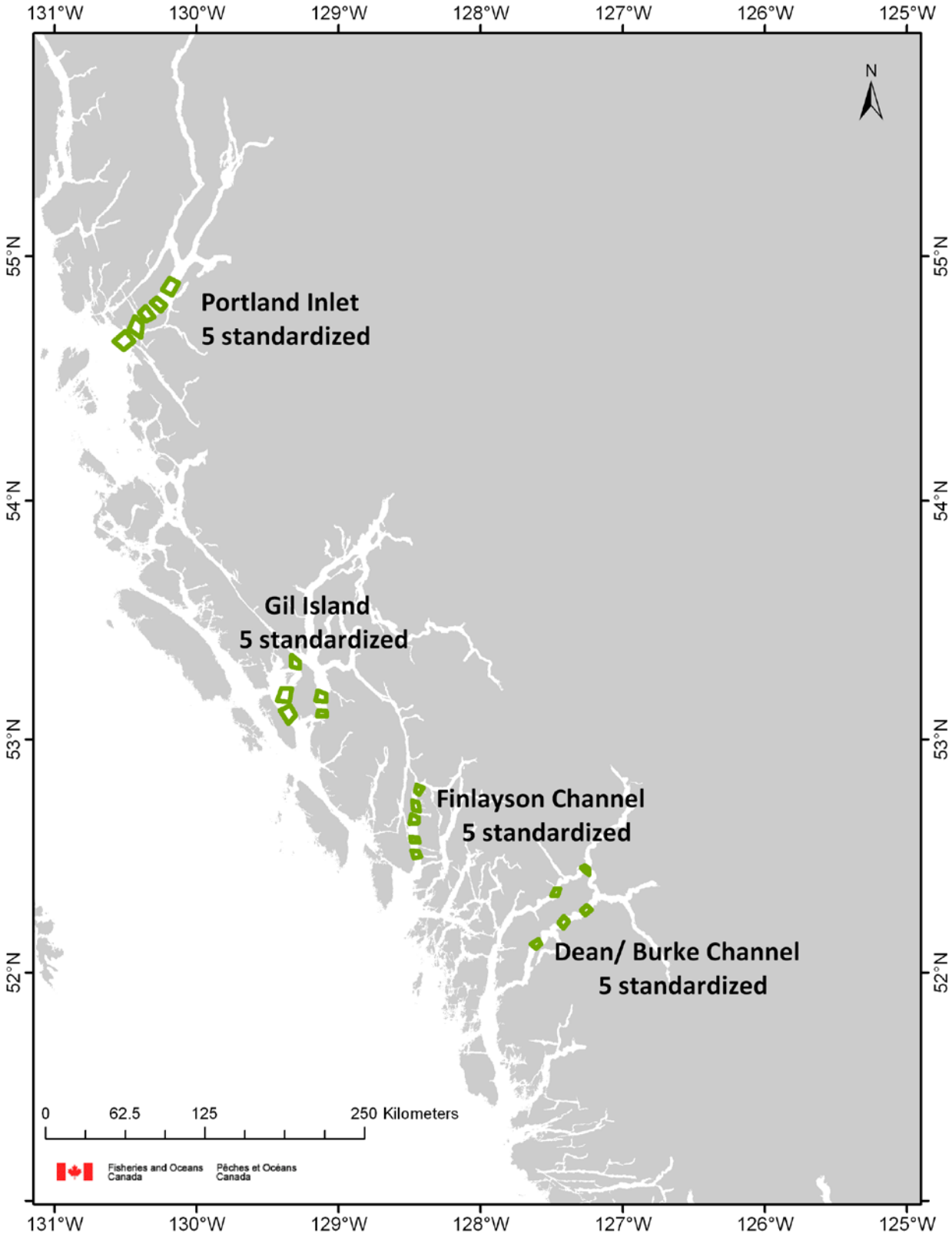

Figure 18. Sablefish Research and Assessment Survey Inlets program locations.

The 2019 Sablefish Research and Assessment Survey was conducted on the Pacific Viking from October 8 to November 25, 2019. A total of 109 sets were completed (Figure 10) including 89 Randomized Tagging Program sets (Table 12) and 20 Inlets Program sets (Table 13).

The total catch of the survey was 148,830 kg (Table 14) and the average catch per set was 1365 kg. The most abundant fish species encountered by weight were Sablefish (*Anoplopoma fimbria*), followed by Pacific Halibut (*Hippoglossus stenolepis*), Lingcod (*Ophiodon elongatus*), North Pacific Spiny Dogfish (*Squalus suckleyi*), and the Rougheye/ Blackspotted Rockfish Complex (*Sebastes aleutianus/ melanostictus*). The number of sets where the species was captured as well as the total catch count, proportion of the total catch, and a breakdown by area for the 25 most abundant species captured during the Randomized Tagging Program are shown in Table 15. Annual summaries of catch for common species are shown for the Randomized Tagging Program in Table 16 and in Table 17 for the Inlet Program. Biological data, including individual length, weight, sex, maturity, and age structure were collected from a total of 18,188 individual fish of 6 different species (Table 18). An annual summary of the number of fish sampled for biological data during the Randomized Tagging Program is shown in Table 19 and in Table 20 for the Inlets Program.

Table 12. Summary of sets completed during the 2019 Sablefish Randomized Tagging Program showing the number of sets in each combination of spatial and depth strata.

Spatial Strata	**Depth Strata**			
	RD1 (100-250 fm)	RD2 (250-450 fm)	RD3 (450-750)	**Total**
S1 (South West Coast Vancouver Island or SWCVI)	6	8	5	19
S2 (North West Coast Vancouver Island or NWCVI)	6	7	5	18
S3 (Queen Charlotte Sound or QCS)	8	6	5	19
S4 (South West Coast Haida Gwaii or SWCHG)	6	7	4	17
S5 (North West Coast Haida Gwaii or NWCHG)	5	7	4	16
Total	**31**	**35**	**223**	**89**

Table 13. Summary of sets completed during the 2019 Sablefish Inlets Program.

Location	**Number of sets**
Dean/Burke Channel	5
Finlayson Channel	5
Gil Island	5
Portland Inlet	5

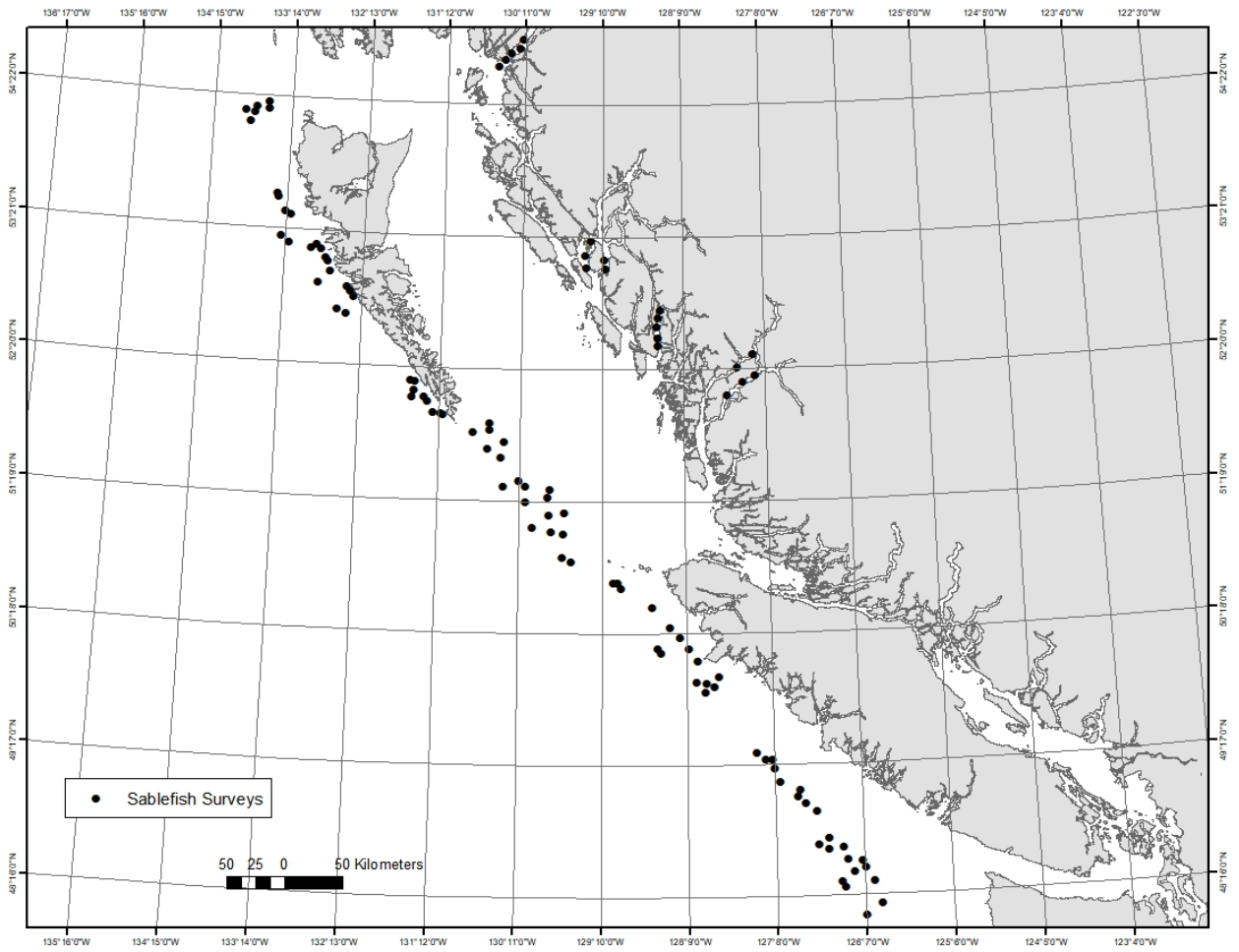

Figure 19. Set locations of the 2019 Sablefish Research and Assessment Survey.

Table 14. Total catch for the top 35 species (by weight) captured during the 2019 Sablefish Research and Assessment Survey.

Species	Scientific Name	Total Catch (count)	Total Catch (kg)
Sablefish	*Anoplopoma fimbria*	78836	141565
Pacific Halibut	*Hippoglossus stenolepis*	256	2130
Lingcod	*Ophiodon elongatus*	200	1887
North Pacific Spiny Dogfish	*Squalus suckleyi*	570	1324
Rougheye/Blackspotted Rockfish Complex	*Sebastes aleutianus/melanostictus complex*	290	501
Redbanded Rockfish	*Sebastes babcocki*	221	386
Arrowtooth Flounder	*Atheresthes stomias*	101	230
Pacific Grenadier	*Coryphaenoides acrolepis*	200	172
Yelloweye Rockfish	*Sebastes ruberrimus*	49	167
Giant Grenadier	*Albatrossia pectoralis*	46	150
Grooved Tanner Crab	*Chionoecetes tanneri*	379	143
Shortraker Rockfish	*Sebastes borealis*	11	45
Shortspine Thornyhead	*Sebastolobus alascanus*	32	30
Pacific Sleeper Shark	*Somniosus pacificus*	2	12
Pacific Cod	*Gadus macrocephalus*	3	9
Oregontriton	*Fusitriton oregonensis*	219	8
	Lithodes couesi	17	8
Dover Sole	*Microstomus pacificus*	8	8
Pink Snailfish	*Paraliparis rosaceus*	9	7
Petrale Sole	*Eopsetta jordani*	3	6
Pacific Flatnose	*Antimora microlepis*	4	6
Yellowmouth Rockfish	*Sebastes reedi*	3	5
Rosethorn Rockfish	*Sebastes helvomaculatus*	8	3
Giant Pacific Octopus	*Enteroctopus dofleini*	1	3
Rockfishes	*Sebastes sp.*	3	2
Silvergray Rockfish	*Sebastes brevispinis*	1	2
Canary Rockfish	*Sebastes pinniger*	1	2
Brown Box Crab	*Lopholithodes foraminatus*	3	1
Fragile Urchin	*Allocentrotus fragilis*	15	1
Aurora Rockfish	*Sebastes aurora*	1	0
	Paralomis multispina	1	0
Longspine Thornyhead	*Sebastolobus altivelis*	4	0
Sharpchin Rockfish	*Sebastes zacentrus*	2	0
	Hippasteria	1	0
	Rathbunaster californicus	1	0

Table 15. Number of sets where the species was captured, total catch count, proportion of the total catch, and a breakdown by area for the 25 most abundant species (by weight) captured during the 2019 Sablefish Research and Assessment Survey Randomized Tagging Program sets.

Species	Scientific Name	Number of Sets	Catch (count)	Proportion of Total Catch (%)	4B	3C	3D	5A	5B	5C	5D	5E
Sablefish	*Anoplopoma fimbria*	109	78836	97.49	0	7144	13516	8183	14506	9264	5445	20778
North Pacific Spiny Dogfish	*Squalus suckleyi*	25	570	0.70	0	233	62	80	96	3	0	96
Rougheye/Blackspotted Rockfish Complex	*Sebastes aleutianus/melanostictus* complex	15	290	0.36	0	17	7	5	19	0	0	242
Pacific Halibut	*Hippoglossus stenolepis*	39	256	0.32	0	20	31	18	85	8	24	70
Redbanded Rockfish	*Sebastes babcocki*	25	221	0.27	0	14	40	33	65	0	0	69
Pacific Grenadier	*Coryphaenoides acrolepis*	15	200	0.25	0	91	29	14	31	0	0	35
Lingcod	*Ophiodon elongatus*	18	200	0.25	0	19	38	64	42	0	0	37
Arrowtooth Flounder	*Atheresthes stomias*	22	101	0.12	0	1	15	12	20	1	0	52
Yelloweye Rockfish	*Sebastes ruberrimus*	7	49	0.06	0	0	2	8	20	0	0	19
Giant Grenadier	*Albatrossia pectoralis*	13	46	0.06	0	34	4	0	1	0	0	7
Shortspine Thornyhead	*Sebastolobus alascanus*	25	32	0.04	0	4	6	3	7	0	0	12
Shortraker Rockfish	*Sebastes borealis*	7	11	0.01	0	0	0	0	3	0	0	8
Pink Snailfish	*Paraliparis rosaceus*	4	9	0.01	0	7	0	0	2	0	0	0
Rosethorn Rockfish	*Sebastes helvomaculatus*	6	8	0.01	0	0	0	5	0	0	0	3
Dover Sole	*Microstomus pacificus*	8	8	0.01	0	2	1	0	1	0	1	3
Longspine Thornyhead	*Sebastolobus altivelis*	3	4	0.00	0	0	4	0	0	0	0	0
Pacific Flatnose	*Antimora microlepis*	2	4	0.00	0	2	0	0	0	0	0	2
Pacific Cod	*Gadus macrocephalus*	2	3	0.00	0	0	0	0	0	0	0	3
Rockfishes	*Sebastes*	1	3	0.00	0	0	3	0	0	0	0	0
Petrale Sole	*Eopsetta jordani*	2	3	0.00	0	0	0	0	3	0	0	0
Yellowmouth Rockfish	*Sebastes reedi*	1	3	0.00	0	0	0	0	3	0	0	0
Sharpchin Rockfish	*Sebastes zacentrus*	1	2	0.00	0	0	2	0	0	0	0	0
Pacific Sleeper Shark	*Somniosus pacificus*	2	2	0.00	0	0	0	0	1	1	0	0
Darkfin Sculpin	*Malacocottus zonurus*	1	1	0.00	0	0	0	0	1	0	0	0
Canary Rockfish	*Sebastes pinniger*	1	1	0.00	0	0	1	0	0	0	0	0

Table 16. Annual summary of the total catch (piece count) for the top 10 species (by total piece count over all years) for the Sablefish Research and Assessment Survey Randomized Tagging Program sets. Data from 2003 through 2006 have been omitted from this table.

Species	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
Sablefish	1883	2032	1552	1737	2256	1684	1809	1426	2542	1807	3660	4680	6096	41195
	3	6	9	5	8	5	5	6	8	3	4	8	5	3
Arrowtooth Flounder	1655	1163	1787	553	1037	921	414	864	610	427	686	336	100	12931
Pacific Grenadier	880	608	829	676	742	715	254	534	686	627	276	346	200	9067
North Pacific Spiny Dogfish	437	162	565	414	868	966	386	287	365	699	158	964	567	8952
Rougheye/Blackspotted Rockfish Complex	558	513	418	406	266	941	223	488	320	386	257	177	290	6349
Pacific Halibut	185	125	224	172	256	342	99	447	444	283	165	323	223	3712
Redbanded Rockfish	154	257	150	131	244	208	127	241	295	217	287	219	221	3169
Lingcod	201	109	93	97	165	71	88	92	121	154	106	192	200	2090
Giant Grenadier	162	146	179	118	105	195	80	87	206	72	67	106	46	1894
Yelloweye Rockfish	71	58	60	21	106	34	13	17	81	97	22	311	49	1054

Table 17. Annual summary of the total catch (piece count) for the top 10 species (by total piece count over all years) for the Sablefish Research and Assessment Survey Inlet Program sets. Data from 2003 through 2006 have been omitted from this table.

Species	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
Sablefish	3453	2498	4339	7507	11034	6213	3271	3341	2708	5050	8110	11607	17871	119027
Pacific Halibut	111	99	78	109	108	113	88	265	333	243	90	64	33	2012
Arrowtooth Flounder	101	108	49	25	11	20	11	49	30	24	14	18	1	554
North Pacific Spiny Dogfish	8	1	2	15	18	12	4	5	44	14	1	0	3	145
Dover Sole	4	23	1	0	0	1	2	5	1	1	2	0	1	50
Walleye Pollock	6	3	3	3	3	4	1	4	2	2	1	0	0	42
Pacific Sleeper Shark	5	4	2	0	1	0	0	2	0	2	0	0	1	30
Shortraker Rockfish	4	5	4	1	3	2	0	0	3	0	0	1	0	27
Pacific Cod	0	8	1	5	0	1	1	2	1	0	1	0	0	20
Rougheye/Blackspotted Rockfish Complex	2	1	1	1	0	2	0	2	0	1	1	3	0	17

Table 18. Number of fish sampled for biological data during the 2019 Sablefish Research and Assessment Survey showing the number of tag releases, lengths, age structures, and DNA tissue samples that were collected by species.

Species	Scientific Name	Tags	Lengths Collected	Age Structures Collected	DNA Tissue Collected
Pacific Halibut	*Hippoglossus stenolepis*	0	247	0	0
Pacific Sleeper Shark	*Somniosus pacificus*	0	1	0	1
Rougheye/Blackspotted Rockfish Complex	*Sebastes aleutianus/melanostictus* complex	0	195	195	193
Sablefish	*Anoplopoma fimbria*	12042	17701	5389	0
Shortraker Rockfish	*Sebastes borealis*	0	11	11	0
Yelloweye Rockfish	*Sebastes ruberrimus*	0	49	49	49

Table 19. Annual summary of the number of common fish species sampled for biological data during the Sablefish Research and Assessment Survey Randomized Tagging Program sets. Data from 2003 through 2006 have been omitted from this table.

Species	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
Sablefish	10385	11059	9331	10270	12463	10486	10118	8204	12094	9910	15841	13094	13721	198039
Rougheye/Blackspotted Rockfish Complex	0	282	289	266	240	393	179	373	270	270	183	144	195	3140
Pacific Grenadier	0	461	562	378	471	380	188	0	0	0	0	0	0	2440
Arrowtooth Flounder	0	441	379	245	400	656	140	0	0	0	0	0	0	2261
North Pacific Spiny Dogfish	0	0	219	326	440	674	207	0	0	0	0	0	0	1866
Redbanded Rockfish	0	224	145	131	243	204	113	0	0	0	29	0	0	1089
Giant Grenadier	0	129	141	111	99	195	79	0	0	0	0	0	0	754
Pacific Halibut	0	0	2	60	5	15	0	0	0	0	158	261	216	717
Yelloweye Rockfish	0	55	60	21	106	32	12	0	75	58	21	150	49	639
Shortraker Rockfish	0	53	65	73	18	59	18	13	10	59	26	24	11	437
Pacific Flatnose	0	18	39	27	17	24	11	0	0	10	0	0	0	146
Shortspine Thornyhead	0	1	9	26	22	53	34	0	0	0	0	0	0	145
Lingcod	0	0	27	36	1	3	1	0	0	0	0	0	0	68
Rosethorn Rockfish	0	8	6	2	23	7	3	0	0	0	0	0	0	49
Dover Sole	0	3	1	3	13	18	3	0	0	0	0	0	0	41
Emarginate Snailfish	0	30	0	0	1	0	0	0	0	0	0	0	0	31

Table 20. Annual summary of the number of common fish species sampled for biological data during the Sablefish Research and Assessment Survey Randomized Inlet Program sets. Data from 2003 through 2006 have been omitted from this table.

Species	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
Sablefish	2554	1993	3070	5064	5984	3900	2503	2379	2234	3272	4693	3582	3964	64611
Pacific Halibut	0	0	0	0	0	4	0	0	0	0	90	63	31	188
North Pacific Spiny Dogfish	0	0	0	0	8	11	0	0	0	0	0	0	0	25
Arrowtooth Flounder	0	0	0	0	3	18	0	0	0	0	0	0	0	21
Shortraker Rockfish	0	0	3	1	2	2	0	0	3	0	0	1	0	12
Rougheye/Blackspotted Rockfish complex	0	0	0	1	0	2	0	2	0	1	1	3	0	10
Walleye Pollock	0	0	0	0	1	1	0	0	0	0	0	0	0	9

Strait of Georgia Dogfish Longline Hook Survey

The Strait of Georgia Dogfish Longline Hook Survey is designed to provide biological, catch, and effort data for North Pacific Spiny Dogfish in the Strait of Georgia. The survey was first conducted in 1986 and 1989 and then resurrected in 2004 when a gear comparison study was completed. The comparison was necessary because the J shaped hooks used in the 1980s were no longer readily available as commercial fishing had shifted towards circle shaped hooks. The commercial fishery shifted to circle hooks because they are safer to handle and are believed to retain catch better than J hooks. The 2004 study included sets with both gear types as well as different numbers of hooks which allowed the calculation of catch per unit effort correction factors. The modern Strait of Georgia Dogfish Longline Hook survey was conducted with circle hooks in 2005 and then was repeated triennially through 2014. The survey was deferred in both 2017 and 2018 due to staffing limitations and research vessel availability.

The Strait of Georgia Dogfish Longline Hook survey follows a fixed station design using standardized “snap and swivel” longline hook gear with prescribed fishing protocols including bait, and soak time. There are 10 core index sites distributed between Cape Mudge and Active Pass, on both sides of the Strait of Georgia: French Creek, Hornby Island, Cape Lazo, Cape Mudge, Grant Reef, Sinclair Bank, Epsom Point, Sturgeon Bank, Active Pass, Porlier Pass (Figure 11). Entrance Island and Halibut Bank are additional, lower priority sites that are visited if there is sufficient time during the survey.

One longline set is conducted in each of four depth stratum at each index site, and generally one site will be completed per day. The depth strata are as follows: 2: 56 to 110 m, 3: 111 to 165 m, 4: 166 to 220 m, and 5: greater than 220 m. Historically an additional shallow depth stratum (1: less than 56 m) was fished but this stratum has been eliminated from the survey due both to time constraints and to the high rockfish bycatch which typically occurred. Depth stratum five is not fished at the Hornby Island site as there is no habitat greater than 220 m at the site.

Temperature depth recorders were deployed at the start, middle, and end of every fishing set.

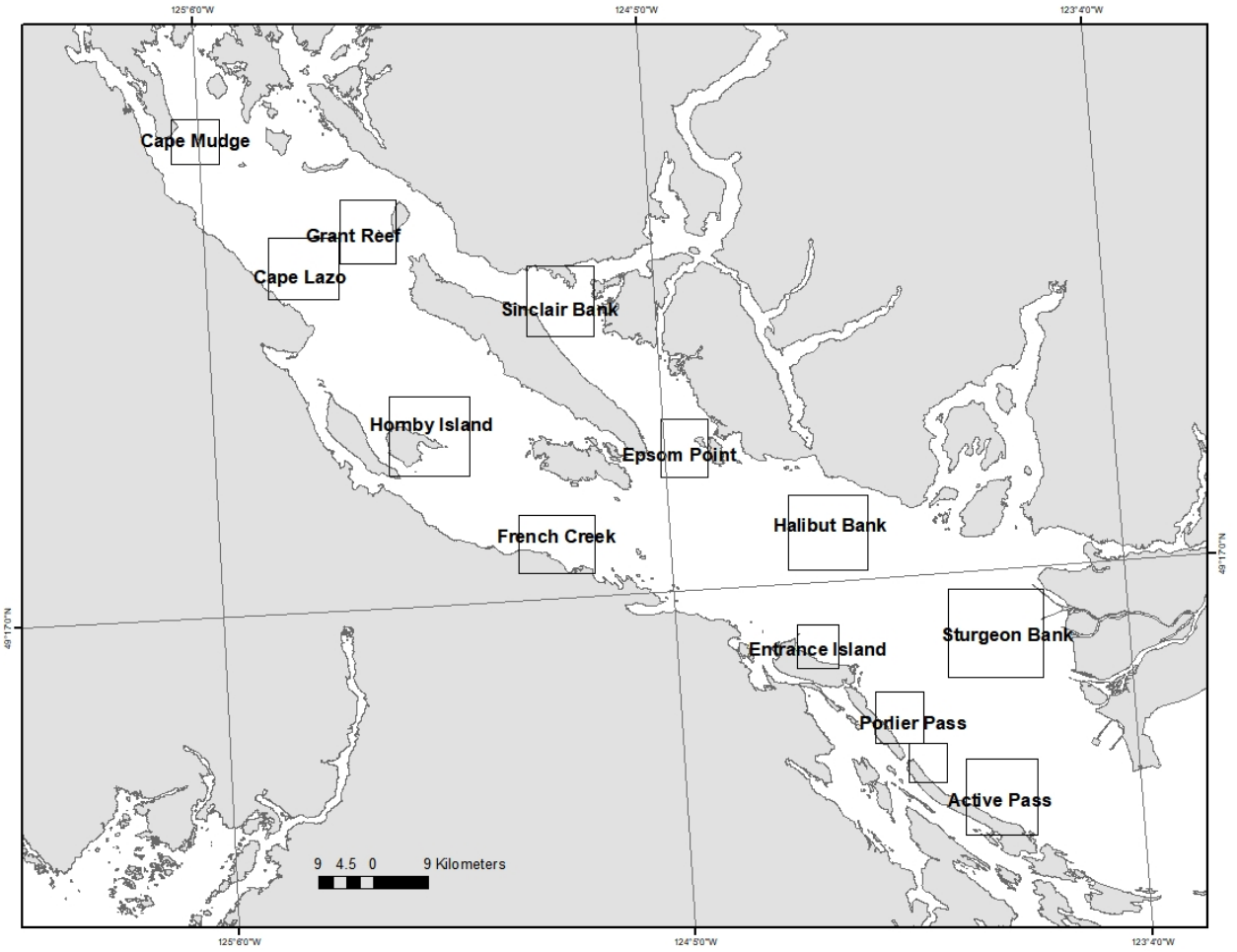

Figure 20. Strait of Georgia Dogfish Longline Hook Survey sites. The Porlier Pass site consists of both a northern and a southern region.

The 2019 Strait of Georgia Dogfish Longline Survey was conducted on board the Canadian Coast Guard vessel Neocaligus from October 1 to 14, 2019. A total of 39 sets were completed at the 10 core sites (Table 21,Figure 12). There was not sufficient time to visit the Halibut Bank and Entrance Island sites.

Table 21. Summary of sets completed during the 2019 Strait of Georgia Dogfish Longline Hook Survey. There is no habitat in depth stratum five at the Hornby Island site.

	Depth stratum				
Site	**2: 56 to 110 m**	**3: 111 to 165 m**	**4: 166 to 220 m**	**5: > 220 m**	**Total**
Cape Mudge	1	1	1	1	**4**
Grant Reef	1	1	1	1	**4**
Cape Lazo	1	1	1	1	**4**
Sinclair Bank	1	1	1	1	**4**
Hornby Island	1	1	1	N/A	**3**
Epsom Point	1	1	1	1	**4**
French Creek	1	1	1	1	**4**
Halibut Bank					
Sturgeon Bank	1	1	1	1	**4**
Entrance Island					
Porlier Pass	1	1	1	1	**4**
Active Pass	1	1	1	1	**4**
Total	**10**	**10**	**10**	**9**	**39**

The total catch of the survey was 5,810 pieces (Table 22), averaging only two different species of fish and invertebrates per set. The most abundant fish species encountered were North Pacific Spiny Dogfish (*Squalus suckleyi*), Yelloweye Rockfish (*Sebastes ruberrimus*) and Quillback Rockfish (*Sebastes maliger*). The number of sets where the species was captured as well as the total catch count and proportion of the total catch of all fish species are shown in Table 23. Biological data, including individual length, weight, sex, maturity, and age structure were collected from a total of 7872 individual fish of 23 different species (Table 24).

Table 22. Total catch, showing piece count by species for the 2019 Strait of Georgia Dogfish Longline Hook Survey.

Species	**Scientific Name**	**Total Catch (count)**
North Pacific Spiny Dogfish	*Squalus suckleyi*	5606
Yelloweye Rockfish	*Sebastes ruberrimus*	85
Quillback Rockfish	*Sebastes maliger*	41
Spotted Ratfish	*Hydrolagus colliei*	26
Longnose Skate	*Raja rhina*	19
Bluntnose Sixgill Shark	*Hexanchus griseus*	6
Copper Rockfish	*Sebastes caurinus*	5
Sablefish	*Anoplopoma fimbria*	4
Petrale Sole	*Eopsetta jordani*	3
Pacific Staghorn Sculpin	*Leptocottus armatus*	2
Greenstriped Rockfish	*Sebastes elongatus*	2
Pacific Sanddab	*Citharichthys sordidus*	1
Canary Rockfish	*Sebastes pinniger*	1
Pacific Hake	*Merluccius productus*	1
Pacific Cod	*Gadus macrocephalus*	1
Unknown Fish	Unknown fish	1
Sunflower Starfish	*Pycnopodia helianthoides*	1
Starfish	Asteroidea	1
Sponges	Porifera	1
Oregontriton	*Fusitriton oregonensis*	1

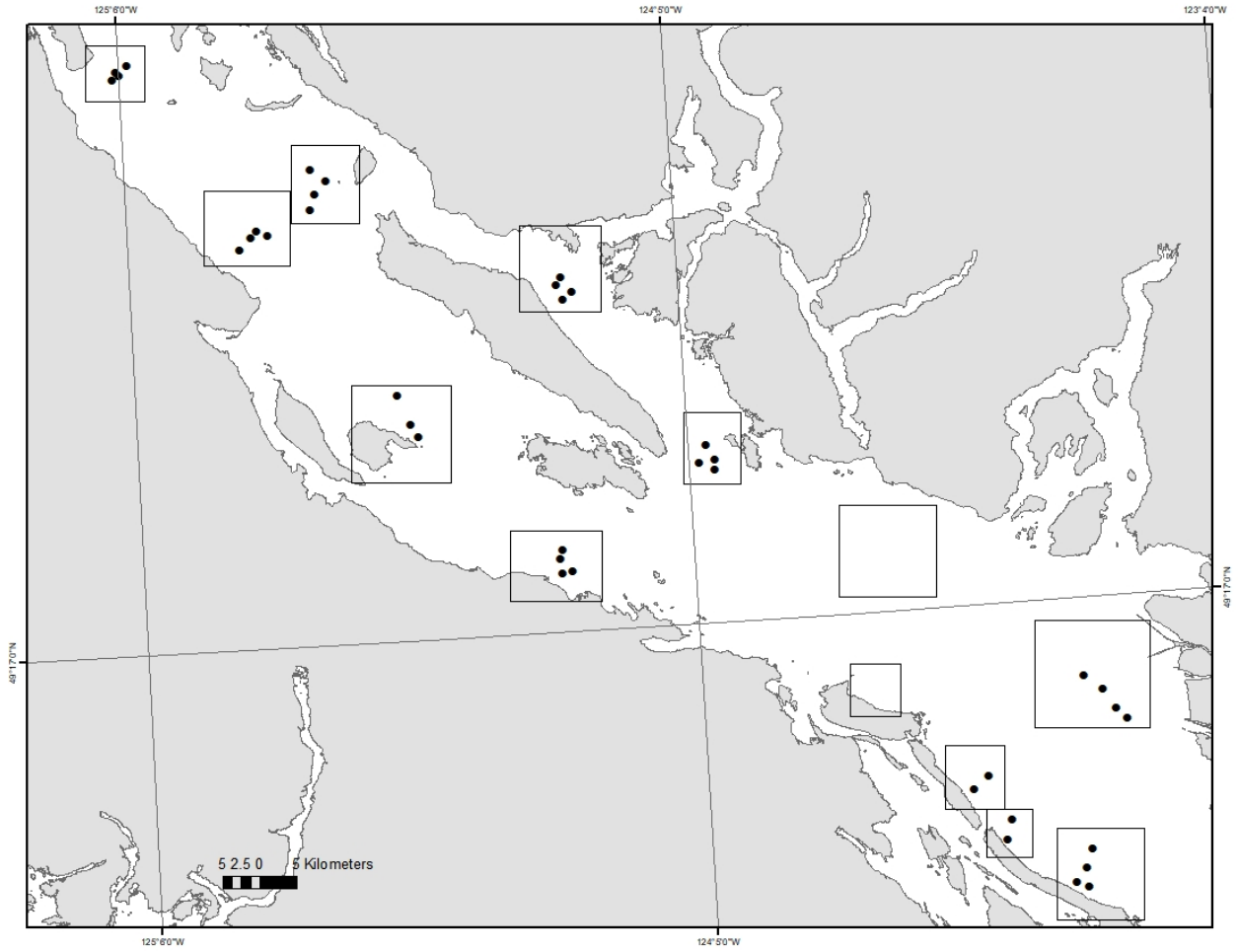

Figure 21. Set locations of the 2019 Strait of Georgia Dogfish Longline Hook Survey.

Table 23. Number of sets, catch (piece count), and proportion of the total fish catch for fish species caught during the 2019 Strait of Georgia Dogfish Longline Hook Survey.

Species	Scientific Name	Number of Sets	Catch (count)	Proportion of Total Catch (%)
North Pacific Spiny Dogfish	*Squalus suckleyi*	39	5606	96.59
Yelloweye Rockfish	*Sebastes ruberrimus*	12	85	1.46
Quillback Rockfish	*Sebastes maliger*	7	41	0.71
Spotted Ratfish	*Hydrolagus colliei*	10	26	0.45
Longnose Skate	*Raja rhina*	10	19	0.33
Bluntnose Sixgill Shark	*Hexanchus griseus*	4	6	0.10
Copper Rockfish	*Sebastes caurinus*	1	5	0.09
Sablefish	*Anoplopoma fimbria*	4	4	0.07
Petrale Sole	*Eopsetta jordani*	3	3	0.05
Greenstriped Rockfish	*Sebastes elongatus*	2	2	0.03
Pacific Staghorn Sculpin	*Leptocottus armatus*	1	2	0.03
Unknown Fish	*Unknown fish*	1	1	0.02
Pacific Sanddab	*Citharichthys sordidus*	1	1	0.02
Pacific Hake	*Merluccius productus*	1	1	0.02
Pacific Cod	*Gadus macrocephalus*	1	1	0.02
Canary Rockfish	*Sebastes pinniger*	1	1	0.02

Table 24. Number of fish sampled for biological data during the 2019 Strait of Georgia Dogfish Longline Hook Survey showing the number of lengths, age structures, and DNA tissue samples that were collected by species.

Species	Scientific Name	Lengths Collected	Age Structures Collected	DNA Tissue Collected
Bluntnose Sixgill Shark	*Hexanchus griseus*	1	0	1
Canary Rockfish	*Sebastes pinniger*	1	0	0
Copper Rockfish	*Sebastes caurinus*	5	5	5
Greenstriped Rockfish	*Sebastes elongatus*	2	0	0
Longnose Skate	*Raja rhina*	19	0	0
North Pacific Spiny Dogfish	*Squalus suckleyi*	5515	0	0
Pacific Cod	*Gadus macrocephalus*	1	0	0
Pacific Sanddab	*Citharichthys sordidus*	1	0	0
Pacific Staghorn Sculpin	*Leptocottus armatus*	2	0	0
Petrale Sole	*Eopsetta jordani*	2	0	0
Quillback Rockfish	*Sebastes maliger*	41	41	0
Sablefish	*Anoplopoma fimbria*	4	0	0
Spotted Ratfish	*Hydrolagus colliei*	22	0	0
Yelloweye Rockfish	*Sebastes ruberrimus*	85	84	85

Multi-species Small-mesh Bottom Trawl Survey

An annual fixed-station survey of commercially important shrimp grounds off the West Coast of Vancouver Island was initiated in 1973. In 1998, areas in Eastern Queen Charlotte Sound were added to the survey. The survey grounds were defined based on commercial fishing and span the 50-200m depth range. Tow locations within the survey grounds were selected using a systematic grid. Over the years some stations have been removed so there are now a set of standard tows that are repeated each year. Catch rates from this survey are directly tied to the shrimp trawl fishery catch quotas.

Given that the survey is conducted using a shrimp bottom trawl without an excluder device, groundfish can make up a significant portion of the catch in many of the tows. Catch rate indices generated by the survey have been used to track the abundances of several groundfish stocks. Although catch rates are useful indicators of stock status, additional information such as the size and age composition of the catch improves the usefulness of the indices. Consequently, a program was initiated in 2003 to collect biological samples from all groundfish species caught during the survey. Groundfish staff provide assistance in catch sorting and species identification and also collect biological samples from selected fish species. From 2010 through 2013, the goal was to collect biological information from as many different species in each tow as possible - as opposed to detailed information from only a few species. As such, two groundfish program staff members were deployed and the biological sampling effort was focused on length by sex data in favour of collecting ageing structures. Starting in 2014, only one groundfish staff member participated in the survey and the biological sampling program was reduced so that a single person could accomplish all the work. In addition, the sampling program was rationalized to only include species where the survey is expected to provide a useful index of abundance.

Starting in 2013, the West Coast Vancouver Island portion of the survey also included locations in Barkley Sound that were surveyed by the Canadian Coast Guard Ship Neocaligus in previous years. In 2014, the Queen Charlotte Sound portion of the survey was not conducted due to the limited number of vessel days available for the program. The Queen Charlotte Sound area was also not visited in 2015, and from 2017 through 2019 due to staffing limitations.

The 2019 survey was conducted onboard the F/V Nordic Pearl and ran from April 30 to May 15. A total of 118 tows were completed, of which 112 were usable (Figure 13). Tows were determined to be unusable if there was insufficient bottom contact time or if the gear was damaged. The total catch weight of all species was 56,320 kg. The mean catch per tow was 502 kg, averaging 36 different species of fish and invertebrates in each. Over all tows over the entire survey, the most abundant fish species encountered were North Pacific Spiny Dogfish (*Squalus suckleyi*), Rex Sole (*Glyptocephalus zachirus*), Dover Sole (*Microstomus pacificus*), Slender Sole (*Lyopsetta exilis*), and Flathead Sole (*Hippoglossoides elassodon*). The number of tows where the species was captured, total catch weight from successful tows, estimated biomass, and relative survey error for the top 25 fish species by weight are shown in Table 25 for the West Coast Vancouver Island tow locations. Biomass indices have not been calculated for the Barkley Sound tow locations as these locations have not yet been used for any groundfish assessments.

Biological data were collected from a total of 8,192 individual fish from 21 different species (Table 26). Most biological samples included fish length and sex but age structures were also collected for Bocaccio (*Sebastes paucispsinis*) and Lingcod (*Ophiodon elongatus*) and both age structures and tissue samples for DNA analysis were collected from Rougheye/ Blackspotted

Rockfish (*Sebastes aleutianus/ melanostictus*) and Yelloweye Rockfish (*Sebastes ruberrimus*). Almost half of all the individual fish measured during the survey were Eulachon (*Thaleichthys pacificus*). Although we include this species in these summaries, the groundfish program staff typically does not directly collect the biological data from this species or American Shad (*Alosa sapidissima*).

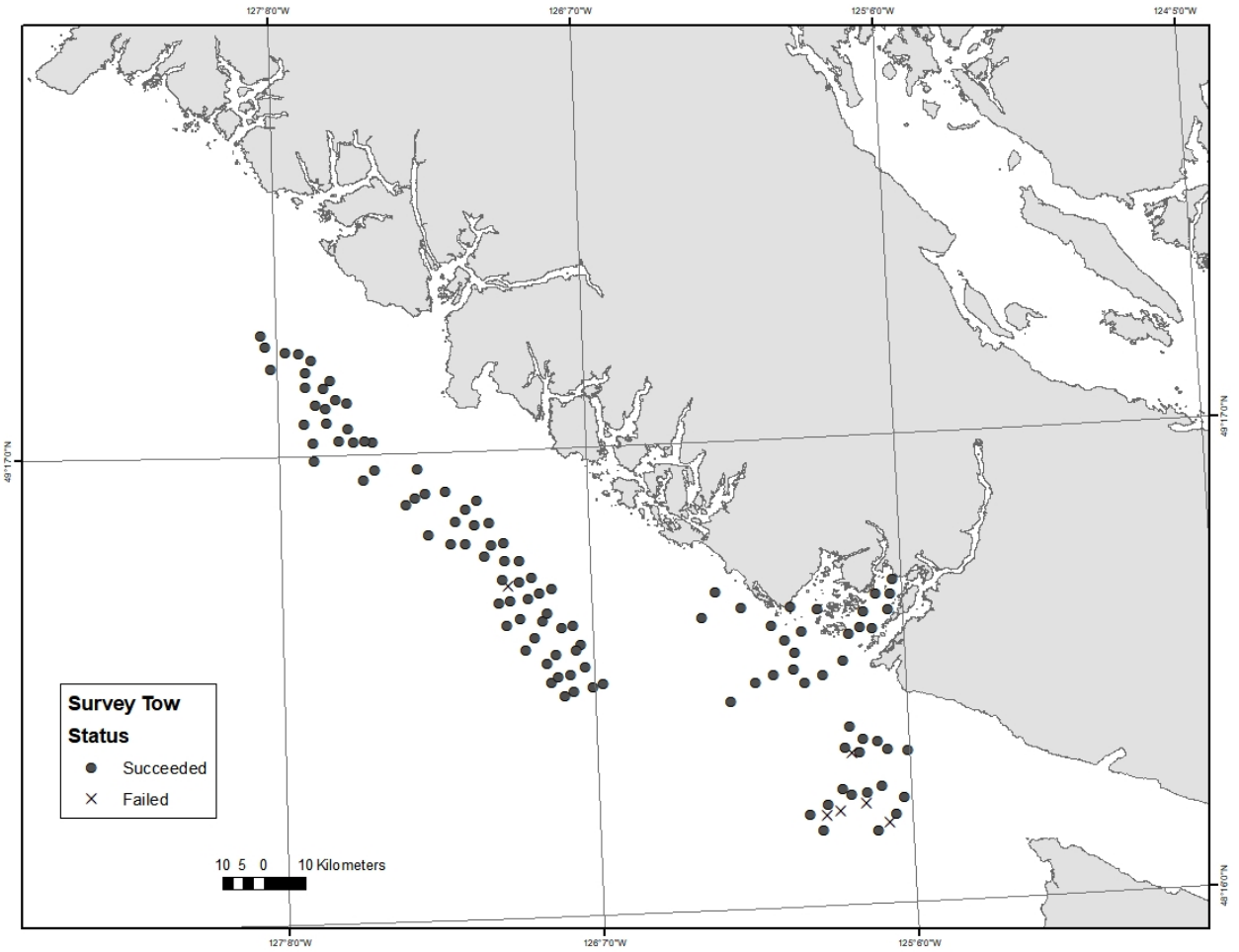

Figure 22. Tow locations of the 2019 Multi-species Small-mesh Bottom Trawl Survey.

Table 25. Number of tows, catch weight from successful tows, estimated biomass, and relative survey error for the top 25 species (by weight) captured in the West Coast Vancouver Island tow locations of the 2019 Multi-species Small-mesh Bottom Trawl Survey.

Species	Scientific Name	Number of Tows	Catch (kg)	Biomass (t)	Relative Error
North Pacific Spiny Dogfish	Squalus suckleyi	51	7163	5485	0.65
Rex Sole	Glyptocephalus zachirus	71	5542	5162	0.06
Dover Sole	Microstomus pacificus	71	3985	3639	0.08
Slender Sole	Lyopsetta exilis	70	3105	2913	0.08
Pacific Sanddab	Citharichthys sordidus	58	1953	1672	0.14
Flathead Sole	Hippoglossoides elassodon	68	1738	1704	0.12
Sablefish	Anoplopoma fimbria	54	1580	1308	0.67
Arrowtooth Flounder	Atheresthes stomias	67	757	696	0.15
Spotted Ratfish	Hydrolagus colliei	69	677	588	0.12
Longnose Skate	Raja rhina	68	544	494	0.11
Eulachon	Thaleichthys pacificus	57	454	396	0.17
Lingcod	Ophiodon elongatus	44	373	367	0.46
Petrale Sole	Eopsetta jordani	49	339	308	0.2
English Sole	Parophrys vetulus	58	247	213	0.14
Yellowtail Rockfish	Sebastes flavidus	44	246	236	0.19
Walleye Pollock	Gadus chalcogrammus	54	230	195	0.26
Greenstriped Rockfish	Sebastes elongatus	51	217	195	0.4
Pacific Cod	Gadus macrocephalus	40	193	192	0.23
Blackbelly Eelpout	Lycodes pacificus	60	136	121	0.17
Pacific Hake	Merluccius productus	37	110	102	0.2
Pacific Halibut	Hippoglossus stenolepis	21	99	88	0.24
Sandpaper Skate	Bathyraja interrupta	52	76	68	0.13
Big Skate	Beringraja binoculata	13	70	61	0.3
Darkblotched Rockfish	Sebastes crameri	47	70	67	0.19
Redstripe Rockfish	Sebastes proriger	13	47	47	0.65

Table 26. Number of fish sampled for biological data during the 2019 Multi-species Small-mesh Bottom Trawl Survey showing the number of lengths and age structures that were collected by species.

Species	Scientific Name	Lengths Collected	Age Structures Collected	DNA Tissue Collected
American Shad	*Alosa sapidissima*	159	0	0
Arrowtooth Flounder	*Atheresthes stomias*	19	0	0
Big Skate	*Beringraja binoculata*	128	0	0
Bocaccio	*Sebastes paucispinis*	60	58	0
Dover Sole	*Microstomus pacificus*	755	0	0
English Sole	*Parophrys vetulus*	53	0	0
Eulachon	*Thaleichthys pacificus*	3897	0	400
Lingcod	*Ophiodon elongatus*	141	94	0
Longnose Skate	*Raja rhina*	732	0	0
Pacific Cod	*Gadus macrocephalus*	16	0	0
Pacific Halibut	*Hippoglossus stenolepis*	31	0	0
Petrale Sole	*Eopsetta jordani*	271	0	0
Pink Shrimp (smooth)	*Pandalus jordani*	0	0	0
Rex Sole	*Glyptocephalus zachirus*	883	0	0
Rougheye/Blackspotted Rockfish Complex	*Sebastes aleutianus/melanostictus* complex	7	6	7
Sablefish	*Anoplopoma fimbria*	334	0	0
Sandpaper Skate	*Bathyraja interrupta*	160	0	0
Sidestripe Shrimp	*Pandalopsis dispar*	0	0	0
Walleye Pollock	*Gadus chalcogrammus*	494	0	0
Whitebait Smelt	*Allosmerus elongatus*	50	0	0
Yelloweye Rockfish	*Sebastes ruberrimus*	2	2	2

International Pacific Halibut Commission Fishery-independent Setline Survey

The International Pacific Halibut Commission's (IPHC) Fishery-independent Setline Survey (FISS) is a fixed-station longline hook survey that extends from southern Oregon to the Bering Sea. This survey serves to index Pacific Halibut (*Hippoglossus stenolepis*) abundance and provide accompanying biological samples to assess the Pacific Halibut stock. The British Columbia (regulatory area 2B) portion of this survey has been conducted annually in various configurations from 1963 to the present (www.iphc.washington.edu).

Since 2003, the IPHC has provided the opportunity to deploy an additional technician during the survey to identify the catch to species level on a hook-by-hook basis and to collect biological samples from rockfish. This information has been collected every year since 2003 except for a one-year hiatus in 2013. This program is designed to fully enumerate the non-halibut catch in the survey and collect biological samples from inshore rockfish species.

At the time of writing, the 2019 IPHC survey data are not yet finalized and so have not been included in this report.

Appendix 2: British Columbia commercial groundfish TACs, landings, and research allocations for 2019.

Table 1. British Columbia Groundfish Total Allowable Catch (TAC) and commercial landings in metric tonnes (t) for 2019. Except where noted, TACs are from the 2019 Groundfish Integrated Fisheries Management Plan (https://waves-vagues.dfo-mpo.gc.ca/Library/40804343.pdf). Landings are from the dockside monitoring program (DMP).

Species or Species Group	Trawl Sector (t)		Combined Line Sectors (t)		Total (t)	
	TAC	Landings	TAC	Landings	TAC	Landings
Sharks And Skates						
North Pacific Spiny Dogfish	4,480	182	9,520	0	14,000	182
Big Skate	914	189	118	15	1,032	204
Longnose Skate	195	47	263	63	458	110
Pacific Cod	1,450	488	0	4	1,450	492
Walleye Pollock	4,935	6,249	0	0	4,935	6,249
Pacific Hake [1]	7,000 gulf & 156,067 offshore	99,685	0	0	163,067	99,685
Rockfishes						
Rougheye/Blackspotted Rockfish Complex	636	362	484	302	1,120	664
Pacific Ocean Perch	5,192	3,521	1	1	5,193	3,521
Redbanded Rockfish	295	160	284	176	579	336
Shortraker Rockfish	126	15	111	103	237	118
Silvergray Rockfish	1,945	1,619	254	36	2,199	1,655
Widow Rockfish	2,316	1,737	42	0	2,358	1,737
Yellowtail Rockfish	5,440	3,755	60	6	5,500	3,761
Quillback Rockfish	4	0	169	114	173	114
Bocaccio	80	52	0	3	80	55
Canary Rockfish	965	633	135	13	1,100	646
Redstripe Rockfish	2,572	713	1,168	0	3,740	713
Yellowmouth Rockfish	1,521	1,461	43	5	1,564	1,466
Yelloweye Rockfish	2,364	1	78	88	2,442	89
Copper, China, And Tiger Rockfish	1	0	63	47	64	47

Table 1. Continued.

Species or Species Group	Trawl Sector (t)		Combined Line Sectors (t)		Total (t)	
	TAC	Landings	TAC	Landings	TAC	Landings
Thornyheads						
Shortspine Thornyhead	1	161	54	102	55	263
Longspine Thornyhead	735	22	34	0	769	22
Sablefish	405	113	20	2,371	425	2,483
Lingcod	210	178	2,195	786	2,405	963
Flatfishes						
Arrowtooth Flounder	14,000	6,809	0	0	14,000	6,809
Petrale Sole	900	446	0	0	900	446
Southern Rock Sole	1,552	154	0	1	1,552	155
Dover Sole	3,073	1,194	0	0	3,073	1,194
English Sole	822	537	0	0	822	537
Pacific Halibut [2]	0	4	2,287	2,369	2,287	2,373

[1] Hake offshore TAC is from Fishery Notice FN0573-In-season Allocation of 2019 Offshore Pacific Hake Quota (https://notices.dfo-mpo.gc.ca/fns-sap/index-eng.cfm?pg=view_notice&DOC_ID=222486&ID=all)

*[2] Halibut weights are dressed, head-off, where dressed, head-off weight = round weight * 0.75.*

Table 2. British Columbia Groundfish research allocations in metric tonnes (t) for 2019. Except where noted, research allocations are deducted from the fish available to the commercial fishery by sector prior to the definition of commercial TACs. Values are copied from the 2019 Groundfish Integrated Fisheries Management Plan (https://waves-vagues.dfo-mpo.gc.ca/Library/40804343.pdf).

Species or Species Group	Trawl surveys (t)	Longline surveys (t)	Sablefish surveys (t)	Total (t)
Sharks And Skates				
North Pacific Spiny Dogfish	3.4	--	--	3.4
Big Skate	1.1	0.5	--	1.6
Longnose Skate	0.9	1.2	--	2.1
Pacific Cod	3.4	2.2	--	5.6
Walleye Pollock	4.9	--	--	4.9
Pacific Hake	2.6	--	--	2.6
Rockfishes				
Rougheye/Blackspotted Rockfish Complex	1.3	0.3	--	1.6
Pacific Ocean Perch	21.8	0	--	21.8
Redbanded Rockfish	1.9	2.8	--	1.6
Shortraker Rockfish	0.7	0.2	--	0.9
Silvergray Rockfish	14.6	1.7	--	16.3
Widow Rockfish	0.2	0	--	0.2
Yellowtail Rockfish	3.4	0.1	--	3.5
Quillback Rockfish	0.4	3.1	--	3.9
Bocaccio	0.2	0.1	--	0.3
Canary Rockfish	2	1.2	--	3.2
Redstripe Rockfish	3.9	--	--	3.9
Yellowmouth Rockfish	4.7	--	--	4.7
Yelloweye Rockfish	0.2	15.8	--	16
Copper, China, And Tiger Rockfish	0.2	0.4	--	0.6
Thornyheads				
Shortspine Thornyhead	2.1	--	--	2.1
Longspine Thornyhead	--	--	--	--

Table 2. Continued.

Species or Species Group	Trawl surveys (t)	Longline surveys (t)	Sablefish surveys (t)	Total (t)
Sablefish	5.7	0.6	60	66.3
Lingcod	0.7	3.5	--	4.2
Flatfishes				
Arrowtooth Flounder	34.5	--	--	34.5
Petrale Sole	0.9	--	--	0.9
Southern Rock Sole	2.7	--	--	2.7
Dover Sole	8.4	--	--	8.4
English Sole	9.2	--	--	9.2
Pacific Halibut [1]	4.3	27.2	--	31.5

[1] The halibut poundage for the groundfish trawl survey is part of the trawl fishery's halibut bycatch mortality cap. The groundfish trawl fishery has a bycatch mortality cap of 454 tonnes that is not part of the allocated commercial TAC.