CANADA

British Columbia Groundfish Fisheries and Their Investigations in 2020

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

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Table of Contents

I. Agency Overview 1
II. Surveys 3
A. Databases and Data Acquisition Software 3
B. Commercial Fishery Monitoring and Biological Sampling 3
C. Research Surveys 4
III. Reserves 9
IV. Review of Agency Groundfish Research, Assessment and Management 11
A. Hagfish 11
B. Dogfish and other sharks 12
C. Skates 13
D. Pacific Cod 14
E. Walleye Pollock 15
F. Pacific Whiting (Hake) 16
G. Grenadiers 16
H. Rockfish 17
I. Thornyheads 24
J. Sablefish 25
K. Lingcod 28
L. Atka Mackerel 28
M. Flatfish 28
N. Pacific Halibut & IPHC Activities 29
O. Other Groundfish Species 29
V. Ecosystem Studies 30
A. Data-limited Species 30
VI. Other related studies 31
VII. Publications 31
A. Primary Publications 31
B. Other Publications 31
Appendix 1: Details of Fisheries and Oceans, Canada Pacific Region Groundfish Surveys in 2020 34
Appendix 2: British Columbia commercial groundfish TACs, landings, and research allocations for 2020 65

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, Neocaligus, and the Sir John Franklin. The Sir John Franklin, replacement for the W.E Ricker, was deployed for its inaugural field season in 2020. However, due to the COVID-19 pandemic, crew training and vessel familiarization in relation to fishing activities was curtailed and there were a limited number of surveys deployed on the vessel (and no groundfish surveys). Training and familiarization activities are expected to continue in 2021, followed by a full suite of surveys.

Groundfish commercial fisheries continued to operate in 2020; however, on April 2, 2020 the Minister of Fisheries and Oceans Canada suspended the use of at-sea observers due to the COVID-19 pandemic. On April 14, 2020, “Emergency Electronic Monitoring (EM)” measures were introduced for groundfish trawl trips which would normally have been subject to monitoring by the at-sea observer program.

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 2020 Groundfish Integrated Fisheries Management Plan v.1.3 (IFMP) is available from the Federal Science Library: https://waves-vagues.dfo-mpo.gc.ca/Library/40935218.pdf.

Allocations of fish for financing scientific and management activities are identified in the Groundfish IFMP. Collaborative Agreements were developed for 2020-21 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 2021-22.

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 11.7 million individual fish specimens. In 2020, data entry activities concentrated on input of current-year groundfish research cruises and biological data from at-sea and dockside observers, fish ages, 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 (EM) including video. 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.

Changes to commercial fishery monitoring and sampling programs due to COVID-19

Prior to the COVID-19 pandemic, all vessels fishing under an Option A trawl license (groundfish trawl trips outside the Strait of Georgia, excluding the hake fishery) were required to be accompanied by an at-sea observer. On April 2, 2020, the Minister of Fisheries and Oceans Canada issued a Fisheries Management Order (FMO 2020-01) under section 9.1 of the Fisheries Act "*to lift the existing at-sea observer requirements imposed under existing licences to fish, which create a human health risk for at-sea observers and fishers and constitute a public human health risk*." On April 14, 2021, an Emergency Electronic Monitoring (EM) Program was initiated, requiring vessels fishing with an Option A trawl license to be outfitted with an approved EM system in place of an at-sea observer. Effective October 29, 2020, the emergency EM measures were expanded to require a specific version of the EM system as well as the installation and use of video-monitored fixed measuring grids for releasing fish. Alternatively, vessels were once again permitted to carry an at-sea observer (subject to availability and applicable COVID-19 guidelines); however, all vessels opted to continue with the EM measures.

The absence of at-sea observers from all commercial trips after April 2, 2020 means that no at-sea biological samples were collected after that date. Dockside samples continued to be collected

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).

Data from the synoptic bottom trawl surveys and hard bottom longline hook surveys are published annually to the Government of Canada Open Government Portal and to OBIS:

- Open Government Portal
  - Synoptic Bottom Trawl Surveys
  - Hard Bottom Longline Surveys
- OBIS
  - Queen Charlotte Sound Bottom Synoptic Trawl Survey
  - West Coast Vancouver Island Synoptic Trawl Survey
  - Hecate Strait Synoptic Trawl Survey
  - West Coast Haida Gwaii Synoptic Trawl Survey
  - Strait of Georgia Synoptic Trawl Survey
  - Inside North Hard Bottom Longline Survey
  - Inside South Hard Bottom Longline Survey
  - Outside North Hard Bottom Longline Survey
  - Outside South Hard Bottom Longline Survey

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).

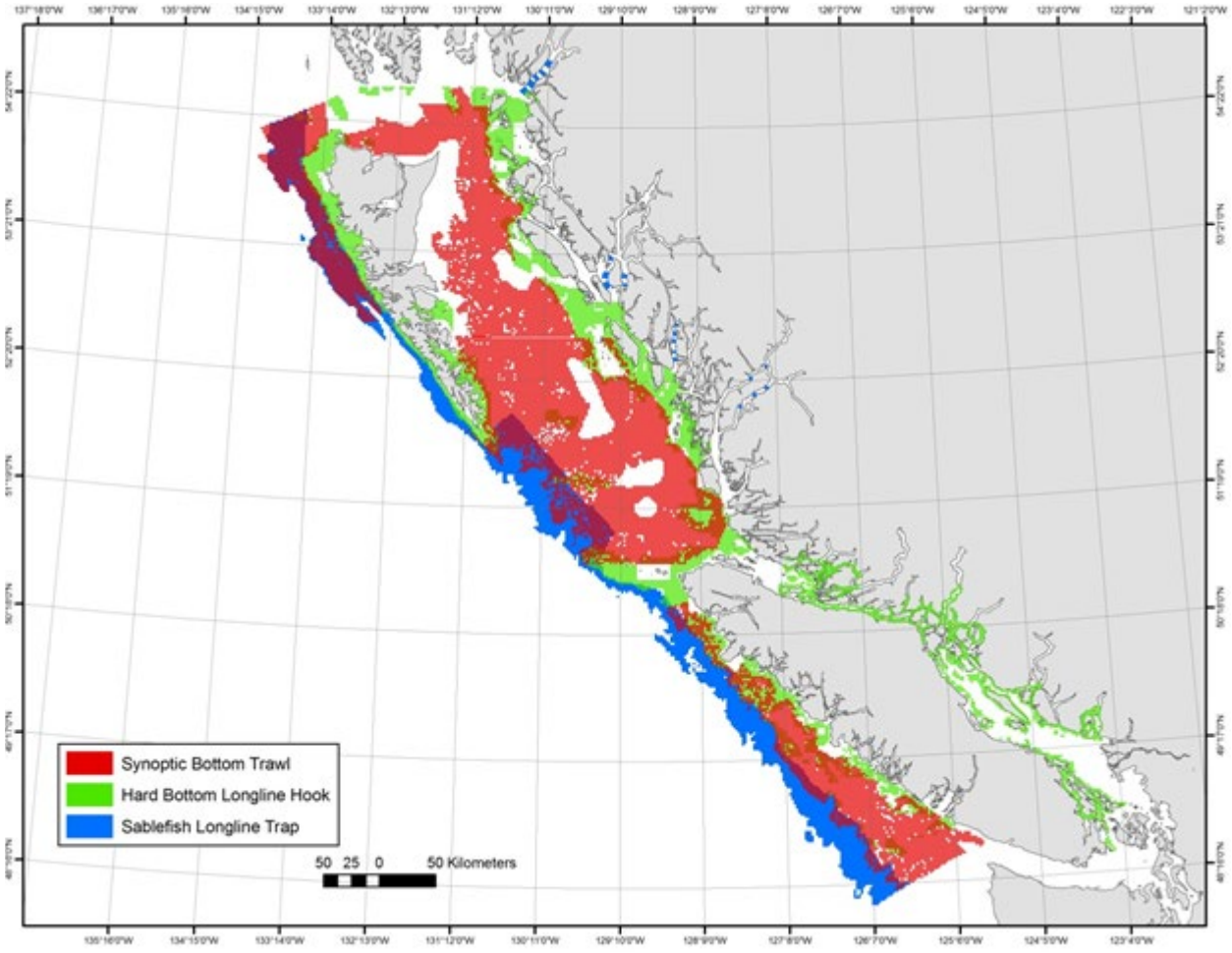

Figure 1. Random depth-stratified survey coverage.

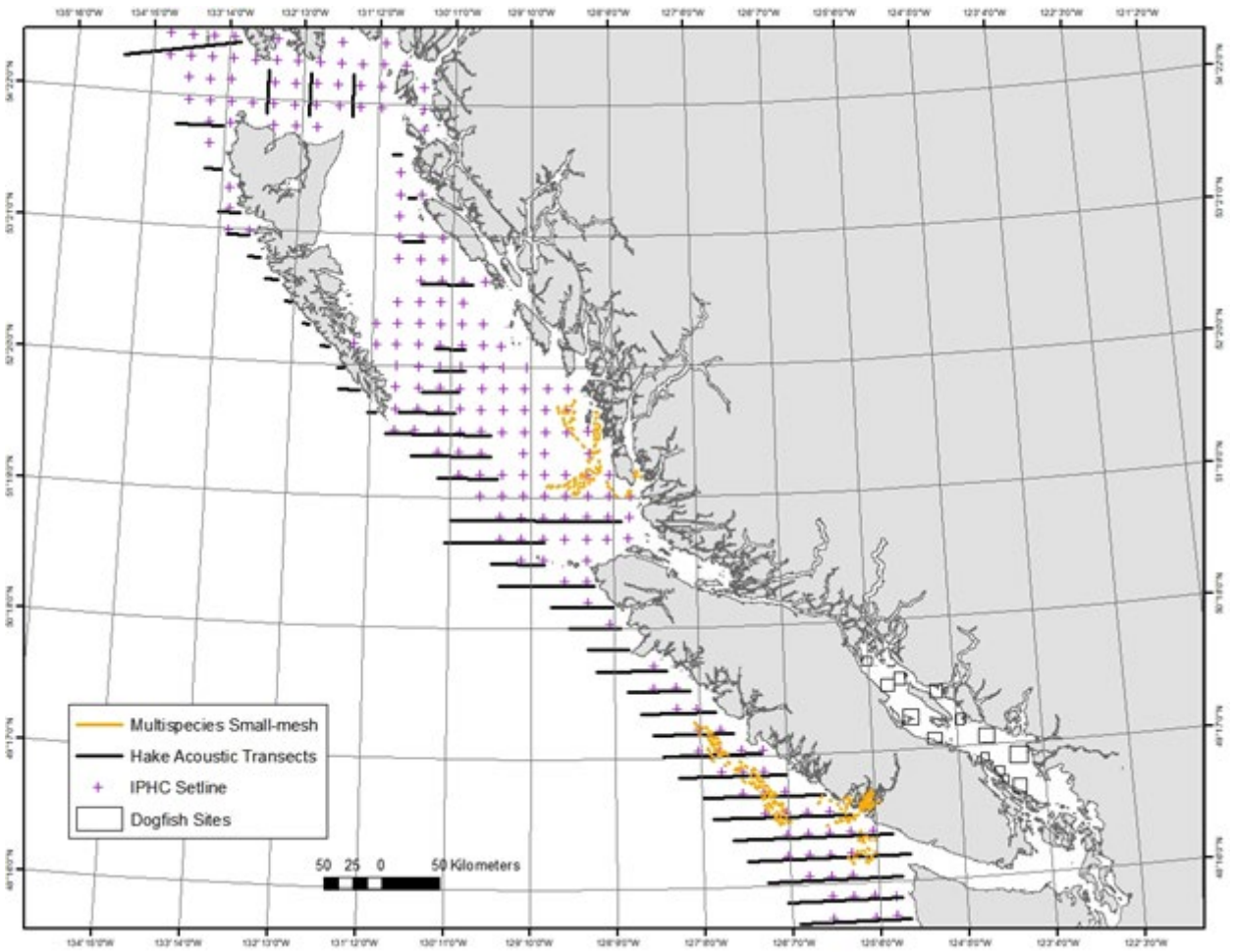

Figure 2. Non-random depth-stratified surveys that form part of the Groundfish surveys program including the Multispecies Small-mesh Bottom Trawl Survey, the Pacific Hake Acoustic Survey, the International Pacific Halibut Commission (IPHC) Setline Survey and the Strait of Georgia Dogfish Longline Hook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

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 with DFO staff, and one survey occurs on a chartered commercial fishing vessel with a mix of DFO staff and contracted technicians. In aggregate, the surveys provide coast-wide coverage of most of the trawlable habitat between 50 and 500 meters depth.

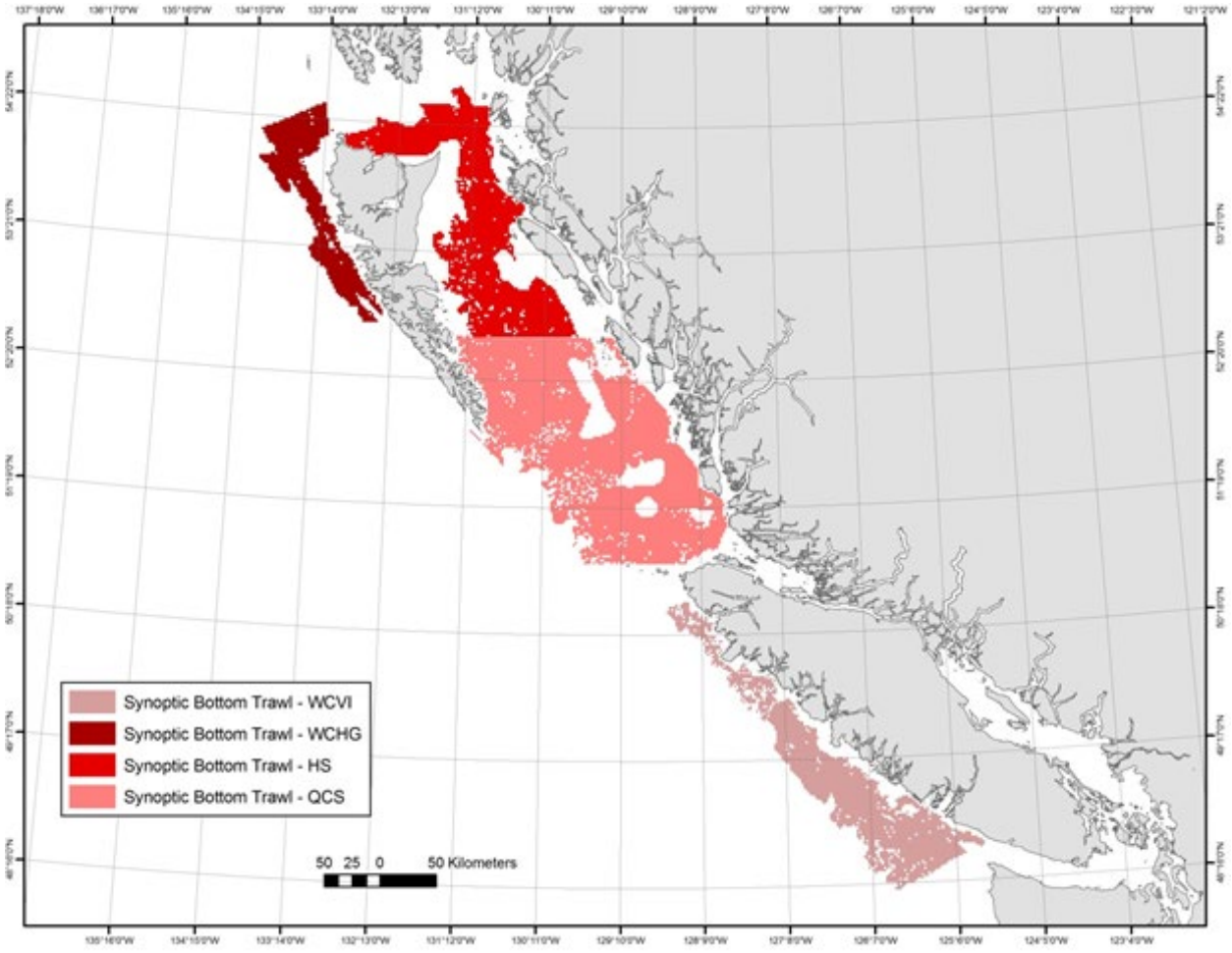

Figure 3. Multispecies Synoptic Bottom Trawl Survey coverage.

The WCHG survey was the only synoptic bottom trawl survey completed in 2020. The WCVI survey was scheduled for mid-May to mid-June in 2020, but was postponed to 2021 due to the COVID-19 pandemic. The WCHG survey was completed by contracted technicians on the F/V Nordic Pearl from late August to late September 2020. Ninety-six successful tows were completed (Figure 4). The dominant species in the catch were Pacific Ocean Perch (*Sebastes alutus*), Silvergray Rockfish (*Sebastes brevispinis*), the Rougheye/ Blackspotted Rockfish complex (*Sebastes aleutianus/melanostictus*), and Yellowmouth Rockfish (*Sebastes reedi*).

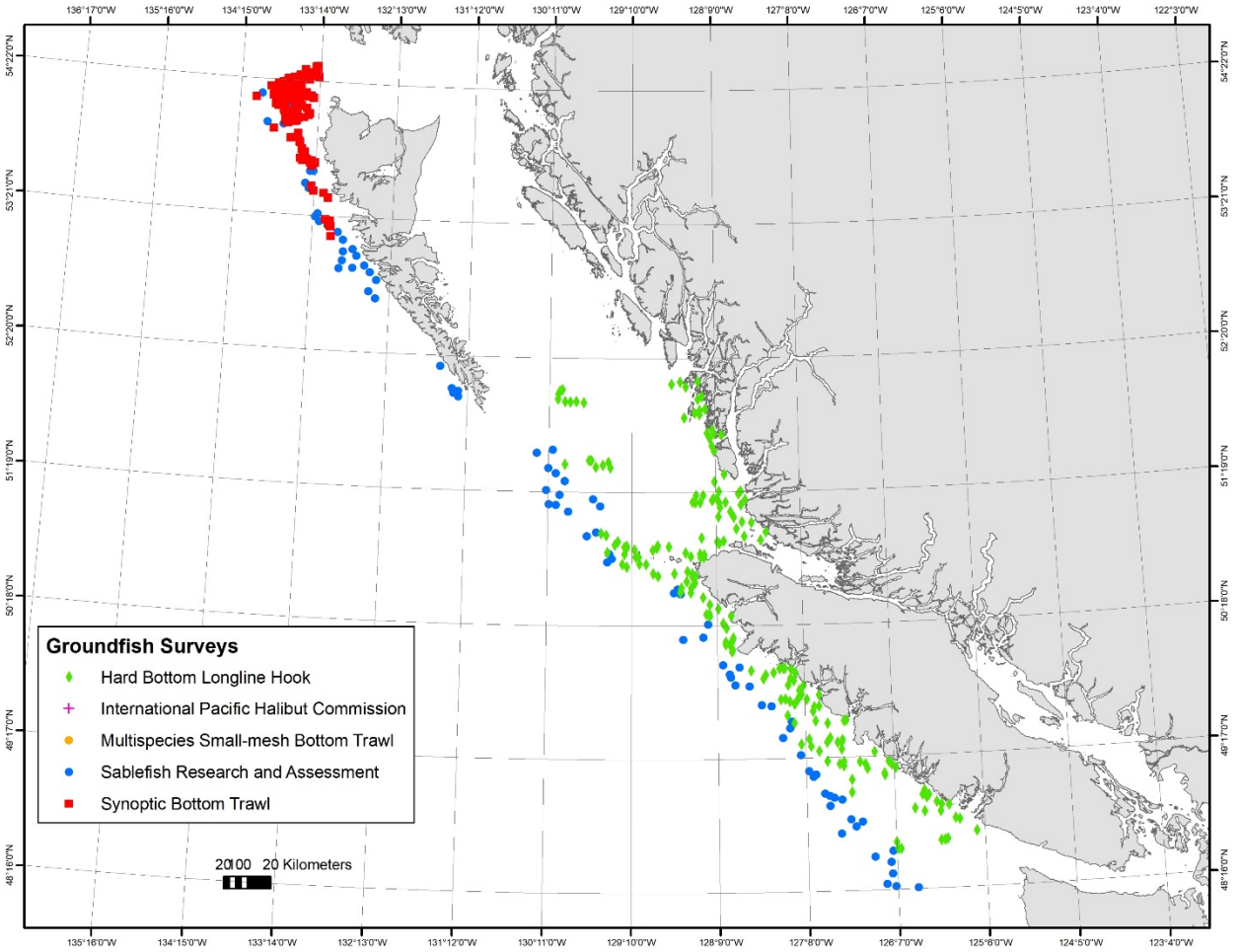

Figure 4. Fishing locations of the 2020 Groundfish surveys.

The **Hard Bottom Longline Hook (HBLL) Surveys** are typically 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 and are conducted by contracted technicians, while the inside surveys are conducted by DFO and occur on a Canadian Coast Guard vessel. In aggregate, the HBLL surveys provide coast-wide coverage of most of the untrawlable habitat between 20 and 220 meters depth.

In 2020 the southern region of the outside area was surveyed. The survey in the inside area was scheduled for the southern region but was postponed to 2021 due to the COVID-19 pandemic (Figure 4). The outside HBLL survey was conducted on the chartered commercial longline vessels Banker II, and Borealis 1 during August and September. A total of 196 sets were completed. The dominant species in the catch were Yelloweye Rockfish (*Sebastes ruberrimus*), Pacific Halibut (*Hippoglossus stenolepis*), Sablefish (*Anoplopoma fimbria*), and Quillback Rockfish (*Sebastes maliger*).

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 a collaborative agreement with the Canadian Sablefish Association and occurs on a chartered commercial vessel, and is typically conducted by a mix of DFO staff and contracted technicians. This survey covers the depth range of 150 m to 1250 m for the entire outer BC coast as well as a number of central coast inlets.

In 2020, the survey was conducted on the F/V Pacific Viking from early October to late November by contracted technicians. A total of 89 sets were completed in the offshore areas while the inlet portion of the survey was canceled due to the COVID-19 pandemic (Figure 4). The most abundant fish species encountered were Sablefish (*Anoplopoma fimbria*), Pacific Halibut (*Hippoglossus stenolepis*), Lingcod (*Ophiodon elongatus*), North Pacific Spiny Dogfish (*Squalus suckleyi*), and Yelloweye Rockfish (*Sebastes ruberrimus*).

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, and occurs on a Canadian Coast Guard Vessel with DFO staff. 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 2020 survey was canceled due to the COVID-19 pandemic.

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. Marine Conservation initiatives in British Columbia are illustrated in Figure 5.

In the Pacific Region, an initiative is underway to develop 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 continued 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 NMCAR 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. The two Rockfish Conservation Areas that were formerly within the NMCAR 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).

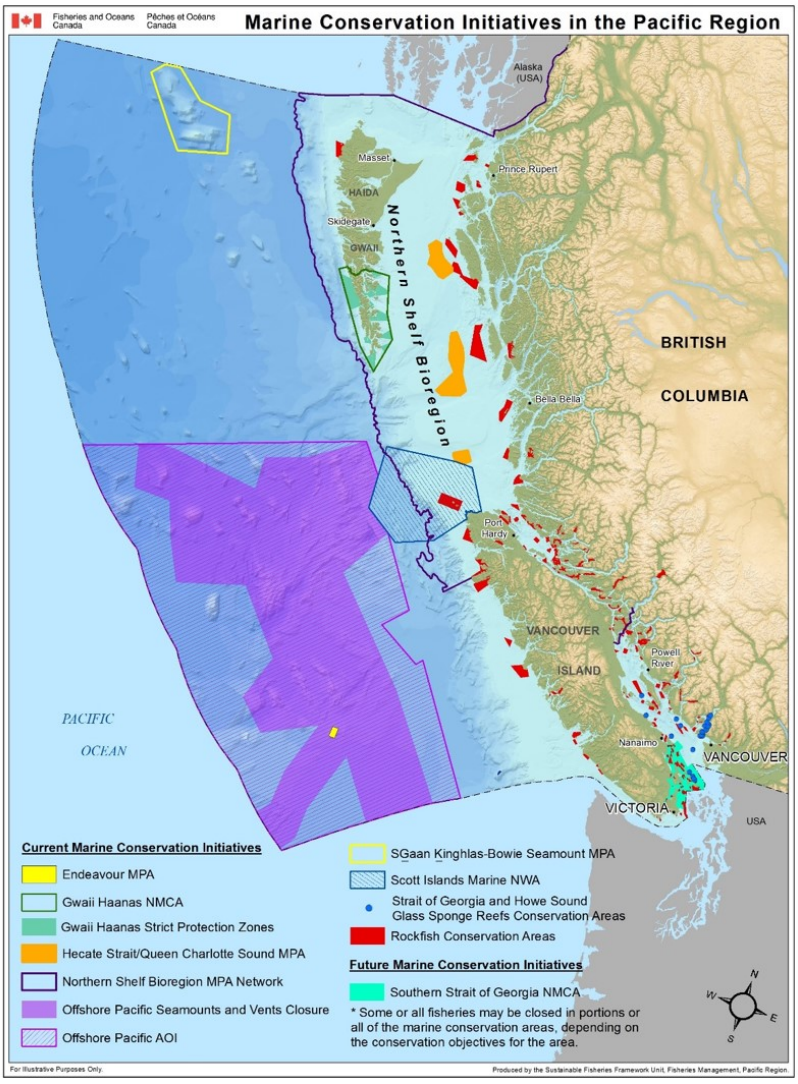

Figure 5. Marine Conservation Initiatives in the Pacific Region (Map by F. Yu).

IV. Review of Agency Groundfish Research, Assessment and Management

A. Hagfish

1. Research

No new research in 2020.

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 2020 through the annual groundfish multispecies trawl and longline surveys and commercial catch monitoring. North Pacific Spiny Dogfish are routinely sampled in surveys and by observers, however in 2020 due the suspension of the At Sea Observer Program and reduced survey sampling by contracted survey technician no biological samples were collected.

ii) Other Shark Species

Other species of shark are sampled opportunistically during annual groundfish multispecies trawl and longline surveys and at-sea observer sampling of the trawl fishery. In 2020 however sampling was severely curtailed with only five Blue sharks sampled. 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 2020 and the trawl fleet intercepting only 6,9 % 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 1.0% of their dogfish quota. Commercial TACs and landings for 2020 are provided in Appendix 2. To support groundfish research and account for unavoidable mortality incurred during the 2020 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 2020 through trawl and longline surveys and commercial fishery monitoring. Most individual skates encountered on groundfish research surveys are sampled (length, weight if feasible, sex) and released alive if possible, however none were sampled in 2020 due to a reduced sampling protocol implemented for contracted survey technicians. Species sampled in the commercial fishery by EM derived visual estimates of length and weight in 2020 were Longnose Skate (n=43), Sandpaper Skate (n=18) and Roughtail Skate (n=7).

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 2020 are provided in Appendix 2. To support groundfish research and account for unavoidable mortality incurred during the 2020 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 2020 through trawl and longline surveys. With the suspension of the At Sea Observer program due to COVID-19, there was no commercial sampling.

2. Assessment

The last full assessments of Pacific Cod stocks were done in 2018, using the same delay-difference model that was used in 2013. The Research Document (Res Doc 2020/70) is available at https://www.dfo-mpo.gc.ca/csas-sccs/Publications/ResDocs-DocRech/2020/2020_070-eng.html . 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.

Both 3CD and 5ABCD stock assessments were updated in 2020 and published as a Science Response (https://www.dfo-mpo.gc.ca/csas-sccs/Publications/ScR-RS/2021/2021_002-eng.html) following an approximate 75% drop in the synoptic survey index in 2018 in 3CD, accompanied by three years of commercial catches well below average. There is a 2-10% probability that the 3CD stock will fall into the Critical Zone in 2022 under a range of 2021 catch levels. There is a < 0.01% probability that the 5ABCD stock will fall into the Critical Zone in 2022. Given the large decrease in the 2018 3CD survey index and the lack of a survey in 2020 due to COVID-19, a 2021 survey observation is critical. An update to the 3CD stock assessment is scheduled to occur once the 2021 survey data are available.

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 2020 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. Following the 2020 assessment update, the commercial TAC in Area 3CD was reduced to 300 metric tonnes. See Appendix 2 for details. In addition, winter spawning closures are in effect in both Areas 3CD and 3CD.

E. Walleye Pollock

1. Research

Data collection continued in 2020 through trawl and longline surveys. With the suspension of the At Sea Observer program due to COVID-19, there was no commercial sampling after March, 2020.

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. The assessment speculated that the northern stock might be the southern tip of a larger SE Alaskan stock.

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 2020 are provided in Appendix 2. To support groundfish research and account for unavoidable mortality incurred during the 2020 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.

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.

With the suspension of the At Sea Observer program due to COVID-19, there was no commercial sampling at sea after March 2020; however, dockside sampling continued for the duration of the year.

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 2021 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 2021 model had almost the same model structure used in 2020, 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-6's, followed by age 4'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 2020 was not agreed upon by the Joint Management Committee, which means that the TAC for 2020 was set by each country individually without further mediation. Canada set their TAC to 104,480 t which is 26.12% of 400,000 t. The U.S. set their TAC to 424,810 t which is 73.88% of 575,000 t. In the usual case where the two countries agree on a coastwide TAC, Canada is allocated 26.12% and the US is allocated 73.88% of the total as agreed upon in the hake treaty. In this case, each country decided a coastwide TAC for themselves and then applied their proportion of the TAC to that. Canadian commercial TACs and landings for 2020 are provided in Appendix 2. To support groundfish research and account for unavoidable mortality incurred during the 2020 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 2020.

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. With the suspension of the At Sea Observer program due to COVID-19, there was no commercial sampling after March 2020.

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.

We have now developed and tested an automatic fish detector for the acoustic data to facilitate data processing and are currently fine-tuning this detector with additional data. We were also able to deploy acoustic recorders at our sites near Nanaimo during the spring and summer 2020 COVID lockdown. After accounting for differences in the wind speeds in April of 2020, lockdown-related reductions in ferry traffic, seaplane activity, and recreational boating activity near Nanaimo (Snake Island) combined to reduce the sound pressure levels by 86% when compared with same time period in 2019. We are now using this dataset and this natural experiment to further our exploration of impacts of noise on fish acoustic behaviour. Also in spring of 2020, we were able to record instances of herring spawning and are in the process of describing the acoustic signature of herring spawn.

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 by employing 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. We think that the up-take of the MyCatch app by anglers was affected by the COVID19 pandemic; however, we are hoping to increase awareness about the app in 2021. A graduate student, Taylor Saucier, has started at Ball State University with collaborator Dr. Paul Venturelli under this project and is continuing work that Dana and collaborators have done to assess recreational compliance in RCAs.

Dana is also working with a graduate student at the University of Victoria, Hailey Davies, with collaborator Dr. Francis Juanes. Hailey is studying survival of rockfish following the use of a descending device by using a tag-recapture experiment as well as the use of camera systems to record the release. We completed an initial field season in October-November 2020 and are planning additional field work in the summer of 2021.

ii) Offshore Rockfish

The Offshore Rockfish program in 2020 continued with one DFO person working in collaboration with an industry-sponsored scientist. All efforts were devoted to stock assessment. 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 Threatened in December of 2020 by the Committee On the Status of Endangered Wildlife In Canada (COSEWIC). DFO is now responsible for completing a Recovery Potential Analysis which will probably be completed in 2021, drawing from the results presented in the 2019 rebuilding plan analysis (Cox et al 2020).

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 assessed as being below the limit reference point (LRP) in 2010, which resulted in a published rebuilding plan. We applied the newly developed Management Procedure (MP) framework for groundfish species (DFO 2021) to evaluate the principal objective of the rebuilding plan which is to rebuild the stock above the LRP over 1.5

generations with at least 95% [19 times out of 20] probability of success. We also evaluated performance of MPs with respect to two additional conservation metrics, four average-catch objectives, and one catch-variability objective. To account for uncertainty in underlying population dynamics and data sources, we developed six alternative OM scenarios, which differed with respect to specific model and data assumptions. These OM scenarios were divided into a "reference set" (four OMs) and a "robustness set" (two OMs). We conditioned all OMs on observed catch data, indices of abundance, and available age composition data. We used closed-loop simulation to evaluate the performance of the MPs and screened out MPs that did not meet a basic set of criteria, resulting in five remaining candidate MPs: annual constant-catch MPs of 10 tonnes or 15 tonnes, and three MPs that adjust the TAC based on the relative slope of the inside hard-bottom longline (HBLL) survey index of abundance. All five final MPs met the principle objective with greater than 0.98 probability (49 times out of 50), across all four OM reference set scenarios. This was largely because none of the reference set OMs estimated the stock to be below the LRP in 2020. Within the two OM robustness set scenarios, the scenario that simulated higher variability in the future HBLL survey performed similarly to the reference set scenarios. However, under the scenario that assumed a lower rate of natural mortality for the stock ("Low M"), all MPs had lower probabilities of meeting the principle objective, with the lowest probability achieved by the current MP (constant catch of 15 t). Because all the MPs met the principle objective under the reference set scenarios, there were no strong trade-offs between conservation and catch objectives. Of the two OM robustness set scenarios,
trade-offs were most apparent under the Low M scenario, where the probability of meeting the principle objective decreased as the probability of achieving an average short-term catch of 10 t increased. We discuss major uncertainties, including uncertainty in natural mortality, selectivity, and historical catches, noting that we attempted to account for these uncertainties by evaluating performance of MPs across multiple OMs. We highlighted issues regarding estimates of current stock status for Inside Yelloweye Rockfish, and the role of reference points in the MP Framework. Performance of MPs with respect to meeting two alternative assessment criteria for the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) are also evaluated.

The Inside population of Yelloweye Rockfish was designated as Threatened in December of 2020 by the Committee On the Status of Endangered Wildlife In Canada (COSEWIC). DFO is now responsible for completing a Recovery Potential Analysis which will probably be completed in 2021, drawing from the results presented in the 2020 rebuilding plan analysis (Haggarty et al 2021).

DFO (Fisheries and Oceans Canada). 2020. Evaluation of management procedures for the inside population of Yelloweye Rockfish rebuilding plan in British Columbia. Canadian Science Advisory Secretariat Science Advisory Report 2020/nnn. https://www.dfo-mpo.gc.ca/csas-sccs/Publications/SAR-AS/2020/2020_056-eng.html.

Haggarty, D.R., Huynh, Q.C., Forrest, R.E., Anderson, S.C., Bresch, M.J., Keppel, E.A. in press. Evaluation of potential rebuilding strategies for Inside Yelloweye Rockfish (Sebastes ruberrimus) in British Columbia. DFO Can. Sci. Advis. Sec. Res. Doc. 2020/nnn. vi + 142 p.

DFO (Fisheries and Oceans Canada). 2021. A management procedure framework for groundfish in British Columbia. Canadian Science Advisory Secretariat Science Advisory Report 2021/002. https://www.dfo-mpo.gc.ca/csas-sccs/Publications/SAR-AS/2021/2021_002-eng.html

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 be reassessed in 2021 in advance of a COSEWIC reassessment. In preparation to do so, we have begun analyzing data for the inside and outside stocks and have developed initial operating models for the inside stock. We have also held a series of workshops to discuss the decision context and to develop objectives to be used for the Quillback Rockfish stocks in a MP framework analysis. We have applied for funding to continue this work which is being led by Dana Haggarty and done by consultant Quang Huynh at Blue Matter Science. We expect to complete work on the inside stock before the end of 2021-22 and to in 2022-23 for the outside stock. Completion of work on the outside stock is delayed due to the COVID19-related shut-down and subsequent reduced capacity of the PBS Sclerochronology lab which will delay completion of the outside Quillback age request.

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 (BOR) 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. A coastwide assessment in 2019 using a 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)[1] 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. A model update in 2021 using new survey and commercial CPUE indices will re-assess the magnitude of the large recruitment event.

The Research Document (RD) for the 2019 assessment is not available at present as it needs to be translated into French; however, the Science Advisory Report (Science Advisory Report 2020/025) is publicly available on the CSAS website.

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 II and Type I, respectively, by COSEWIC was designated as 'Special Concern' in 2007. In 2020, a stock assessment was conducted on two stocks of the REBS complex (SAR 2020/047), based loosely on the spatial distribution of genetically confirmed specimens from surveys: a northern stock in 5DE called 'REBS north' and southern stock in 3CD5AB called 'REBS south'. The REBS stocks were assessed using a two-fishery, annual two-sex catch-at-age model, implemented in a Bayesian framework to quantify uncertainty of estimated quantities. For each stock, a composite base case that combined nine models for REBS north and six for REBS south, using three fixed values for natural mortality (M), to incorporate the uncertainty in this parameter, and three values of catch per unit effort (CPUE) process error, were used to evaluate stock status.

For REBS north, the median female spawning biomass at the beginning of 2021 (B_{2021}) was estimated to be 0.595 (0.405, 0.840) of unfished female spawning biomass (B_0). Also, B_{2021} was estimated to be 2.21 (1.50, 3.15) times the equilibrium spawning biomass at maximum sustainable yield, B_{MSY}. There was an estimated probability of 1 that $B_{2021} > 0.4B_{MSY}$ and a probability of 1 that $B_{2021} > 0.8B_{MSY}$ (i.e., of being in the Healthy zone, Figure 6). The probability that the exploitation rate in 2020 was below that associated with MSY was 1 for both groundfish trawl and commercial non-trawl (Other) fisheries.

For REBS south, the median female spawning biomass at the beginning of 2021 (B_{2021}) was estimated to be 0.286 (0.155, 0.680) of unfished female spawning biomass (B_0). Also, B_{2021} was estimated to be 1.07 (0.582, 2.61) times the equilibrium spawning biomass at maximum sustainable yield, B_{MSY}. There was an estimated probability of >0.99 that $B_{2021} > 0.4B_{MSY}$ and a probability of 0.74 that $B_{2021} > 0.8B_{MSY}$ (i.e., of being in the Healthy zone, Figure 7). The

[1]denoting median and 0.05 and 0.95 quantiles of the Bayesian posterior distribution

probability that the exploitation rate in 2020 was below that associated with MSY was 0.42 for the groundfish trawl fishery and 0.64 for the combined commercial non-trawl (Other) fisheries.

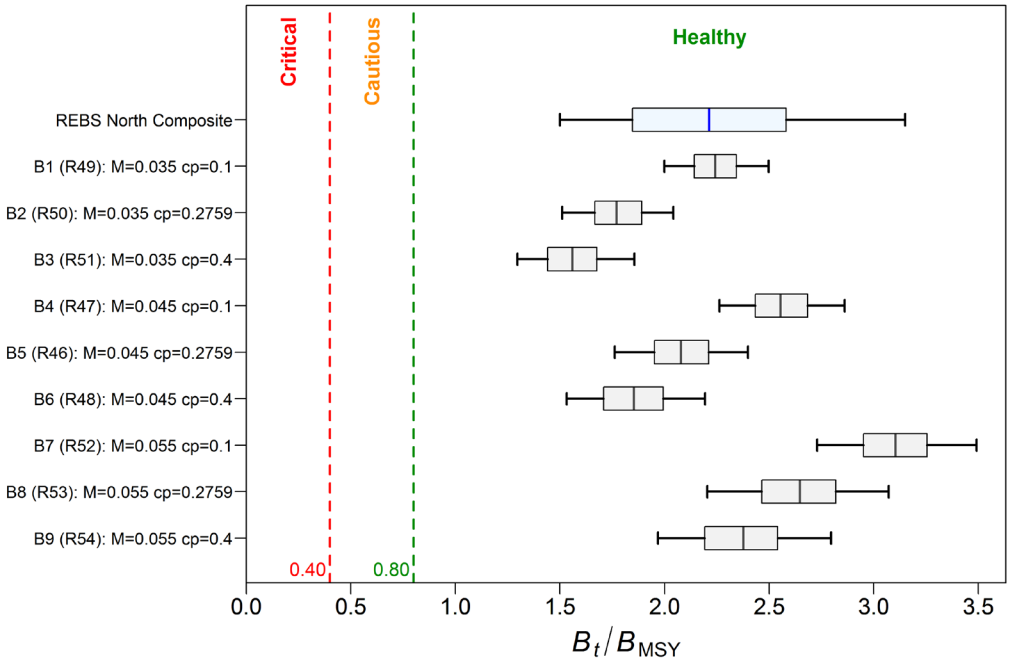

Figure 6. Status of the REBS north 5DE stock relative to the DFO Precautionary Approach (PA) provisional reference points of $0.4B_{MSY}$ and $0.8B_{MSY}$ for the t=2021 composite base cases and the component base runs that are pooled to form the composite base cases. Boxplots show the 0.05, 0.25, 0.5, 0.75 and 0.95 quantiles from the MCMC posterior.

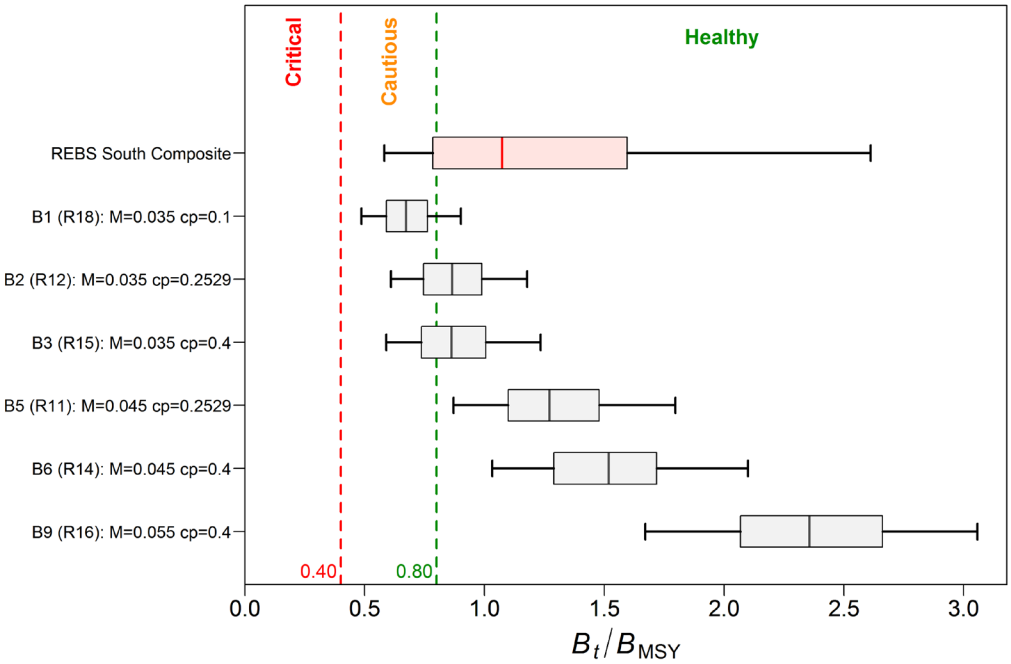

Figure 7. Status of the REBS south 3CD5AB stock relative to the DFO Precautionary Approach (PA)

provisional reference points of 0.4B_{MSY} and 0.8B_{MSY} for the t=2021 composite base cases and the component base runs that are pooled to form the composite base cases. Boxplots show the 0.05, 0.25, 0.5, 0.75 and 0.95 quantiles from the MCMC posterior.

Widow Rockfish

Widow Rockfish (WWR) along the BC coast was assessed in 2019. The research document is in translation; however, a summary report is available (Science Advisory Report 2019/044).

The composite base case for WWR 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. This biomass was estimated to be 1.51 (0.92, 2.61) of the spawning biomass at maximum sustainable yield, B_{MSY}.

Yellowtail Rockfish

Yellowtail Rockfish was last assessed in 2014. The Science Advisory Report (SAR 2015/010) is available on the CSAS website.

Canary Rockfish

In 2007, Canary Rockfish along the Pacific coast of Canada was designated as 'Threatened' by COSEWIC, with commercial fishing identified as the primary threat. The Canary Rockfish stock assessment was last updated in 2009 (Science Response 2009/019). In 2017, DFO prepared a summary of available information on Canary Rockfish in preparation for a re-assessment by COSEWIC; the pre-COSEWIC assessment is awaiting translation before appearing on the CSAS website. A new full stock assessment by DFO is planned for 2021/22.

Silvergray Rockfish

Silvergray Rockfish were last assessed in 2014. The assessment is publicly available on the CSAS website (Research Document 2016/042; SAR 2014/028).

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. In 2011, a stock assessment and recovery potential assessment was published (Research Document 2012/095; Science Advisory Report 2011/060). The estimated spawning biomass in 2011was 0.614 (0.431, 0.829) of the unfished equilibrium spawning biomass (B_0), and 1.606 (2.685, 4.573) of the spawning biomass at maximum sustainable yield (B_{MSY}), which is above the upper reference point for a healthy stock in the Sustainable Fisheries Framework (DFO 2009). A revised stock assessment will be conducted in 2021.

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 (Research Document 2017/058) is available on the CSAS website.

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 2020 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 2020 are provided in Appendix 2. To support groundfish research and account for unavoidable mortality incurred during the 2020 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 2020 are provided in Appendix 2. To support groundfish research and account for unavoidable mortality incurred during the 2020 Groundfish surveys, research catches are allocated before defining the TAC. See Appendix 2 for details.

I. Thornyheads

1. Research

Data collection continued in 2020 through trawl and longline surveys. With the suspension of the At Sea Observer program due to COVID-19, there was no commercial sampling.

2. Assessment

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

Shortspine Thornyhead was assessed in 2015 (Research Document 2017/015; Science Advisory Report 2016/016).

3. Management

Longspine and Shortspine Thornyhead are both IVQ species. Commercial TACs and landings for 2020 are provided in Appendix 2. To support groundfish research and account for unavoidable mortality incurred during the 2020 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 2020 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 contributing to a synthesis of life history characteristics across the Sablefish range (Kapur et al. 2020), 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).

Collection of biological data continued in 2020 through trawl and trap surveys. With the suspension of the At Sea Observer program due to COVID-19, there was no commercial sampling after March 2020.

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., $B_{2018}/B_{MSY} = 0.8$). 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 (Hanselman 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.

The next scheduled update to the BC Sablefish operating model is 2022/23, with a simulation-evaluation of management procedures based on the updated operating model scheduled for 2023/24.

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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 2020 are provided in Appendix 2. To support groundfish research and account for unavoidable mortality incurred during the 2020 Groundfish surveys, research catches are allocated before defining the TAC. See Appendix 2 for details.

K. Lingcod

1. Research

Data collection continued in 2020 through trawl and longline surveys and recreational creel surveys. With the suspension of the At Sea Observer program due to COVID-19, there was no commercial sampling. Additional biological samples (length, weight, sex, maturity and fins for ageing) were collected on the Outside HBLL S survey done in collaboration with industry. We are currently preparing fins for aging in order to inform survey selectivity in our next stock assessment.

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 2020 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 2020 through surveys. With the suspension of the At Sea Observer program due to COVID-19, there was no commercial sampling after March 2020.

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 2021.

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 2020. Planning is currently underway to deliver an updated assessment in 2021/22.

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 2022/23.

Dover Sole

Dover sole was last assessed in 1999. Aging of otoliths was completed in 2020 in anticipation of an updated assessment in 2022.

English Sole

English sole was also last assessed in 2007. No request for updated advice has been received, but aging of otoliths is scheduled for 2021/22 in anticipation of an updated assessment sometime in 2022/23.

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 2020 are provided in Appendix 2. To support groundfish research and account for unavoidable mortality incurred during the 2020 Groundfish surveys, research catches are allocated before defining the TAC. See Appendix 2 for details.

N. Pacific Halibut & IPHC Activities

Pacific halibut caught incidentally by Canadian groundfish trawlers are typically 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. With the suspension of the At Sea Observer program due to COVID-19, there was no commercial sampling after March 2020.

Commercial TACs and landings for 2020 are provided in Appendix 2.

O. 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 was 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 2020

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 10). 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 11).

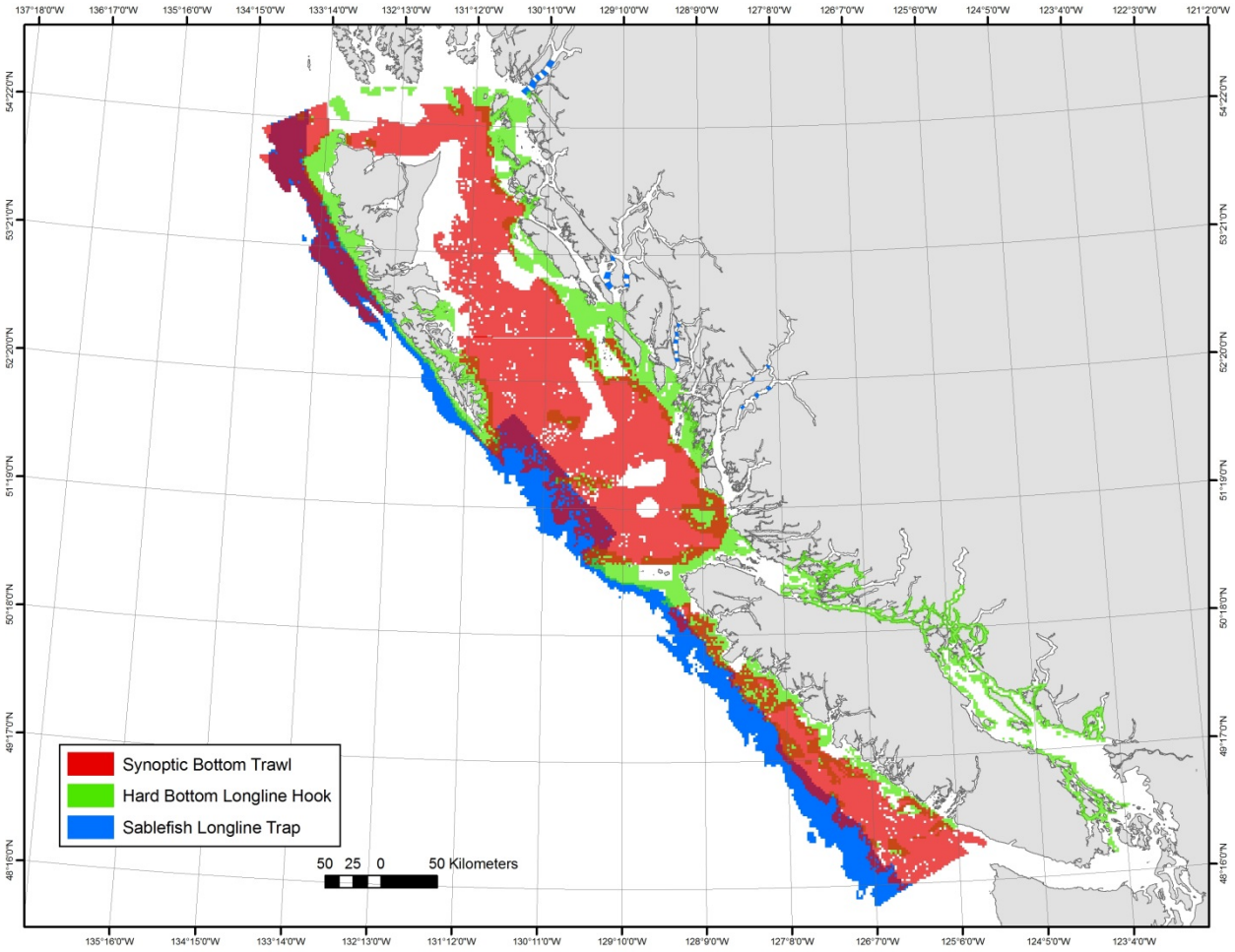

Figure 8. Random depth-stratified survey coverage.

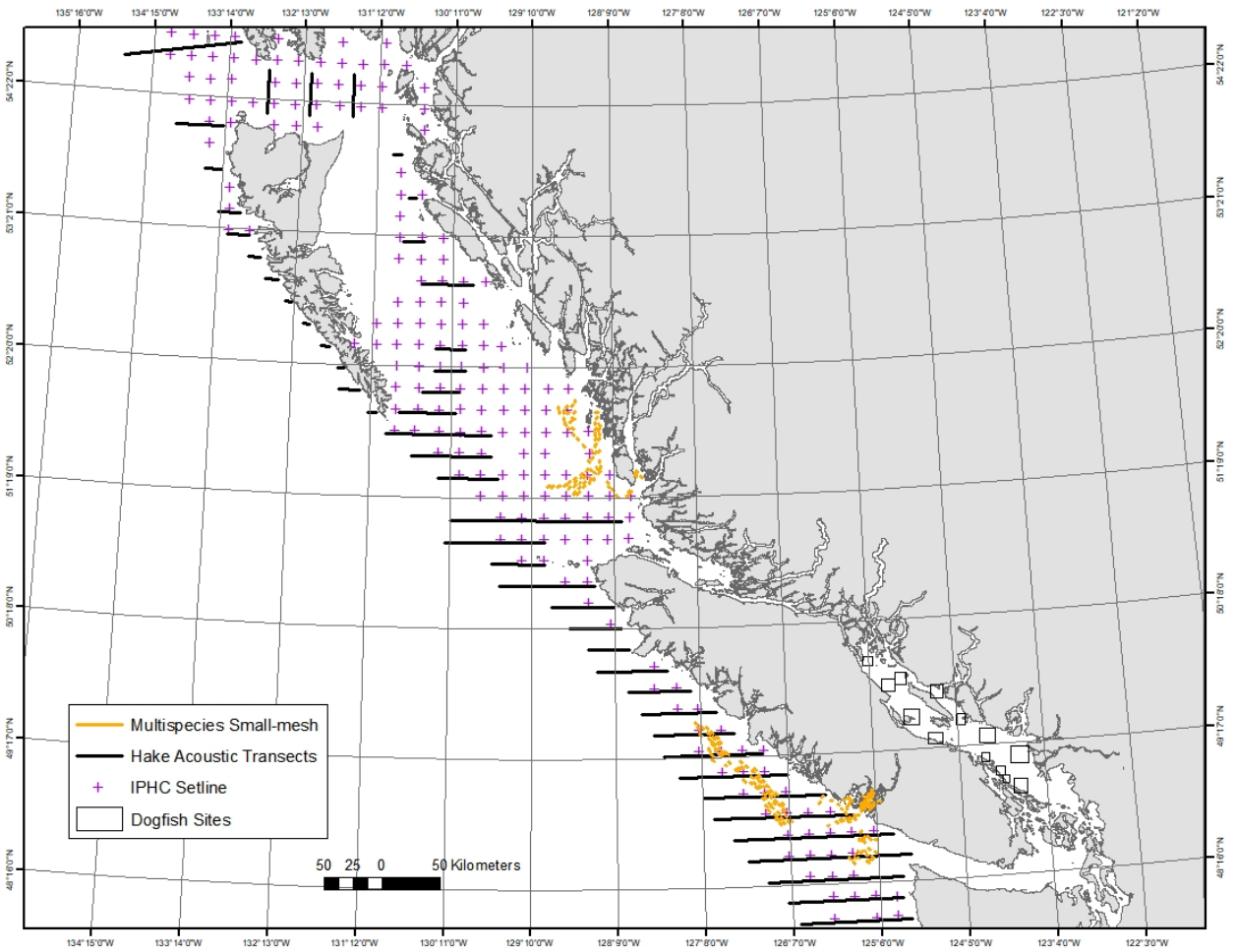

Figure 9. Non-random depth-stratified surveys that form part of the Groundfish surveys program including the Multispecies Small-mesh Bottom Trawl Survey, the Pacific Hake Acoustic Survey, and the International Pacific Halibut Commission (IPHC) Setline Survey.

Each year, two or three area-specific random depth-stratified bottom trawl surveys known as Multispecies 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.

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.

The final randomized survey conducted each year is a coast-wide longline trap survey targeting Sablefish, known as the Sablefish Research and Assessment Survey. 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 1250 m for the entire outer BC coast as well as a number of central coast inlets.

The suite of annual randomized bottom trawl, hook and line, and trap surveys is bolstered by a longline hook survey targeting North Pacific Spiny Dogfish conducted every three years and a hydroacoustic survey targeting Pacific Hake conducted each year. 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 Canadian Coast Guard research vessels by DFO staff.

Each year, Groundfish section staff also participate in the Multispecies 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. Although the IPHC survey went ahead in 2020, the program to provide an extra technician was in hiatus in 2020.

This appendix summarizes the 2020 surveys (Figure 12). The COVID-19 pandemic resulted in the suspension of many field activities and several planned surveys were deferred by one year. Some of the surveys that did go ahead were conducted with adjusted objectives and reduced staff. The surveys in 2020 included a Multispecies Synoptic Bottom Trawl survey conducted off the West Coast of Haida Gwaii, the Hard Bottom Longline Hook Survey conducted in the southern part of “outside” waters and the coast-wide Sablefish Research and Assessment Survey. The Pacific Hake Hydroacoustic Survey was a research program in 2020 and the results are not included in this report.

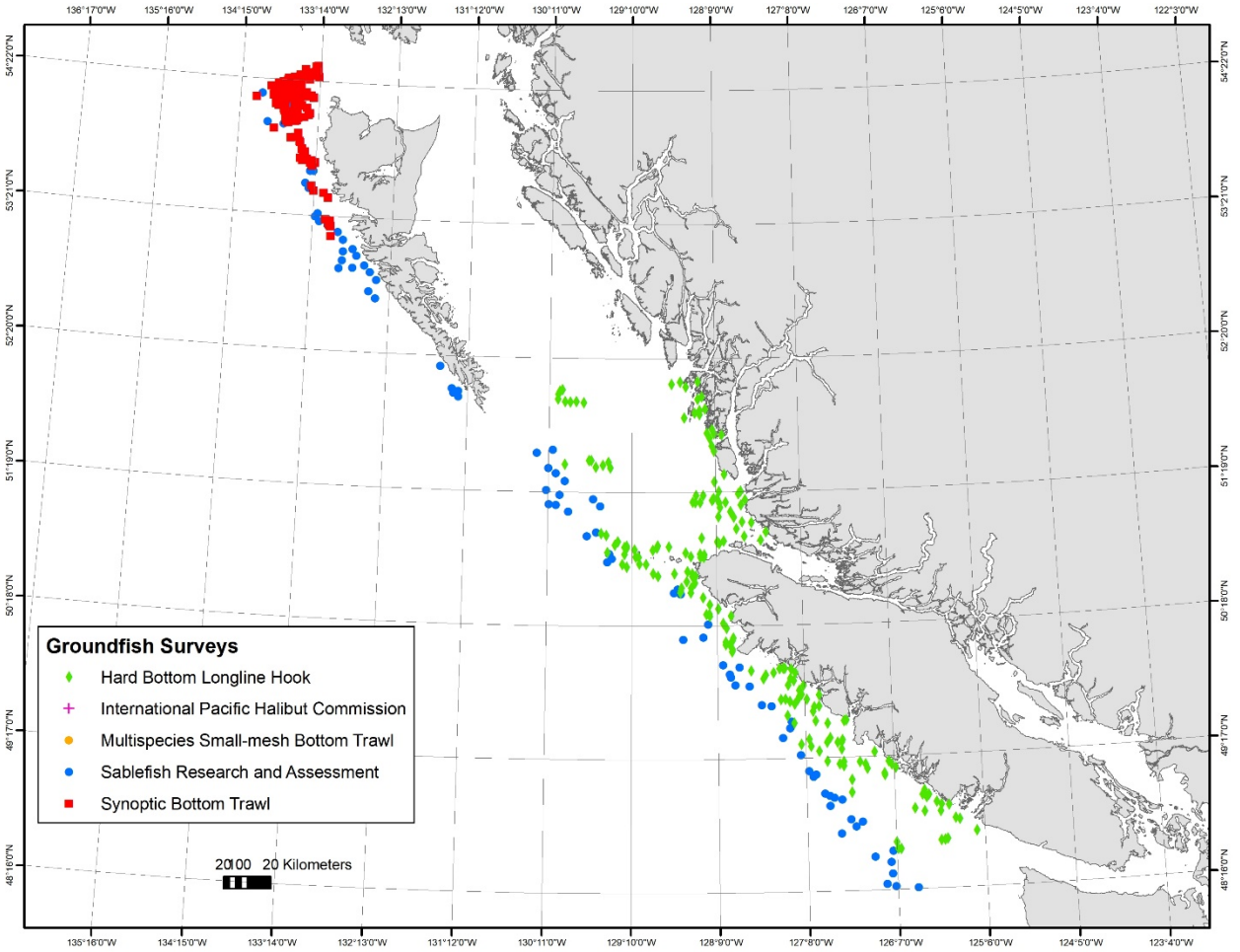

Figure 10. Fishing locations of the 2020 Groundfish surveys.

Multispecies Synoptic Bottom Trawl Surveys

Fisheries and Oceans, Canada (DFO) together with the Canadian Groundfish Research and Conservation Society (CGRCS) have implemented a comprehensive multispecies 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 13).

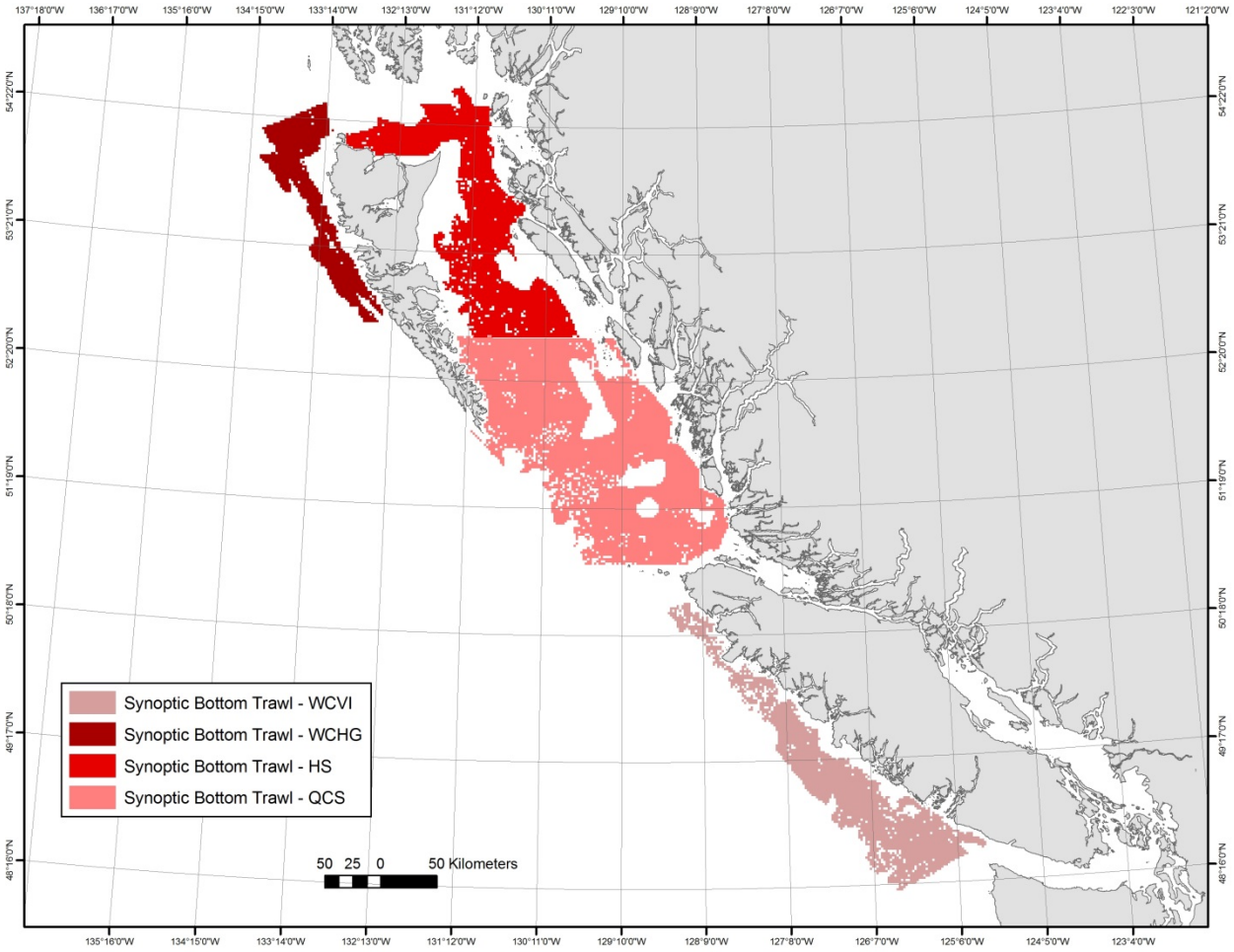

Figure 11. Multispecies Synoptic Bottom Trawl Survey coverage.

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 2020 the West Coast of Vancouver Island survey scheduled for May and June was canceled due to the COVID-19 pandemic. The intent is to complete the survey in 2021. The West Coast Haida Gwaii survey scheduled for the late summer and early fall of 2020 was conducted on a chartered commercial vessel but was not staffed with DFO personnel. As a result, the electronic data acquisition system that directly logs and records information into a database was not used. Instead, this survey was conducted using paper data forms.

The survey objectives were focused on the main goal of the survey design which is catch rate indices. As such, ancillary data collection such as the oceanographic data loggers typically attached to the trawl net were not used and the biological sampling requirements were reduced. The workload for the science staff was reduced because using paper forms is slower and less efficient than the direct electronic capture. The workload was also reduced to avoid burnout for the single science crew who were onboard for the duration of the survey.

West Coast Haida Gwaii Multispecies Synoptic Bottom Trawl Survey

The West Coast Haida Gwaii Multispecies Synoptic Bottom Trawl Survey was conducted on the F/V Nordic Pearl between August 25 and September 23, 2020. A total of 120 blocks were assessed (Table 1, Figure 14). Of the 112 total tows conducted, 96 were successful and 16 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 192,758 kg. The mean catch per tow was 1785 kg with an average of 20 different species of fish and invertebrates. The most abundant fish species encountered were Pacific Ocean Perch (*Sebastes alutus*), Silvergray Rockfish (*Sebastes brevispinis*), the Rougheye/ Blackspotted Rockfish complex (*Sebastes aleutianus/melanostictus*), Yellowmouth Rockfish (*Sebastes reedi*), Sharpchin Rockfish (*Sebastes zacentrus*), and Redstripe Rockfish (*Sebastes proriger*). 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 5,500 individual fish of 28 different species (Table 3).

Table 1. 2020 West Coast Haida Gwaii Multispecies 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-assessed 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
180 to 330 m	0	5	2	65	5	77
330 to 500 m	0	6	0	26	1	33
500 to 800 m	0	7	1	3	0	11
800 to 1300 m	1	2	0	2	6	11
Total	**1**	**20**	**3**	**96**	**12**	**132**

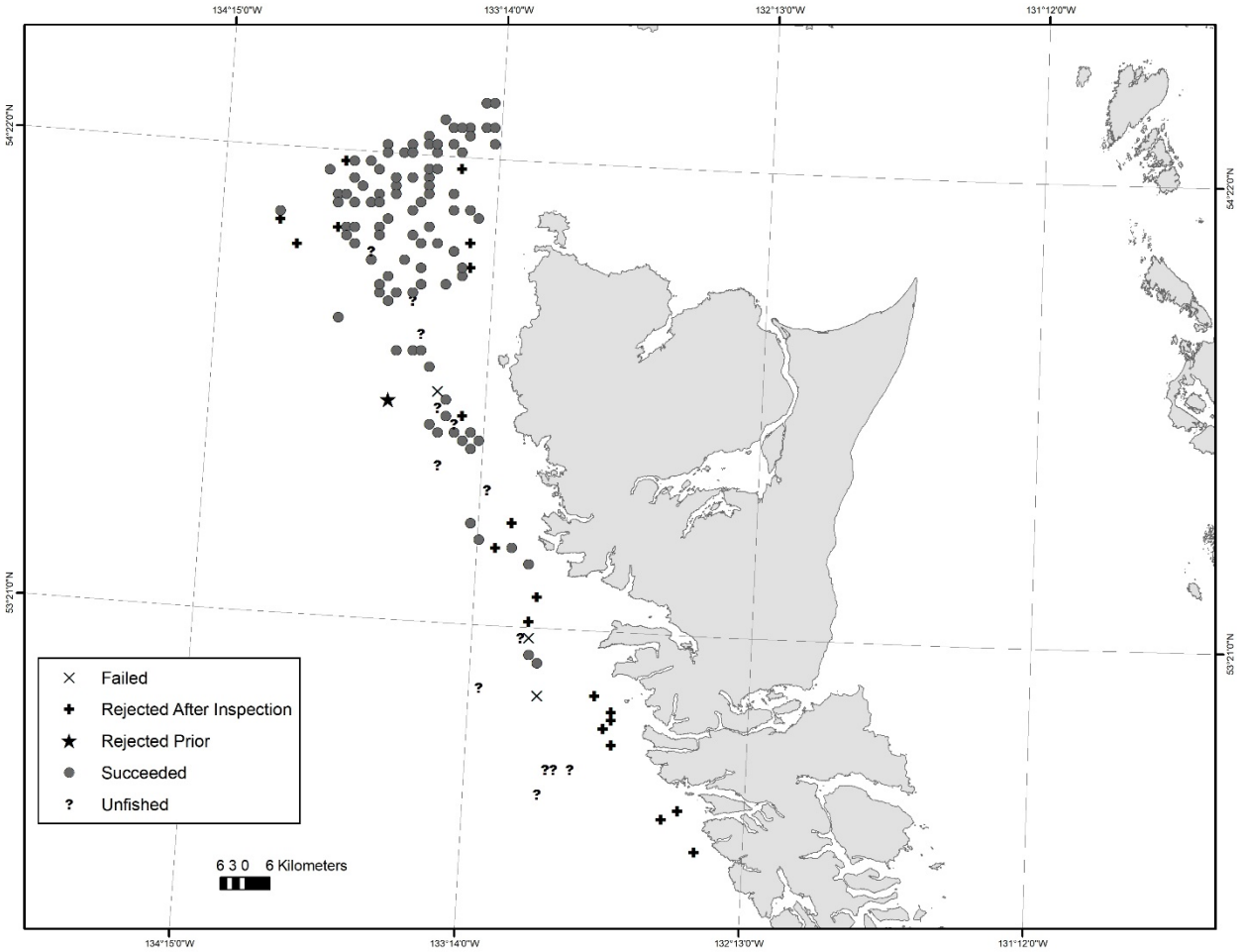

Figure 12. Final status of the allocated blocks for the 2020 West Coast Haida Gwaii Multispecies Synoptic Bottom Trawl Survey.

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 2020 West Coast Haida Gwaii Multispecies Synoptic Bottom Trawl Survey.

Species	Scientific Name	Number of Tows	Catch (kg)	Biomass (t)	Relative Error
Pacific Ocean Perch	*Sebastes alutus*	91	110358	21190	0.21
Silvergray Rockfish	*Sebastes brevispinis*	74	13823	1705	0.26
Rougheye/Blackspotted Rockfish Complex	*Sebastes aleutianus/melanostictus* complex	47	9987	3543	0.34
Sharpchin Rockfish	*Sebastes zacentrus*	63	7918	1053	0.35
Yellowmouth Rockfish	*Sebastes reedi*	33	7685	898	0.49
Redstripe Rockfish	*Sebastes proriger*	43	7094	798	0.40
Shortspine Thornyhead	*Sebastolobus alascanus*	88	4558	1731	0.08
Arrowtooth Flounder	*Atheresthes stomias*	85	2482	351	0.35
Sablefish	*Anoplopoma fimbria*	78	1797	1663	0.17
Splitnose Rockfish	*Sebastes diploproa*	27	1352	168	0.75
Canary Rockfish	*Sebastes pinniger*	11	1122	134	0.48
Dover Sole	*Microstomus pacificus*	79	923	436	0.11
Rex Sole	*Glyptocephalus zachirus*	89	861	204	0.19
Rosethorn Rockfish	*Sebastes helvomaculatus*	67	847	153	0.20
Redbanded Rockfish	*Sebastes babcocki*	73	845	148	0.24
Widow Rockfish	*Sebastes entomelas*	32	808	99	0.42
Pacific Hake	*Merluccius productus*	38	705	290	0.34
Bocaccio	*Sebastes paucispinis*	22	439	54	0.37
Shortraker Rockfish	*Sebastes borealis*	19	434	139	0.24
Pacific Halibut	*Hippoglossus stenolepis*	31	412	56	0.22
Lingcod	*Ophiodon elongatus*	32	405	57	0.21
Pacific Cod	*Gadus macrocephalus*	40	364	45	0.24
Longnose Skate	*Raja rhina*	23	329	65	0.25
Spotted Ratfish	*Hydrolagus colliei*	62	165	30	0.15
Walleye Pollock	*Gadus chalcogrammus*	38	147	20	0.21

Table 3. Number of fish sampled for biological data during the 2020 West Coast Haida Gwaii Multispecies 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
Skate	*Bathyraja* sp.	4	0	0
Aleutian Skate	*Bathyraja aleutica*	3	0	0
Arrowtooth Flounder	*Atheresthes stomias*	29	29	0
Bocaccio	*Sebastes paucispinis*	214	214	0
Canary Rockfish	*Sebastes pinniger*	118	118	0
Dover Sole	*Microstomus pacificus*	29	29	0
Lingcod	*Ophiodon elongatus*	19	19	0
Longnose Skate	*Raja rhina*	43	0	0
Longspine Thornyhead	*Sebastolobus altivelis*	65	65	0
Pacific Cod	*Gadus macrocephalus*	91	91	0
Pacific Grenadier	*Coryphaenoides acrolepis*	57	0	0
Pacific Hake	*Merluccius productus*	28	0	0
Pacific Halibut	*Hippoglossus stenolepis*	56	0	0
Pacific Ocean Perch	*Sebastes alutus*	1873	1873	0
Redbanded Rockfish	*Sebastes babcocki*	485	485	0
Redstripe Rockfish	*Sebastes proriger*	255	255	0
Rex Sole	*Glyptocephalus zachirus*	50	0	0
Rougheye/Blackspotted Rockfish Complex	*Sebastes aleutianus/melanostictus* complex	650	650	649
Roughtail Skate	*Bathyraja trachura*	7	0	0
Sablefish	*Anoplopoma fimbria*	80	80	0
Sandpaper Skate	*Bathyraja interrupta*	18	0	0
Sharpchin Rockfish	*Sebastes zacentrus*	160	0	0
Shortraker Rockfish	*Sebastes borealis*	53	53	0
Shortspine Thornyhead	*Sebastolobus alascanus*	491	373	0
Silvergray Rockfish	*Sebastes brevispinis*	473	456	0
Splitnose Rockfish	*Sebastes diploproa*	32	0	0
Yelloweye Rockfish	*Sebastes ruberrimus*	19	19	0
Yellowmouth Rockfish	*Sebastes reedi*	98	98	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 boundary between the northern and southern regions of the outside area was adjusted in 2010 to better align with the boundaries between the Queen Charlotte Sound and Hecate Strait Synoptic Bottom Trawl surveys. At total of 164 survey blocks in the vicinity of McInnes Island were moved from the southern region to the northern region. As a result, some of the work that was conducted in 2007 and 2009 which was originally part of the southern region is now considered part of the northern region.

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 area were identified through bathymetry analyses, commercial 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 but in 2019 this activity was suspended in favor of spending time completing 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 2020 the southern region of the outside area was surveyed. The scheduled survey of the southern region of the inside area was canceled due to the COVID-19 pandemic. The intent is to cover both the northern and southern regions of the inside area in 2021.

Outside (Pacific Halibut Management Association, PHMA) Survey

The 2020 Outside Hard Bottom Longline Hook Survey was conducted in the southern region. Two commercial hook and line vessels where chartered in August and together completed a total of 196 sets (Figure 15). The F/V Borealis 1 surveyed the mainland coast and Queen Charlotte Sound and completed a total of 66 sets from July 31 to August 19, 2020. The F/V Banker II surveyed the West Coast of Vancouver Island and completed a total of 130 sets from August 1 to September 22, 2020.

The most common species captured during the 2020 Outside Longline Survey was Yelloweye Rockfish (*Sebastes ruberrimus*), followed by Pacific Halibut (*Hippoglossus stenolepis*), Sablefish (*Anoplopoma fimbria*), and Quillback Rockfish (*Sebastes maliger*) (Table 4). Table 5 and Table 6 show the catch of all species by each vessel. Table 7 provides an annual summary of the total catch in the southern region.

During the Outside Longline Survey, detailed biological samples including ageing structures are collected from 50 rockfish in each set with a focus on Yelloweye Rockfish (*Sebastes ruberrimus*). If time permits, Lingcod and additional rockfish will be sampled. Table 8 provides an annual summary by species of the number of fish that were sampled for biological data during the Outside Longline Survey in the southern region. A total of 4884 individual fish were sampled for biological data in 2020. On the Borealis 1, biological data were collected from a total of 1599 individual fish (Table 9) while on the Banker II, biological data were collected from a total of 3285 individual fish (Table 10).

A temperature depth recorder was attached to most of the sets during the 2020 Outside Longline Survey.

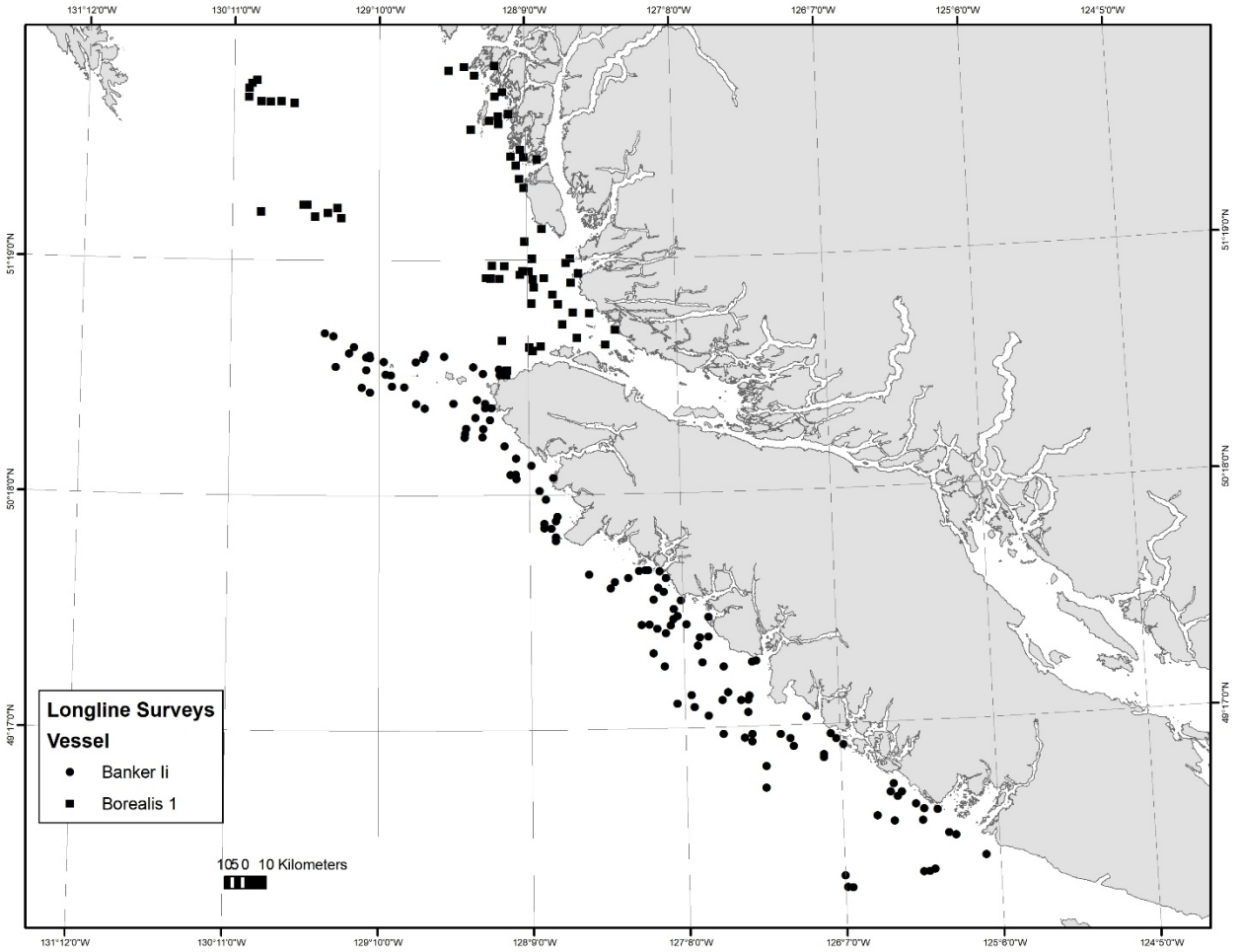

Figure 13. Longline set locations of the 2020 Outside Hard Bottom Longline Hook Survey.

Table 4. Number of sets, catch (piece count), and proportion of the total fish caught of the top 25 fish species (by piece count) from the 2020 Outside Hard Bottom Longline Hook Survey.

Species	Scientific Name	Number of Sets	Catch (count)	Proportion of Total Catch (%)
Yelloweye Rockfish	*Sebastes ruberrimus*	108	2427	15.07
Pacific Halibut	*Hippoglossus stenolepis*	175	2128	13.22
Sablefish	*Anoplopoma fimbria*	59	1987	12.34
Quillback Rockfish	*Sebastes maliger*	91	1673	10.39
Lingcod	*Ophiodon elongatus*	152	1323	8.22
Redbanded Rockfish	*Sebastes babcocki*	28	691	4.29
Spotted Ratfish	*Hydrolagus colliei*	123	684	4.25
Canary Rockfish	*Sebastes pinniger*	78	602	3.74
Longnose Skate	*Raja rhina*	122	588	3.65
North Pacific Spiny Dogfish	*Squalus suckleyi*	119	533	3.31
Pacific Cod	*Gadus macrocephalus*	57	476	2.96
Arrowtooth Flounder	*Atheresthes stomias*	58	418	2.60
Copper Rockfish	*Sebastes caurinus*	32	324	2.01
China Rockfish	*Sebastes nebulosus*	29	321	1.99
Greenstriped Rockfish	*Sebastes elongatus*	45	313	1.94
Cabezon	*Scorpaenichthys marmoratus*	36	284	1.76
Silvergray Rockfish	*Sebastes brevispinis*	53	254	1.58
Big Skate	*Beringraja binoculata*	53	180	1.12
Rosethorn Rockfish	*Sebastes helvomaculatus*	49	178	1.11
Petrale Sole	*Eopsetta jordani*	45	109	0.68
Yellowtail Rockfish	*Sebastes flavidus*	23	106	0.66
Tiger Rockfish	*Sebastes nigrocinctus*	31	75	0.47
Pacific Sanddab	*Citharichthys sordidus*	23	51	0.32
Rockfishes	*Sebastes*	3	48	0.30
Vermilion Rockfish	*Sebastes miniatus*	20	48	0.30

Table 5. Total catch (piece count) by species for the 2020 Outside Hard Bottom Longline Hook Survey sets completed by the Borealis 1.

Species	Scientific Name	Total Catch (count)
Quillback Rockfish	*Sebastes maliger*	920
Pacific Halibut	*Hippoglossus stenolepis*	845
Sablefish	*Anoplopoma fimbria*	654
Yelloweye Rockfish	*Sebastes ruberrimus*	589
Spotted Ratfish	*Hydrolagus colliei*	411
Canary Rockfish	*Sebastes pinniger*	232
Pacific Cod	*Gadus macrocephalus*	171
Lingcod	*Ophiodon elongatus*	168
North Pacific Spiny Dogfish	*Squalus suckleyi*	155
Longnose Skate	*Raja rhina*	123
Arrowtooth Flounder	*Atheresthes stomias*	91
China Rockfish	*Sebastes nebulosus*	87
Silvergray Rockfish	*Sebastes brevispinis*	77
Copper Rockfish	*Sebastes caurinus*	74
Yellowtail Rockfish	*Sebastes flavidus*	68
Rosethorn Rockfish	*Sebastes helvomaculatus*	47
Redbanded Rockfish	*Sebastes babcocki*	46
Greenstriped Rockfish	*Sebastes elongatus*	44
Tiger Rockfish	*Sebastes nigrocinctus*	38
Red Irish Lord	*Hemilepidotus hemilepidotus*	30
Cabezon	*Scorpaenichthys marmoratus*	29
Sandpaper Skate	*Bathyraja interrupta*	17
Petrale Sole	*Eopsetta jordani*	15
Big Skate	*Beringraja binoculata*	15
Southern Rock Sole	*Lepidopsetta bilineata*	14
Vermilion Rockfish	*Sebastes miniatus*	13
Shortspine Thornyhead	*Sebastolobus alascanus*	12
Blue Shark	*Prionace glauca*	11
Yellowmouth Rockfish	*Sebastes reedi*	8
Kelp Greenling	*Hexagrammos decagrammus*	6
Rougheye/Blackspotted Rockfish Complex	*Sebastes aleutianus/melanostictus* complex	6
Buffalo Sculpin	*Enophrys bison*	4
Dover Sole	*Microstomus pacificus*	2
Redstripe Rockfish	*Sebastes proriger*	2
Black Rockfish	*Sebastes melanops*	2
Wolf Eel	*Anarrhichthys ocellatus*	2
Skates	*Rajidae*	2
English Sole	*Parophrys vetulus*	1
Flathead Sole	*Hippoglossoides elassodon*	1
Pacific Hake	*Merluccius productus*	1
Unknown Fish	Unknown fish	1
Starfish	*Asteroidea*	169
Sponges	*Porifera*	21
Anemone	*Actiniaria*	10
Bivalve Molluscs	*Bivalvia*	8
Barnacles	*Cirripedia*	5
Sea Urchins	*Echinacea*	4
Red Rock Crab	*Cancer productus*	3
Octopus	*Octopus*	3
Sea Cucumbers	*Holothuroidea*	2

Species	Scientific Name	Total Catch (count)
Unknown	*Unknown*	1
Sea Pen	*Ptilosarcus gurneyi*	1
Inanimate Object(s)	*Inanimate object(s)*	1

Table 6. Total catch (piece count) by species for the 2020 Outside Hard Bottom Longline Hook Survey sets completed by the Banker II.

Species	Scientific Name	Total Catch (count)
Yelloweye Rockfish	*Sebastes ruberrimus*	1838
Sablefish	*Anoplopoma fimbria*	1333
Pacific Halibut	*Hippoglossus stenolepis*	1283
Lingcod	*Ophiodon elongatus*	1155
Quillback Rockfish	*Sebastes maliger*	753
Redbanded Rockfish	*Sebastes babcocki*	645
Longnose Skate	*Raja rhina*	465
North Pacific Spiny Dogfish	*Squalus suckleyi*	378
Canary Rockfish	*Sebastes pinniger*	370
Arrowtooth Flounder	*Atheresthes stomias*	327
Pacific Cod	*Gadus macrocephalus*	305
Spotted Ratfish	*Hydrolagus colliei*	273
Greenstriped Rockfish	*Sebastes elongatus*	269
Cabezon	*Scorpaenichthys marmoratus*	255
Copper Rockfish	*Sebastes caurinus*	250
China Rockfish	*Sebastes nebulosus*	234
Silvergray Rockfish	*Sebastes brevispinis*	177
Big Skate	*Beringraja binoculata*	165
Rosethorn Rockfish	*Sebastes helvomaculatus*	131
Petrale Sole	*Eopsetta jordani*	94
Pacific Sanddab	*Citharichthys sordidus*	51
Rockfishes	*Sebastes*	48
Yellowtail Rockfish	*Sebastes flavidus*	38
Tiger Rockfish	*Sebastes nigrocinctus*	37
Vermilion Rockfish	*Sebastes miniatus*	35
Blue Shark	*Prionace glauca*	33
Sandpaper Skate	*Bathyraja interrupta*	26
Bocaccio	*Sebastes paucispinis*	19
Yellowmouth Rockfish	*Sebastes reedi*	16
Spinyhead Sculpin	*Dasycottus setiger*	10
Kelp Greenling	*Hexagrammos decagrammus*	8
Pacific Ocean Perch	*Sebastes alutus*	8
Shortspine Thornyhead	*Sebastolobus alascanus*	7
Wolf Eel	*Anarrhichthys ocellatus*	7
Skates	*Rajidae*	7
Southern Rock Sole	*Lepidopsetta bilineata*	6
Dover Sole	*Microstomus pacificus*	3
Black Rockfish	*Sebastes melanops*	2
Starry Flounder	*Platichthys stellatus*	1
Bigmouth Sculpin	*Hemitripterus bolini*	1
Red Irish Lord	*Hemilepidotus hemilepidotus*	1
Buffalo Sculpin	*Enophrys bison*	1
Widow Rockfish	*Sebastes entomelas*	1
Bluntnose Sixgill Shark	*Hexanchus griseus*	1
Fish-Eating Star	*Stylasterias forreri*	204
Starfish	*Asteroidea*	161

Species	Scientific Name	Total Catch (count)
Anemone	*Actiniaria*	31
Giant Pacific Octopus	*Enteroctopus dofleini*	9
Long-Armed Sea Star	*Orthasterias koehleri*	9
Sea Pen	*Ptilosarcus gurneyi*	9
Sunflower Starfish	*Pycnopodia helianthoides*	8
Sea Whip	*Balticina septentrionalis*	7
Sea Urchins	*Echinacea*	6
Sea Cucumbers	*Holothuroidea*	5
Box Crabs	*Lopholithodes*	2
Inanimate Object(s)	*Inanimate object(s)*	2
Bivalve Molluscs	*Bivalvia*	1
Sea Pens	*Pennatulacea*	1
Bubble Gum Coral	*Paragorgia arborea*	1

Table 7. Annual summary of the total catch (piece count) for the top 25 species (by total piece count over all years) for the Outside Hard Bottom Longline Hook Survey southern region. Catch from 2007 and 2009 has been adjusted for sets that were originally in the southern region that were moved to the northern region when the survey areas were realigned to match the synoptic bottom trawl survey boundaries.

Species	2007	2009	2011	2014	2016	2018	2020	Total
North Pacific Spiny Dogfish	7867	4727	5854	1457	779	1268	533	22485
Yelloweye Rockfish	3679	3447	4079	2523	2444	3805	2427	22404
Pacific Halibut	2661	1725	1808	2881	2303	2218	2128	15724
Quillback Rockfish	1530	949	1718	1463	1477	2557	1673	11367
Sablefish	990	1209	912	534	1128	1641	1987	8401
Lingcod	1177	598	494	767	474	1045	1323	5878
Redbanded Rockfish	785	1112	647	507	529	1157	691	5428
Spotted Ratfish	958	255	1188	400	941	719	684	5145
Longnose Skate	1300	570	698	621	429	698	588	4904
Canary Rockfish	749	524	593	469	820	1087	602	4844
Pacific Cod	456	463	552	725	1249	456	476	4377
Arrowtooth Flounder	735	812	682	402	616	519	418	4184
Silvergray Rockfish	580	685	294	96	137	345	254	2391
China Rockfish	446	78	419	304	277	499	321	2344
Copper Rockfish	242	133	235	197	127	394	324	1652
Greenstriped Rockfish	122	126	226	122	176	167	313	1252
Rosethorn Rockfish	106	108	252	111	137	191	178	1083
Big Skate	92	134	118	93	209	203	180	1029
Cabezon	42	16	28	51	8	154	284	583
Vermilion Rockfish	92	11	80	55	32	148	48	466
Yellowtail Rockfish	30	30	61	43	58	98	106	426
Yellowmouth Rockfish	115	84	28	37	85	38	24	411
Petrale Sole	30	13	46	20	28	78	109	324
Tiger Rockfish	41	21	30	17	23	58	75	265
Sandpaper Skate	24	6	15	8	31	39	43	166

Table 8. Annual summary of the number of fish sampled for biological data during the Outside Hard Bottom Longline Hook Survey in the southern region. Totals from 2007 and 2009 have been adjusted for sets that were originally in the southern region that were moved to the northern region when the survey areas were realigned to match the synoptic bottom trawl survey boundaries.

Species	2007	2009	2011	2014	2016	2018	2020	Total
Yelloweye Rockfish	2653	2508	3072	1939	1899	2591	1917	16579
Quillback Rockfish	1256	765	1296	1449	1107	1732	1312	8917
Redbanded Rockfish	412	590	265	355	413	416	348	2799
Canary Rockfish	236	319	192	445	426	29	0	1647
China Rockfish	224	65	228	308	266	237	226	1554
Copper Rockfish	221	133	221	192	130	338	287	1522
Lingcod	0	0	0	0	0	324	741	1065
Silvergray Rockfish	74	193	104	93	23	1	0	488
Greenstriped Rockfish	35	84	72	125	74	27	0	417
Rosethorn Rockfish	32	18	92	113	85	0	0	340
Vermilion Rockfish	27	3	16	54	32	5	0	137
Tiger Rockfish	23	5	22	17	23	15	25	130
Pacific Cod	0	0	0	119	0	0	0	119
Yellowtail Rockfish	4	15	22	41	11	0	0	93
Black Rockfish	4	1	26	8	0	4	4	47
Yellowmouth Rockfish	0	5	2	36	2	0	0	45
Shortspine Thornyhead	5	6	8	16	0	0	0	35
Bocaccio	5	11	5	1	0	1	6	29
Blue Shark	0	0	0	0	0	13	12	25
Rougheye/Blackspotted Rockfish Complex	3	6	1	3	1	2	6	22
Deacon Rockfish	6	0	0	0	14	0	0	20
Redstripe Rockfish	0	1	5	0	0	0	0	6
Southern Rock Sole	0	0	5	0	0	0	0	5
Widow Rockfish	0	0	2	0	0	0	0	2
Dusky Rockfish	0	1	0	0	0	0	0	1
Chilipepper	0	0	1	0	0	0	0	1
Sharpchin Rockfish	0	0	0	1	0	0	0	1
Shortraker Rockfish	0	0	0	1	0	0	0	1
Pacific Ocean Perch	0	0	1	0	0	0	0	1

Table 9. Number of fish sampled for biological data during the 2020 Outside Hard Bottom Longline Hook Survey on the Borealis 1 showing the number of lengths and age structures that were collected by species.

Species	Scientific Name	Lengths Collected	Age Structures Collected	DNA Tissue Collected
Black Rockfish	*Sebastes melanops*	2	2	0
China Rockfish	*Sebastes nebulosus*	86	86	0
Copper Rockfish	*Sebastes caurinus*	61	61	0
Lingcod	*Ophiodon elongatus*	102	102	0
Quillback Rockfish	*Sebastes maliger*	714	716	0
Redbanded Rockfish	*Sebastes babcocki*	42	42	0
Rougheye/Blackspotted Rockfish Complex	*Sebastes aleutianus/melanostictus complex*	6	6	6
Tiger Rockfish	*Sebastes nigrocinctus*	19	19	0
Yelloweye Rockfish	*Sebastes ruberrimus*	567	567	0

Table 10. Number of fish sampled for biological data during the 2020 Outside Hard Bottom Longline Hook Survey on the Banker II showing the number of lengths and age structures that were collected by species.

Species	Scientific Name	Lengths Collected	Age Structures Collected	DNA Tissue Collected
Black Rockfish	*Sebastes melanops*	2	2	0
Blue Shark	*Prionace glauca*	12	0	12
Bocaccio	*Sebastes paucispinis*	6	6	0
China Rockfish	*Sebastes nebulosus*	140	141	0
Copper Rockfish	*Sebastes caurinus*	226	225	0
Lingcod	*Ophiodon elongatus*	639	496	0
Quillback Rockfish	*Sebastes maliger*	598	579	0
Redbanded Rockfish	*Sebastes babcocki*	306	305	0
Tiger Rockfish	*Sebastes nigrocinctus*	6	6	0
Yelloweye Rockfish	*Sebastes ruberrimus*	1350	1154	0

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 16). 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.

Recent Sablefish Research and Assessment surveys have been 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 17). 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, recent surveys have also 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. In earlier years of the program, autonomous, trap-mounted cameras were used to also collect images of the sea floor but their use was suspended following the 2017 survey.

As with all the other surveys in 2020, COVID 19 affected the Sablefish survey. DFO staff were not on board during the survey and the science complement was reduced. The objective for 2020 was the core survey goal of providing an abundance index that is used to determine the fishery total allowable catch. As such, the target number of offshore randomized tagging program sets was maintained while the inlets program were dropped. The electronic data

acquisition system that is typically used was not deployed and instead all data were collected using paper data forms. The workload for the science staff was reduced by removing any ancillary data collection including the data recorders usually deployed as part of the benthic impacts research project as well as lower priority biological samples.

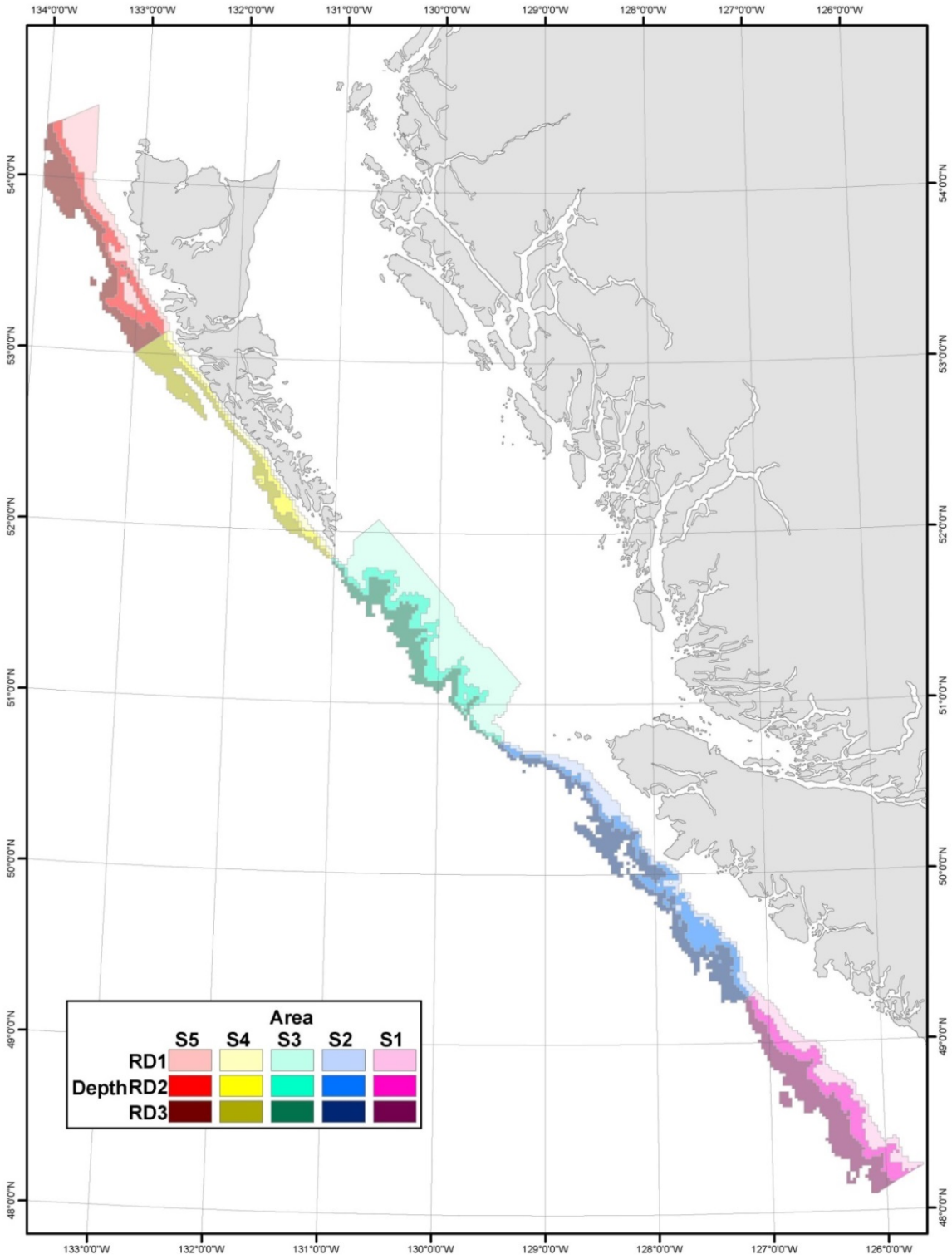

Figure 14. Sablefish Research and Assessment Survey randomized tagging program design showing the boundaries of each of the spatial and depth strata.

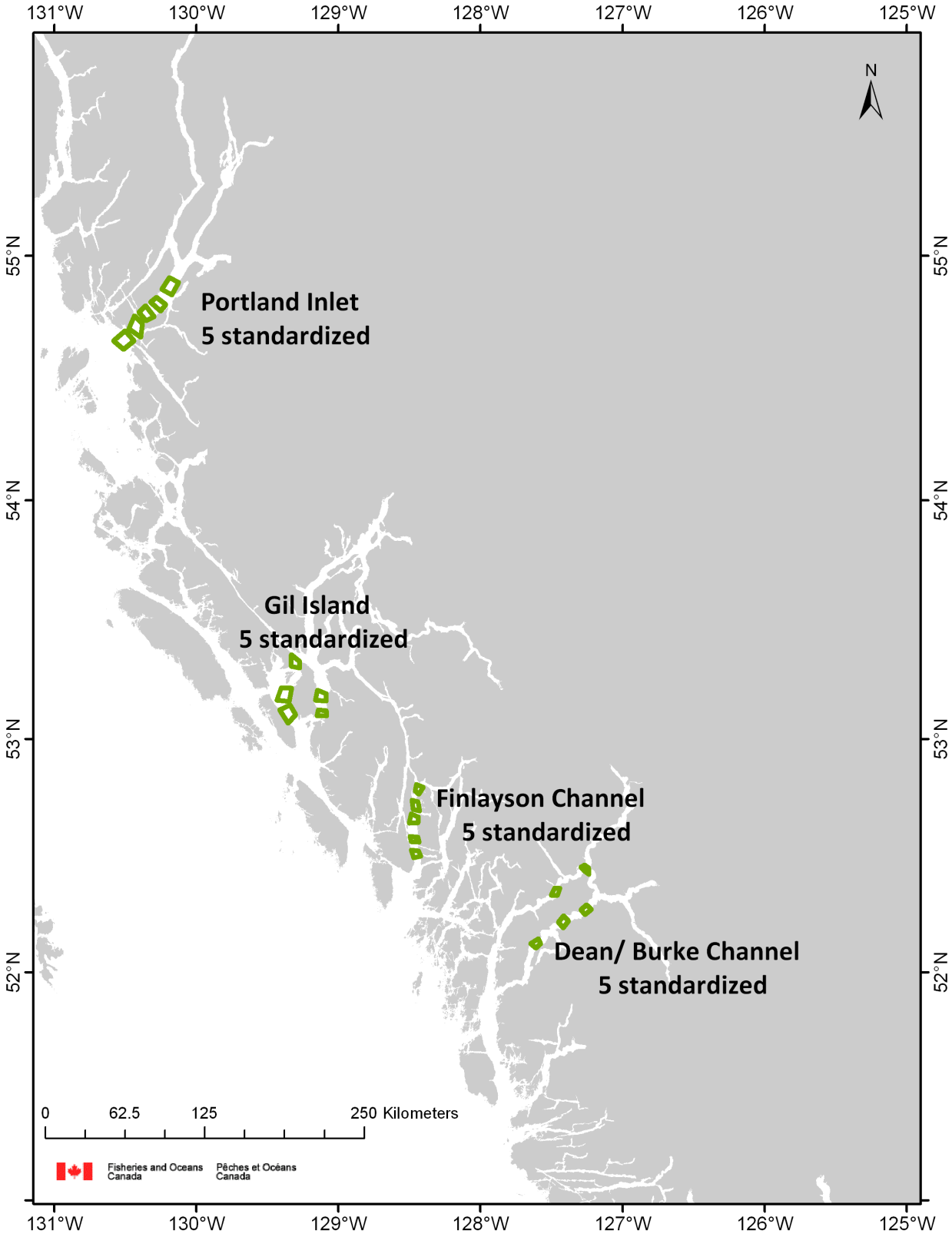

Figure 15. Sablefish Research and Assessment Survey Inlets program locations.

The 2020 Sablefish Research and Assessment Survey was conducted on the Pacific Viking from October 7 to November 21, 2020. A total of 87 Randomized Tagging Program sets were completed (Figure 18, Table 11).

The total catch of the survey was 98,180 kg (Table 12) and the average catch per set was 1128 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 Yelloweye Rockfish (*Sebastes ruberrimus*). 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 13. Annual summaries of catch for common species are shown for the Randomized Tagging Program in Table 14. Biological data, including individual length, weight, sex, maturity, and age structure were collected from a total of 12,068 individual fish of 2 different species (Table 15). An annual summary of the number of fish sampled for biological data during the Randomized Tagging Program is shown in Table 16.

Table 11. Summary of sets completed during the 2020 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)	7	6	4	17
S4 (South West Coast Haida Gwaii or SWCHG)	4	6	5	15
S5 (North West Coast Haida Gwaii or NWCHG)	6	7	5	18
Total	**29**	**34**	**24**	**87**

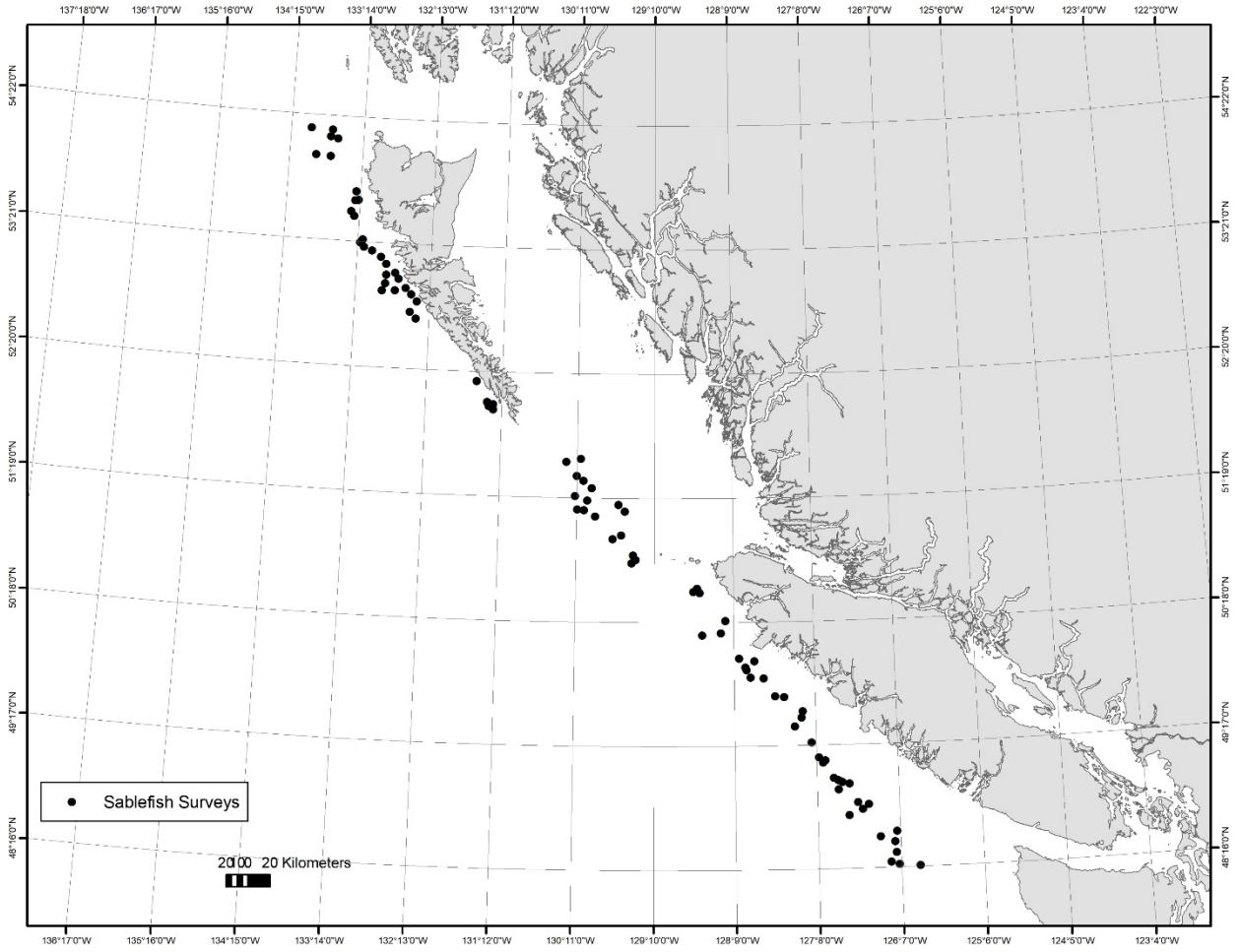

Figure 16. Set locations of the 2020 Sablefish Research and Assessment Survey.

Table 12. Total catch for the top 35 species (by weight) captured during the 2020 Sablefish Research and Assessment Survey.

Species	Scientific Name	Total Catch (count)	Total Catch (kg)
Sablefish	*Anoplopoma fimbria*	48092	92169
Pacific Halibut	*Hippoglossus stenolepis*	180	1554
Lingcod	*Ophiodon elongatus*	168	1522
North Pacific Spiny Dogfish	*Squalus suckleyi*	337	1121
Yelloweye Rockfish	*Sebastes ruberrimus*	85	302
Redbanded Rockfish	*Sebastes babcocki*	158	287
Arrowtooth Flounder	*Atheresthes stomias*	125	286
Rougheye/Blackspotted Rockfish Complex	*Sebastes aleutianus/melanostictus complex*	130	221
Giant Grenadier	*Albatrossia pectoralis*	48	218
Pacific Grenadier	*Coryphaenoides acrolepis*	227	200
Grooved Tanner Crab	*Chionoecetes tanneri*	286	117
Shortraker Rockfish	*Sebastes borealis*	17	64
Shortspine Thornyhead	*Sebastolobus alascanus*	44	55
Dover Sole	*Microstomus pacificus*	10	10
Pacific Cod	*Gadus macrocephalus*	3	6
Brown Box Crab	*Lopholithodes foraminatus*	23	6
Oregontriton	*Fusitriton oregonensis*	213	6
Rosethorn Rockfish	*Sebastes helvomaculatus*	11	4
	Paralomis multispina	12	3
Fragile Urchin	*Allocentrotus fragilis*	32	2
	Lithodes couesi	6	2
Octopus	*Octopus*	1	2
Petrale Sole	*Eopsetta jordani*	1	2
Jellyfish	*Scyphozoa*	1	1
Pacific Flatnose	*Antimora microlepis*	1	1
Walleye Pollock	*Gadus chalcogrammus*	1	1
Pink Snailfish	*Paraliparis rosaceus*	2	1
Prawn	*Pandalus platyceros*	7	0
Fish-Eating Star	*Stylasterias forreri*	5	0
Papillose Sea Cucumber	*Synallactes challengeri*	1	0
Golden King Crab	*Lithodes aequispinus*	1	0
	Solaster	1	0
Longspine Thornyhead	*Sebastolobus altivelis*	2	0
	Myxoderma sacculatum	1	0
	Mediaster tenellus	1	0

Table 13. 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 count) captured during the 2020 Sablefish Research and Assessment Survey Randomized Tagging Program sets. Species that were only captured once have been omitted from the table.

Species	Scientific Name	Number of Sets	Catch (count)	Proportion of Total Catch (%)	3C	3D	5A	5B	5E
Sablefish	*Anoplopoma fimbria*	87	48092	96.88	13983	10047	4844	3835	15383
North Pacific Spiny Dogfish	*Squalus suckleyi*	23	337	0.68	20	33	79	22	183
Pacific Grenadier	*Coryphaenoides acrolepis*	15	227	0.46	11	32	14	2	168
Pacific Halibut	*Hippoglossus stenolepis*	30	180	0.36	12	27	29	15	97
Lingcod	*Ophiodon elongatus*	18	168	0.34	4	2	121	1	40
Redbanded Rockfish	*Sebastes babcocki*	23	158	0.32	11	3	80	22	42
Rougheye/Blackspotted Rockfish Complex	*Sebastes aleutianus/melanostictus* complex	20	130	0.26	9	17	4	43	57
Arrowtooth Flounder	*Atheresthes stomias*	22	125	0.25	14	51	15	10	35
Yelloweye Rockfish	*Sebastes ruberrimus*	6	85	0.17	0	0	71	0	14
Giant Grenadier	*Albatrossia pectoralis*	16	48	0.10	4	13	1	0	30
Shortspine Thornyhead	*Sebastolobus alascanus*	27	44	0.09	2	15	12	1	14
Shortraker Rockfish	*Sebastes borealis*	8	17	0.03	0	2	2	8	5
Rosethorn Rockfish	*Sebastes helvomaculatus*	7	11	0.02	0	0	2	3	6
Dover Sole	*Microstomus pacificus*	8	10	0.02	1	3	3	1	2
Pacific Cod	*Gadus macrocephalus*	2	3	0.01	1	0	0	0	2
Longspine Thornyhead	*Sebastolobus altivelis*	2	2	0.00	0	0	0	0	2

Table 14. 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 2007 have been omitted from this table.

Species	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Sablefish	20326	15529	17375	22568	16845	18095	14266	25428	18073	36604	46808	60965	48092
Arrowtooth Flounder	1163	1787	553	1037	921	414	864	610	427	686	336	100	125
Pacific Grenadier	608	829	676	742	715	254	534	686	627	276	346	200	227
North Pacific Spiny Dogfish	162	565	414	868	966	386	287	365	699	158	964	567	337
Rougheye/Blackspotted Rockfish Complex	513	418	406	266	941	223	488	320	386	257	177	290	130
Pacific Halibut	125	224	172	256	342	99	447	444	283	165	323	223	180
Redbanded Rockfish	257	150	131	244	208	127	241	295	217	287	219	221	158
Lingcod	109	93	97	165	71	88	92	121	154	106	192	200	168
Giant Grenadier	146	179	118	105	195	80	87	206	72	67	106	46	48
Yelloweye Rockfish	58	60	21	106	34	13	17	81	97	22	311	49	85

Table 15. Number of fish sampled for biological data during the 2020 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
Sablefish	*Anoplopoma fimbria*	8277	11968	3587	0
Rougheye/Blackspotted Rockfish Complex	*Sebastes aleutianus/melanostictus* complex	0	126	126	126

Table 16. 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 2007 have been omitted from this table.

Species	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Sablefish	11059	9331	10270	12463	10486	10118	8204	12094	9910	15841	13094	13721	11942
Rougheye/Blackspotted Rockfish Complex	282	289	266	240	393	179	373	270	270	183	144	195	126
Pacific Grenadier	461	562	378	471	380	188	0	0	0	0	0	0	0
Arrowtooth Flounder	441	379	245	400	656	140	0	0	0	0	0	0	0
North Pacific Spiny Dogfish	0	219	326	440	674	207	0	0	0	0	0	0	0
Redbanded Rockfish	224	145	131	243	204	113	0	0	0	29	0	0	0
Giant Grenadier	129	141	111	99	195	79	0	0	0	0	0	0	0
Pacific Halibut	0	2	60	5	15	0	0	0	0	158	261	216	0
Yelloweye Rockfish	55	60	21	106	32	12	0	75	58	21	150	49	0
Shortraker Rockfish	53	65	73	18	59	18	13	10	59	26	24	11	0
Pacific Flatnose	18	39	27	17	24	11	0	0	10	0	0	0	0
Shortspine Thornyhead	1	9	26	22	53	34	0	0	0	0	0	0	0
Lingcod	0	27	36	1	3	1	0	0	0	0	0	0	0
Rosethorn Rockfish	8	6	2	23	7	3	0	0	0	0	0	0	0
Dover Sole	3	1	3	13	18	3	0	0	0	0	0	0	0
Rosy Snailfish	30	0	0	1	0	0	0	0	0	0	0	0	0

Appendix 2: British Columbia commercial groundfish TACs, landings, and research allocations for 2020.

Table 1. British Columbia Groundfish Total Allowable Catch (TAC) and commercial landings in metric tonnes (t) for 2020. Except where noted, TACs are from the 2020 Groundfish Integrated Fisheries Management Plan (https://waves-vagues.dfo-mpo.gc.ca/Library/40935218.pdf). Landings are the published quota sector summaries (https://www.pac.dfo-mpo.gc.ca/fm-gp/groundfish-poissons-fond/publications-eng.html) and may not yet be complete for 2020.

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	309	9,520	53	14,000	362
Big Skate	914	114	118	15	1,032	129
Longnose Skate	195	92	263	72	458	164
Pacific Cod	1,450	481	0	0	1,450	481
Walleye Pollock	4,935	6,516	0	0	4,935	6516
Pacific Hake [1]	7,000 gulf & 104,480 offshore	94,280	0	0	111,480	94,280
Rockfishes						
Rougheye/Blackspotted Rockfish Complex	636	TBD	484	TBD	1,120	TBD
Pacific Ocean Perch	5,192	2,618	1	0	5,193	2,618
Redbanded Rockfish	295	129	284	141	579	270
Shortraker Rockfish	126	17	111	79	237	96
Silvergray Rockfish	1,945	1,423	254	24	2,199	1,447
Widow Rockfish	2,500	1,987	46	0	2,546	1,987
Yellowtail Rockfish	5,440	3,315	60	0	5,500	3,315
Quillback Rockfish	4	0	151	58	155	58
Bocaccio	300	290	0	0	300	290
Canary Rockfish	965	596	135	7	1,100	603
Redstripe Rockfish	1,550	35	43	0	1,593	35
Yellowmouth Rockfish	2,364	1,154	78	0	2,442	1,154
Yelloweye Rockfish	3	6	113	73	116	79
Copper, China, And Tiger Rockfish	1	1	63	47	64	48

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	736	142	34	83	770	225
Longspine Thornyhead	405	21	20	0	425	21
Sablefish	257	88	2680	2,420	2,937	2,508
Lingcod	2572	306	1168	547	3,740	853
Flatfishes						
Arrowtooth Flounder	5000	1,954	0	0	5,000	1,954
Petrale Sole	900	416	0	0	900	416
Southern Rock Sole	1,552	170	0	0	1,552	170
Dover Sole	3,073	1,313	0	0	3,073	1,313
English Sole	822	354	0	0	822	354
Pacific Halibut [2,3]	454	135	2,299	2,198	2,753	2,333

[1] Hake TAC provided by Chris Grandin

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

[3]The groundfish trawl fishery has a bycatch mortality cap of 454 tonnes that is not part of the allocated commercial TAC. Halibut caught while fishing under the authority of a groundfish trawl licence cannot be retained and must be returned to the water as quickly as possible

Table 2. British Columbia Groundfish research allocations in metric tonnes (t) for 2020. 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 2020 Groundfish Integrated Fisheries Management Plan (https://waves-vagues.dfo-mpo.gc.ca/Library/40935218.pdf).

Species or Species Group	Trawl surveys (t)	Longline surveys (t)	Sablefish surveys (t)	Total (t)
Sharks And Skates				
North Pacific Spiny Dogfish	12.1	--	--	12.1
Big Skate	0.2	--	--	0.2
Longnose Skate	1.2	--	--	1.2
Pacific Cod	2.6	--	--	2.6
Walleye Pollock	1.2	--	--	1.2
Pacific Hake	4.6	--	--	4.6
Rockfishes				
Rougheye/Blackspotted Rockfish Complex	16.1	23.7	--	39.8
Pacific Ocean Perch	99.9	--	--	99.9
Redbanded Rockfish	1.7	11.6	--	13.3
Shortraker Rockfish	0.9	5.4	--	6.3
Silvergray Rockfish	12.2	12.7	--	24.9
Widow Rockfish	0.8	--	--	0.8
Yellowtail Rockfish	6.5	2.0	--	8.5
Quillback Rockfish	0.1	5.8	--	5.9
Bocaccio	0.5	--	--	0.5
Canary Rockfish	6.2	6.5	--	12.7
Redstripe Rockfish	13.7	--	--	13.7
Yellowmouth Rockfish	7.2	3.0	--	10.2
Yelloweye Rockfish	0.2	15.8	--	13.0
Copper, China, And Tiger Rockfish	0.0	2.8	--	2.8
Thornyheads				
Shortspine Thornyhead	6.6	0.9	--	7.5
Longspine Thornyhead	0.5	--	--	0.5

Table 2. Continued.

Species or Species Group	Trawl surveys (t)	Longline surveys (t)	Sablefish surveys (t)	Total (t)
Sablefish	12.1	1.0	60	73.1
Lingcod	2.0	5.7	--	7.7
Flatfishes				
Arrowtooth Flounder	20.7	--	--	20.7
Petrale Sole	1.5	--	--	1.5
Southern Rock Sole	0.5	--	--	0.5
Dover Sole	6.1	--	--	6.1
English Sole	2.6	--	--	2.6
Pacific Halibut [1]	1.6	27.2	--	28.8

[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.