CANADA

Report on Groundfish Activities by DFO Pacific Region in 2023

April 2024

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

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A. 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 Diane Lebouthillier
Deputy Minister	Annette Gibbons
Regional Director General	Susan Chambers
Fisheries Management Branch	
Regional Director of Fisheries Management	Neil Davis
Director of Resource Management	Danielle Scriven (Acting)
Regional Manager of Groundfish	Maureen Finn (Acting)
Science Branch	
Regional Director of Science	Andrew Thomson
Strategic Science Initiatives Division (SSID)	March Klaver (Acting)
Centre for Science Advice – Pacific	Miriam O
Stock Assessment and Research Division (StAR)	John Holmes
Groundfish Section	Dana Haggarty
Quantitative Assessment Methods Section	Steve Schut
Fisheries and Assessment Data Section	Shelee Hamilton
Marine Invertebrates Section	Ken Fong
Salmon Assessment	Antonio Velez-Espino
Salmon Coordinator	Dawn Lewis
Aquatic Diagnostics, Genomics & Technology Division (ADGT)	Jon Chamberlain
Applied Technology (includes Sclerochronology Lab)	Jackie Detering (Acting)
Genetics	Geoff Lowe (Acting)
Aquatic Animal Health	Kristen Westfall (Acting)
Ecosystem Science Division (ESD)	Eddy Kennedy
Marine Spatial Ecology & Analysis	Tammy Norgard
Aquatic Ecosystem & Marine Mammals	Sean MacConnachie
Regional Ecosystem Effects on Fish & Fisheries	Michelle Charbonneau
Freshwater Ecosystems	Jeffery Lemieux
Nearshore Ecosystems	Cher LaCoste
Ocean Science Division (OSD):	Kim Houston
Ecology and Biogeochemistry	Neil Dangerfield
Modelling & Prediction	Di Wan (Acting)
State of the Ocean	Stephen Page

Canadian Hydrographic Service (CHS) Mariah McCooey

Groundfish research and stock assessment work is conducted amongst the Groundfish, Fisheries and Assessment Data, and Quantitative Methods Sections within the Stock Assessment and Research (StAR) division. Groundfish specimen ageing and genetics are conducted in the Applied Technologies and Genetics Sections in Aquatic Diagnostics, Genomics & Technology Division (ADGT). Acoustic fisheries research and surveys are led by the Ecology and Biogeochemistry Section in Ocean Science Division (OSD). Ecosystem studies, marine protected areas research and planning, and habitat research is undertaken in collaboration with staff in the Ecosystems Science Division (ESD). The Canadian Hydrographic Service (CHS) is responsible for hydrographic surveys and navigational products and services in Canada.

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 (SMEs) 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. A proceedings document summarizing the meeting is also available for meetings that took place until summer of 2023; but this series has now been discontinued. Updates to accepted stock assessments as well as management procedure updates can be published as Science Response documents. All four types of documents can be downloaded from the Canadian Stock Assessment Secretariat website. 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. In 2023, Groundfish surveys were completed on the Neocaligus and Sir John Franklin.

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 2023 Groundfish Integrated Fisheries Management Plan v.3.0 (IFMP) is available from the Federal Science Library (https://waves-vagues.dfo-mpo.gc.ca/library-bibliotheque/41098067.pdf).

Allocations of fish for financing scientific and management activities are identified in the Groundfish IFMP. Use of Fish Collaborative Agreements were developed for 2023-24 between Fisheries and Oceans Canada and Wild Canadian Sablefish (multi-year agreement to the end of 2026), Pacific Halibut Management Association of BC (multi-year agreement to the end of 2026), and the Canadian Groundfish Research and Conservation Society to support groundfish science activities through the allocation of fish to finance the activities (updated annually).

Fish stock provisions

Following amendments made to Canada's *Fisheries Act*, new regulations amending the Fishery (General) Regulations, ss. 69-70, were published in *Canada Gazette Part II*, including required contents of rebuilding plans. The Fish Stocks provisions have come into force for 30 prescribed major fish stocks on **April 4, 2021**. Rebuilding requirements under the Fish Stock Provisions will apply to Inside Yelloweye Rockfish and Bocaccio. Domestic Fisheries Policy is currently finalizing approvals for revised Rebuilding Plan Guidelines to support the development of rebuilding plans to meet these requirements. Other Pacific groundfish stocks listed as "major stocks" but that don't require rebuilding plans include Outside Yelloweye Rockfish, Pacific Hake, and Sablefish. Other Pacific groundfish stocks will be gazetted in following batches in subsequent years.

The second batch of major stocks to be gazetted is expected soon.

I. Surveys

B. 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 along with a Microsoft Access 2016 front-end.

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 29,516 trips and 12,090,314 individual fish specimens. In 2023, data entry activities concentrated on input of current-year groundfish research cruises and hake dockside commercial samples.

The **Sclerochronology Lab Direct Data Entry Application**, or **SCLDDE** for short, is a software application developed in 2021-2022 for direct entry of fish ages and related data by Sclerochronology Lab (SCL) staff into GFBio. The application incorporates the age request process (where a researcher selects available samples from GFBio and requests ages), provides a means for SCL staff to view and prioritize requests, and then provides data entry forms for real-time entry of ages and other associated information. In 2023, the Sclerochronology lab transitioned to using the SCLDDE for all groundfish aging, with 85% of the ages directly entered into GFBio using the tool. In total, 20,267 groundfish ages were recorded in GFBio for Pacific Hake, Pacific Ocean Perch, Bocaccio, Sablefish, Lingcod, and Dover Sole.

GFFOS is a SQL database developed by DFO Science staff and maintained by the Groundfish Data Unit. GFFOS contains reformatted and manipulated data from commercial groundfish

fishery data held in the Fishery Operations System (FOS) oracle database. The groundfish modules of FOS are maintained by the Fisheries Management Branch of DFO and hold data such as hail out / hail in information, fisher logs, observer logs, and offload information from the dockside monitoring program. GFFOS imports key information from FOS tables, reformatted to facilitate querying by DFO Science staff, and uses the available sources of catch information to produce “best estimates” of catch.

C. Commercial Fishery Monitoring and Biological Sampling

Fishery Monitoring

Groundfish commercial fisheries in British Columbia are subject to 100% catch monitoring. This requirement is met using an electronic monitoring (EM) system on each trip. In addition, a dockside monitoring program (DMP) validates all commercial landings. EM systems must meet standards specified by DFO, must be functional for the duration of any fishing trip, and are subject to an audit following every trip. The combination of fisher logbooks with EM and DMP are intended to provide an accurate and complete record of all fishing that takes place under a commercial groundfish fishing licence. The Groundfish Trawl fishery currently uses an EM program to fulfil the 100% at-sea monitoring requirement previously fulfilled by the at-sea observer program (ASOP). The EM program includes equipment (cameras, hydraulic and rotational sensors, GPS) which must meet certain standards, video-monitored fixed measuring grids for all releases of lingcod and sablefish which are subject to size limits, and an audit program to ensure the accuracy of fishing logs. Consequences for non-compliance with EM audit standards may include partial or 100 per cent replacement of fisher logbook data with EM estimates when audits do not meet standards.

Commercial fishery data from 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. EM data are held separately but may be used to replace fisher logbook data in FOS per audit requirements. Groundfish Science maintains the SQL database GFFOS, which contains the post-audit groundfish FOS data, reformatted to be useful for scientific purposes.

Pacific Salmon Bycatch Monitoring

Enhanced Bycatch Monitoring Program

The BC commercial groundfish fishery encounters Pacific salmon (*Oncorhynchus spp.*) incidentally while targeting groundfish species. Beginning in 2021, in response to concerns about potentially high numbers of Pacific salmon, particularly Chinook salmon (Oncorhynchus tshawytscha) being encountered by midwater trawl gear, DFO engaged with industry representatives and monitoring service providers to review monitoring procedures and develop an enhanced monitoring and sampling program for salmon bycatch. The purpose of the enhanced monitoring was to improve the accuracy of estimates of salmon catch by species and collect coded wire tag (CWT) and stock composition information to assess potential impacts on Chinook salmon (*Oncorhynchus tshawytscha*) stocks of concern.

Prior to implementation of the enhanced monitoring program, there were no requirements for monitoring Pacific salmon in the groundfish trawl fishery, other than the requirements that apply to all species encountered in the fishery. As a prohibited species, Pacific salmon were not allowed to be targeted and were required to be released at-sea if caught. Therefore, available estimates of Pacific salmon catch were based on fisher logbook information, with dockside validation only when Pacific salmon were landed incidentally. Before March 2020, the at-sea observer program (ASOP) provided independent monitoring of retained and released catch of Pacific salmon as described above. In addition, opportunistic at-sea or shoreside biological sampling, including the retention of heads from adipose clipped Chinook and Coho and the recording of lengths and weights, occurred as a lower priority to other groundfish catch monitoring duties.

The enhanced monitoring program for salmon bycatch was developed collaboratively with representatives from DFO Pacific Region Science and Fisheries Management (Salmon and Groundfish), the groundfish trawl industry, the David Suzuki Foundation, and monitoring service providers from Archipelago Marine Research Ltd. and J.O. Thomas and Associates Ltd. The program was implemented on September 26, 2022 and included revised retention and monitoring requirements in order to provide more accurate estimates of bycatch counts by species and collect CWT and genetic samples.

In consideration of information needs for assessment and management, the following four objectives were used to guide development of the program:

1. Accurately estimate fishery catch counts (pieces) of fish of each Pacific salmon species;
2. Ensure sufficiently precise and representative CWT sampling to quantify the fishery mortality for Chinook CWT exploitation rate indicator stocks;
3. Use genetic stock identification to identify the stock composition of Chinook catch, including for populations that do not have CWT exploitation rate indicator stocks; and
4. Estimate the spatial and temporal distribution of Chinook catch to determine when and where mortality on stocks of concern may be occurring.

Initial results of the enhanced monitoring program are included in a report completed in 2023 (Lagasse et al. 2024). This report summarizes estimates of Pacific salmon bycatch in the groundfish trawl fishery since 2008, with a focus on the 2022/23 fishery. Catch of Pacific salmon in the 2022/23 fishery was the highest recorded since 2008 with a total catch of 28,117 Pacific salmon, including 26,273 Chinook salmon (93%). Most of this catch occurred during the enhanced monitoring period from September 26, 2022 to February 20, 2023, with 15,234 Chinook salmon sampled during this period for CWT analysis and estimation of stock composition. Most of the Canadian-origin Chinook salmon catch originated from southern BC stock management units, with some stocks of concern identified.

The program continued through the 2023/24 fishery and funding has been renewed for the 2024/25 fishery. Additional results will be described in future reports.

Changes to Groundfish Fishery Management

Preliminary results of the Enhanced Salmon Sampling Program showed a significant amount of Pacific salmon bycatch in the areas around the northeastern portion of Vancouver Island. In November 2023, based on these results and in a precautionary effort to reduce salmon bycatch in this area, DFO implemented area closures in specific subareas of Pacific Fisheries Management Area (PFMA) 12 for the remainder of the 2023/24 groundfish mid-water trawl fishing season.

Beginning in the 2024/25 groundfish season, DFO implemented a fleetwide Chinook bycatch cap of 9,500 pieces to reduce Chinook bycatch in groundfish trawl. DFO is continuing to work with groundfish trawl harvesters and other interested parties to develop a longer-term strategy to minimize salmon bycatch in groundfish trawl fisheries.

Literature Cited:

Lagasse, C.R., Fraser, K.A., Houtman, R., Grundmann, E., Komick, N., O'Brien, M., Braithwaite, E., Cornthwaite, A. M. 2024. Review of Salmon Bycatch in the Pacific Region 2022/23 Groundfish Trawl Fishery and Preliminary Results of an Enhanced Monitoring Program. Can. Manuscr. Rep. Fish. Aquat. Sci. 3273: v + 35 p. https://publications.gc.ca/collections/collection_2024/mpo-dfo/fs97-4/Fs97-4-3273-eng.pdf

Biological Sampling

Biological samples have previously been collected from the commercial groundfish fishery by at-sea observers in the trawl fishery and through dockside sampling of the trawl fishery and sablefish trap/longline fishery. Since the suspension of ASOP in April 2020 there have been no at-sea biological samples from the groundfish trawl fishery. DMP sampling by the service provider was reduced but continued for the hake trawl fishery, and sablefish vessels have continued setting aside samples for subsequent dockside sampling by DFO staff.

New Groundfish Trawl Biological Sampling Program:

In 2022, DFO Science & Fisheries Management staff worked with Archipelago Marine Research and the Canadian Groundfish Research and Conservation Society to develop a program to resume collection of biological samples from the portion of the groundfish trawl fishery that would have been subject to ASOP. The first pilot of the new sampling program began in late March of 2023 with the collection of shore-side samples of rockfish from "wet boats" (vessels that do not freeze or otherwise process fish at-sea) landing at the port of Ucluelet on the West Coast of Vancouver Island. Subsequently the program was expanded to include wet boats landing at Port Hardy and Prince Rupert.

The collection of shore-side rockfish samples is dependent on the fact that all wet boats are required to land 100% of their rockfish catch, thus ensuring that random shore-side samples are representative of the entire catch, not just the retained catch. For other, non-rockfish species, catch sorting and discarding regularly occur at-sea, such that shore-side sampling would only represent retained fish. For these species an at-sea sampling program was developed to collect

random samples of non-rockfish species prior to sorting. This program was initiated in November of 2023, focusing on Arrowtooth Flounder, with the goal of iteratively expanding to other non-rockfish species.

The new program is described in detail in Appendix 2.

Hake Sampling:

In 2023, hake biological samples from 38 trips were uploaded to GFBio. A few trial rockfish samples were uploaded, but the majority of the 2023 shoreside sample data are anticipated to be received from the service provider in spring 2024. Starting in 2024, it is anticipated that commercial sample data will be delivered quarterly and uploaded to GFBio on an annual basis, or more frequently as required.

D. 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 core surveys include the Multispecies Synoptic Bottom Trawl, Hard Bottom Longline Hook (HBLL), 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
  - Sablefish Standardized Trap Survey (Inlets)
  - Sablefish Offshore Stratified Random Trap Survey
- 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 core 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 has been completed every three to five years. The Groundfish section also routinely participates

in the Canadian portion of the Joint Canada US Hake Acoustic Survey and collects groundfish information from a DFO Small-Mesh Bottom Trawl Survey (Figure 2).

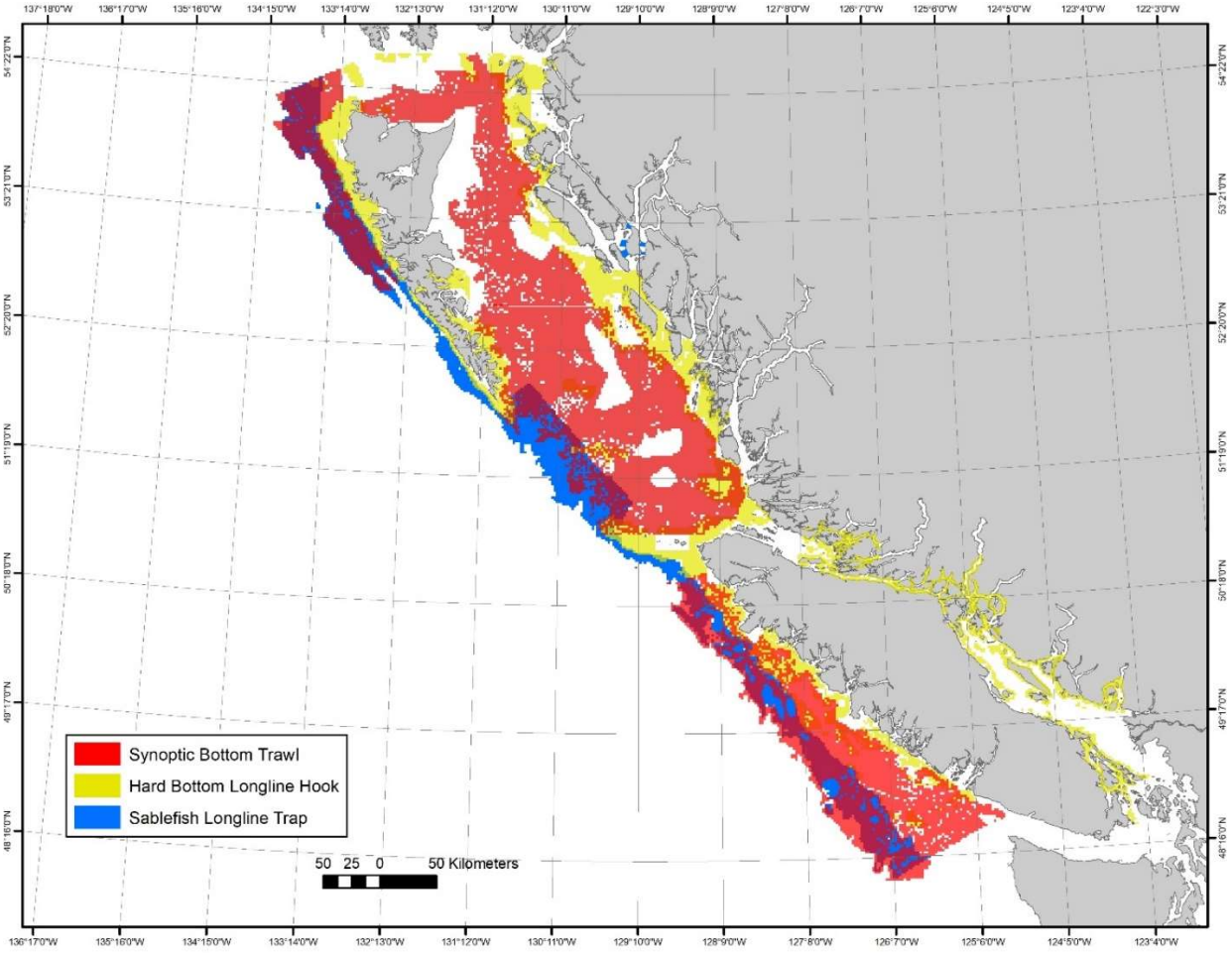

Figure 1. Random depth-stratified survey coverage.

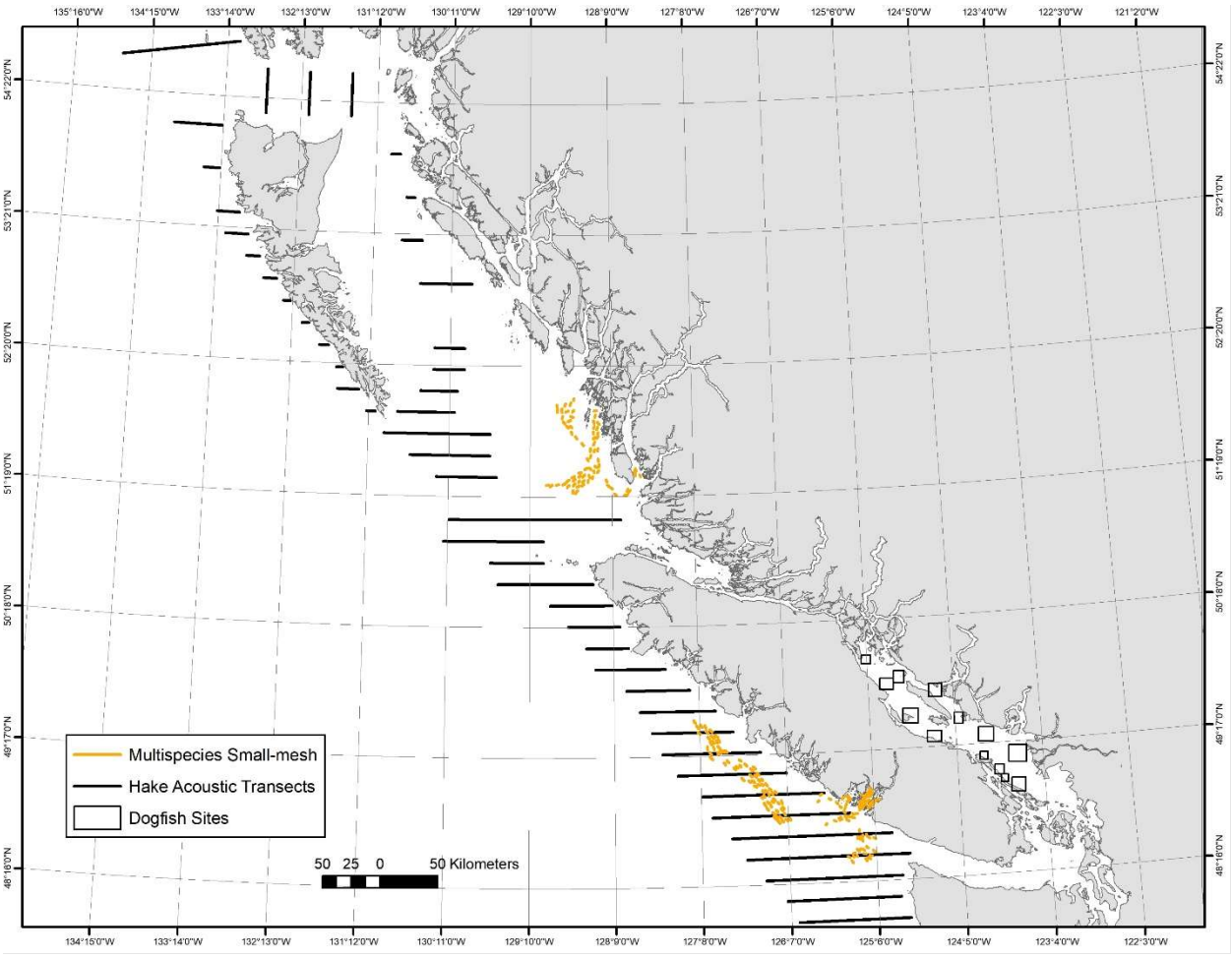

Figure 2. Non-random depth-stratified surveys that form part of the Groundfish fishing surveys program including the Multispecies Small-mesh Bottom Trawl Survey, the Pacific Hake Acoustic Survey, and the Strait of Georgia Dogfish Longline Hook Survey.

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 covered 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 while 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.

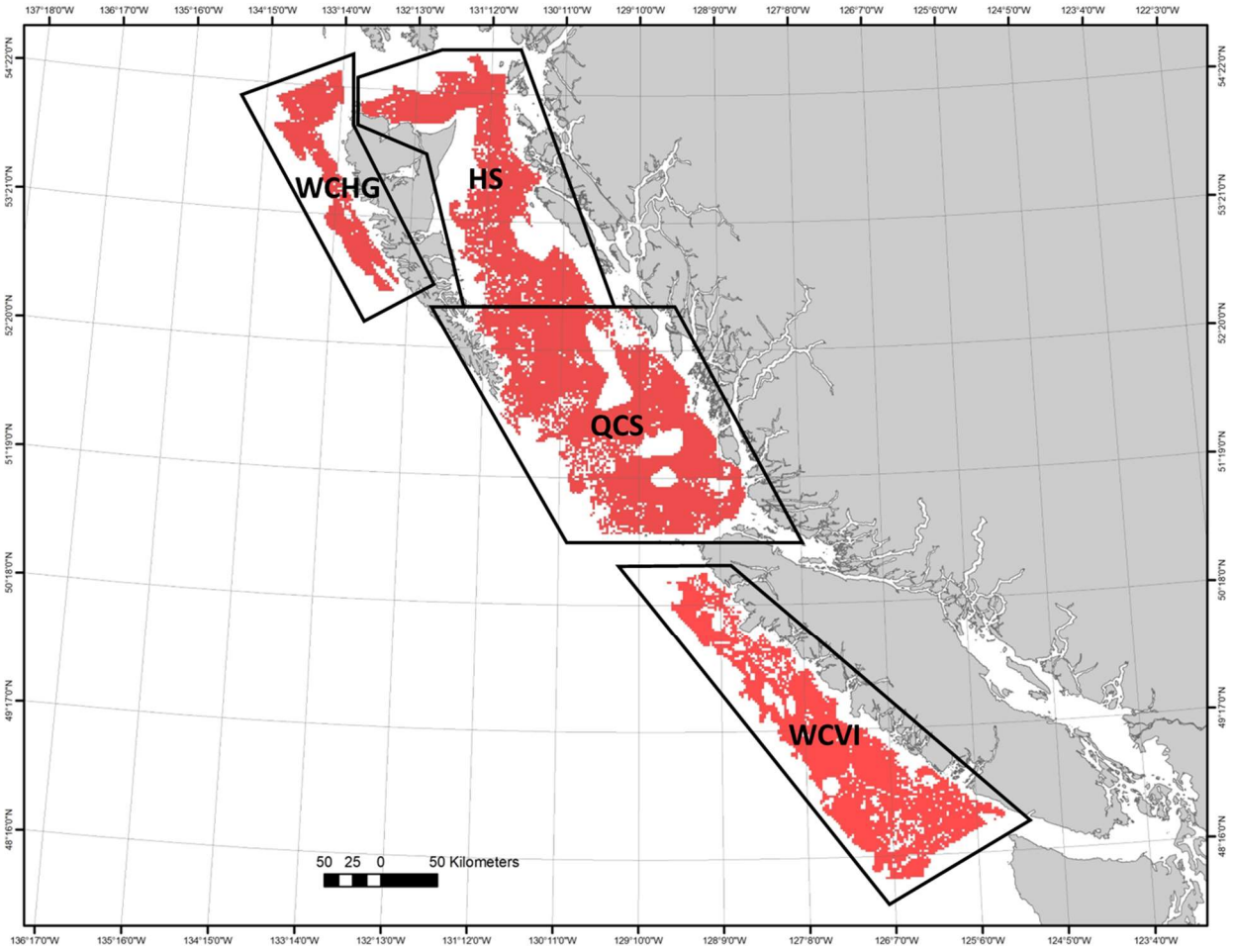

Figure 3. Multispecies Synoptic Bottom Trawl Survey coverage showing the extents of the West Coast of Haida Gwaii (WCHG), Hecate Strait (HS), Queen Charlotte Sound (QCS) and West Coast of Vancouver Island (WCVI) survey areas.

The Hecate Strait (HS) and Queen Charlotte Sound (QCS) Multispecies Synoptic Bottom Trawl surveys were conducted in 2023. The HS survey was completed on the research vessel Sir John Franklin from mid-May to mid-June while the QCS survey was completed on the chartered commercial trawl vessel Nordic Pearl from early July to early August. A total of 355 successful tows were completed over the two surveys with 148 in HS and 207 in QCS (Figure 4). The dominant species in the HS survey catches Spotted Ratfish (*Hydrolagus colliei*), Arrowtooth Flounder (*Atheresthes stomias*), Dover Sole (*Microstomus pacificus*), Walleye Pollock (*Gadus chalcogrammus*), and Rex Sole (*Glyptocephalus zachirus*). The dominant species in the QCS survey catches were Pacific Ocean Perch (*Sebastes alutus*), Silvergray Rockfish (*Sebastes brevispinis*), Arrowtooth Flounder (*Atheresthes stomias*), Walleye Pollock, (*Gadus chalcogrammus*), Redstripe Rockfish (*Sebastes proriger*), and Yellowmouth Rockfish (*Sebastes reedi*).

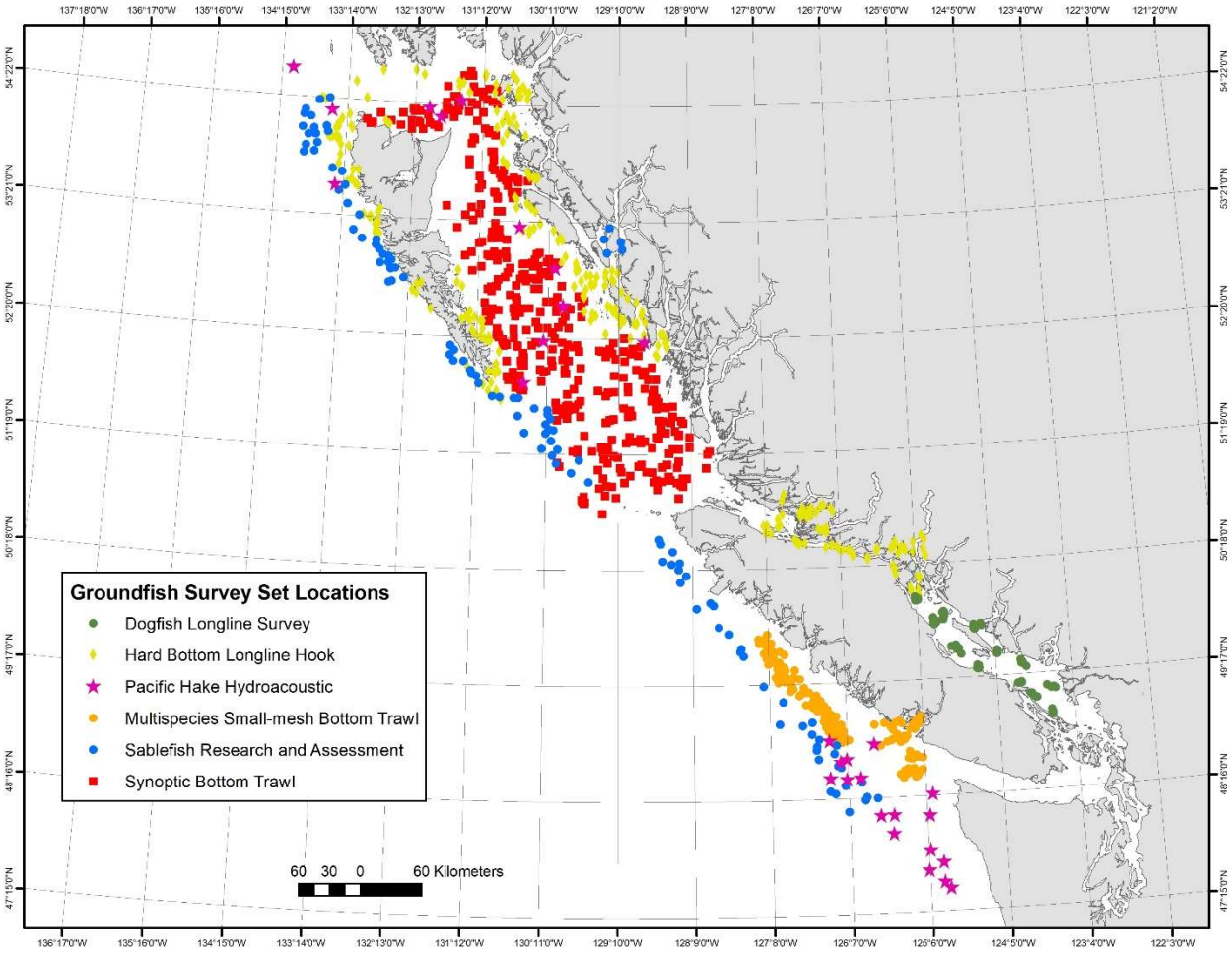

Figure 4. Fishing locations of the 2023 Groundfish surveys.

The **Hard Bottom Longline Hook (HBLL) Surveys** are conducted annually in "outside" waters (not between Vancouver Island and the mainland) and "inside" waters (between Vancouver Island and the mainland). Both the "outside" and "inside" areas are divided into northern and southern regions and surveys annually alternate between the regions such that the whole coast is covered 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 fishing vessels with contracted technicians. The inside surveys are conducted by DFO and occur on a Canadian Coast Guard vessel with DFO staff. In aggregate, the HBLL surveys provide coast-wide coverage of most of the untrawlable habitat between 20 and 220 meters depth.

In 2023 the northern regions of both the outside and inside areas were surveyed (Figure 4). The outside HBLL survey was conducted on the chartered commercial longline vessels Banker II, Borealis 1, and Free to Wander from mid-July to mid-September. A total of 192 sets were completed and the most abundant species were Yelloweye Rockfish (*Sebastes ruberrimus*), Pacific Halibut (*Hippoglossus stenolepis*), Quillback Rockfish (*Sebastes maliger*), Sablefish (*Anoplopoma fimbria*), and Pacific Cod (*Gadus macrocephalus*). The inside survey was conducted on the research vessel Neocaligus during August and the first week of September. A

total of 69 successful random sets were completed and the most abundant species were North Pacific Spiny Dogfish (*Squalus suckleyi*), Quillback Rockfish (*Sebastes maliger*), Yelloweye Rockfish (*Sebastes ruberrimus*), and Spotted Ratfish (*Hydrolagus colliei*).

In addition to the standard randomized sets, the 2023 HBLL survey in the inside area included a comparative fishing experiment. This work was a continuation of the work completed in 2022. The goal of this work is to help assess the option of replacing the North Pacific Spiny Dogfish abundance index from the quasi-triennial Strait of Georgia Dogfish (DOG) survey with one from the annual HBLL Inside survey. The ultimate goal is to stop conducting the October DOG survey but the two surveys differ not only in timing, locations and depth range, but also in the hook size, spacing, and bait. The 2022 and 2023 comparative sets were deployed in the standard DOG sites and depths. Each comparative set was half DOG gear and bait and half HBLL gear and bait. A total of 24 and 26 sets were completed in 2022 and 2023, respectively.

The **Sablefish Research and Assessment Survey** is an annual longline trap survey targeting Sablefish. This survey fishes at randomly selected locations in offshore waters as well as at fixed stations in mainland inlets. The survey provides catch rates and biological data for use in stock assessments and, historically, Sablefish have been tagged and released from each set. The survey is conducted under a collaborative agreement with Wild Canadian Sablefish Ltd. and occurs on a chartered commercial fishing vessel 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 several central coast inlets.

Parts of the 2023 Sablefish survey were reduced in scope compared to recent years. First, tagging operations have moved to a biennial rotation: there was no tagging in 2023 but tagging is planned for 2024. Second, the inlets component was reduced from four inlets to one. In addition, the bottom contact work previously conducted was replaced with a gear selectivity study designed to examine the effects of different escape ring configurations.

In 2023, the survey was conducted on the commercial fishing vessel Ocean Pearl from early October to mid-November. Unlike recent years where poor weather prevented completion of the planned work, all 91 offshore sets and 5 inlets sets were completed in 2023. A further 16 gear selectivity study sets were completed in offshore locations (Figure 4). The most abundant species were Sablefish (*Anoplopoma fimbria*), Lingcod (*Ophiodon elongatus*), North Pacific Spiny Dogfish (*Squalus suckleyi*), Pacific Halibut (*Hippoglossus stenolepis*), and the Rougheye/Blackspotted Rockfish complex (*Sebastes aleutianus/melanostictus* complex).

The **Strait of Georgia Dogfish Longline Hook (DOG) Survey** is conducted every two to five years and follows a fixed-station design that fishes at 10 to 12 locations in the Strait of Georgia. The 2023 survey was conducted on the research vessel Neocaligus in October and focused on comparative fishing to help assess the option of replacing the survey with the North Pacific Spiny Dogfish abundance index from the annual HBLL Inside survey. The comparative fishing protocols followed the same design used during the Inside HBLL survey with different gear and bait configurations on half of each set. As noted above, the HBLL and DOG surveys use slightly different gear and bait. Although both surveys currently use circle hooks, the DOG survey switched from J to circle hooks in 2005. Comparative fishing was conducted in 2004 but the catch rates for inshore rockfish species were too low to effectively assess the impact of the

change. As a result, the 2023 DOG survey included not only HBLL to DOG but also J to circle hook comparisons. A total of 47 sets comparing HBLL to current DOG as well as an additional 6 sets comparing current DOG (circle hook) to historic DOG (J-hook) were completed. The most abundant species were North Pacific Spiny Dogfish (*Squalus suckleyi*), Yelloweye Rockfish (*Sebastes ruberrimus*) and Quillback Rockfish (*Sebastes maliger*).

The **Multispecies Small-mesh Bottom Trawl (MSSM) 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 assist in catch sorting and species identification and also collect biological samples from selected fish species. The 2023 survey was conducted onboard the research vessel Sir John Franklin from late April to mid-May and a total of 131 usable tows were completed (Figure 4). The most abundant species were Dover Sole (*Microstomus pacificus*), Rex Sole (Gly*ptocephalus zachirus*), Slender Sole (*Lyopsetta exilis*), Spotted Ratfish (*Hydrolagus colliei*), and Eulachon (*Thaleichthys pacificus*).

The design, including fishing protocols and gear configuration, of the MSSM survey is currently under review by DFO's Marine Invertebrates Section. One way to optimize vessel time for the shrimp data would be to reduce the overall catches by using an excluder device in the net. However, any such change would ultimately impact the groundfish catch. We are currently working on a project to assess the value of the groundfish catch and biological sample data that have been collected over the time series of this survey.

The **International Pacific Halibut Commission** (IPHC) conducts an annual stock assessment longline survey in waters from California to Alaska, including British Columbia (BC) waters. The survey's main goal is to provide data on Pacific Halibut (*Hippoglosus stenolepis*) for stock assessment purposes. However, data are also recorded on other species caught, making it the longest ongoing groundfish survey in BC waters and hence a valuable source of data for many species. The gfiphc R package (https://github.com/pbs-assess/gfiphc), developed at PBS and updated annually, contains much of the relevant data (and enables extraction from **GFBio** for the rest). It also includes code for deriving relative biomass index trends for non-halibut groundfish species within BC, based on methods that take into account the changing survey methodologies (see Anderson et al., 2019). Results for 113 species are directly viewable at http://htmlpreview.github.io/?https://github.com/pbs-assess/gfiphc/blob/master/vignettes/data_for_all_species.html, and are incorporated into the groundfish synopsis report (DFO 2022).

Literature Cited:

DFO. 2022. A data synopsis for British Columbia groundfish: 2021 data update. DFO Can. Sci. Advis. Sec. Sci. Resp. 2022/020. https://www.dfo-mpo.gc.ca/csas-sccs/Publications/ScR-RS/2022/2022_020-eng.html

II. 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. The Government of Canada is working with First Nations, the Provinces and partners to conserve 25 per cent of Canada's oceans by 2025 and 30 per cent by 2030.

In the Pacific Region, an initiative is underway to develop a network of Marine Protected Areas (MPAs) in BC's Northern Shelf Bioregion (NSB). The Network Action Plan resulting from many years of planning to design a network of marine protected areas (MPAs) in the NSB was endorsed and made public during the IMPAC5 conference in Vancouver in February 2023. The Action Plan will guide the establishment and ongoing management of the Network to protect this unique marine area for present and future generations. The first new Marine Refuge in the NSB was also announced. In consultation with the Mamalilikulla First Nation and the Province of British Columbia, Gwaxdlala/Nalaxdlala – also known as Lull Bay and Hoeya Sound – was identified as an important area that includes a globally unique ecosystem of fragile and slow-growing corals and sponges that provide habitat for more than 240 marine species. This marine refuge is found in Knight Inlet.

Also announced at IMPAC5, the Honourable Joyce Murray, Minister of Fisheries, Oceans and the Canadian Coast Guard together with the Council of the Haida Nation, Nuu-chah-nulth Tribal Council, Pacheedaht First Nation and Quatsino First Nation announced progress on the proposed Tang.ɣwan — hačxwiqak — Tsigis Marine Protected Area (MPA), a large ecologically unique ocean area located on average 150 kilometres off the west coast of Vancouver Island (Figure 6). Covering 133,019 square kilometres, the proposed MPA is home to extraordinary seafloor features, including more than 46 underwater mountains, known as seamounts, and all known hydrothermal vents in Canada. These deep-sea biological "hotspots" are globally rare and support deep-water species unique to this area. The MPA regulations were published in the Canada Gazette Part 1 on February 18, 2023.

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.

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). A monitoring framework for the SKB MPA was recently reviewed at CSAS and a science advisory report is available (DFO 2023a).

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).

In February 2024, Fisheries and Oceans Canada closed commercial and recreational bottom-contact fisheries, including midwater trawl, to protect a newly discovered and highly sensitive *Lophelia* coral reef. This is the first and only known live coral reef in Pacific Canada and was first discovered during ROV surveys in 2021 and 2022. Located in Finlayson Channel, northern B.C., the largely pristine cold-water live coral reef contains unique habitats, high biodiversity and biomass, and has cultural significance to the Kitasoo Xai'xais and Heiltsuk First Nations. Protecting *Lophelia* Reef aligns with DFO's priorities of reconciliation and the protection of sensitive benthic areas. The closure demonstrates a robust protective measure by the Department based on a significant scientific discovery as this site, while small, is a globally unique reef that is highly susceptible to damage, most notably from fishing gear. The Pacific *Lophelia* coral reef is identified within the Northern Shelf Bioregion Marine Protected Area's Network Action PPlan andis a proposed Parks Canada National Marine Conservation Area Reserve (NMCAR), which is currently in the feasibility assessment stage.

Literature Cited:

DFO. 2023a. Monitoring Framework for SGaan Kinghlas-Bowie Seamount Marine Protected Area, British Columbia, Canada. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2023/011.

Yamanaka, K.L., and Logan, G. 2010. Developing British Columbia's inshore rockfish conservation strategy. Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science. 2:28–46. DOI: 10.1577/C08-036.1

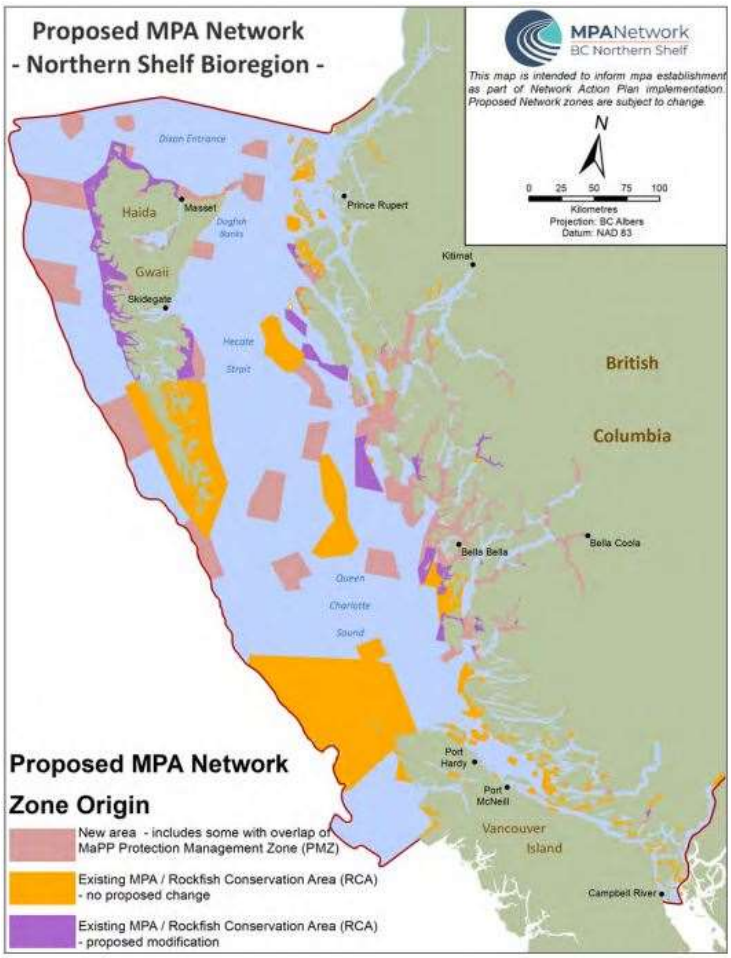

Figure 5. Proposed Northern Shelf Bioregion MPA Network (Network Action Plan).

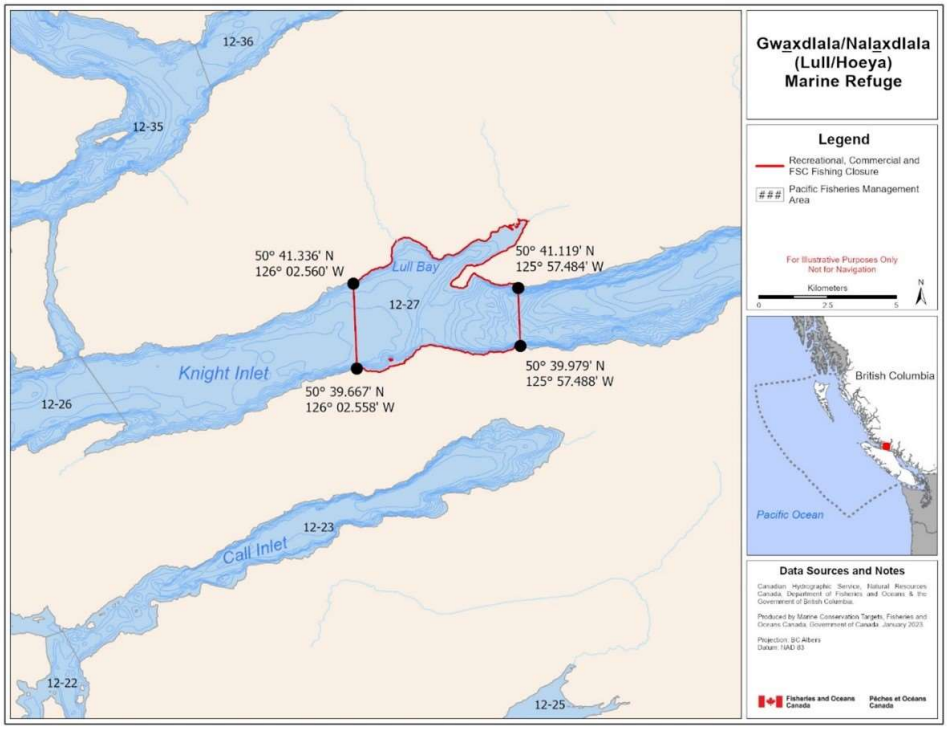

Figure 6. Gwaxdlala/Nalaxdlala – also known as Lull Bay and Hoeya Sound Marine Refuge.

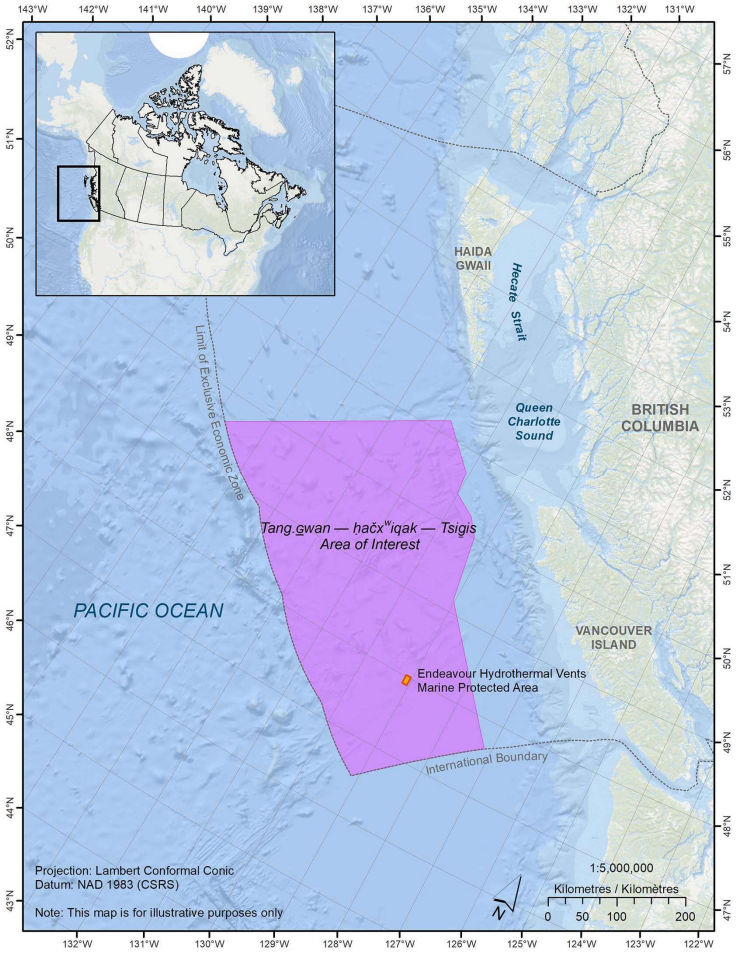

Figure 7. The proposed Tang.ɢwan – ḥačxwiqak – Tsigis Marine Protected Area

III. Review of Agency Groundfish Research, Assessment and Management

A. Hagfish

Research

No new research in 2022.

Assessment

Nothing to report.

Management

There is currently no fishery for Hagfish in BC.

B. Dogfish and other sharks (superorder Selchii)

Research

North Pacific Spiny Dogfish

Data collection continued in 2023 through the annual groundfish multispecies trawl and longline surveys. Due the suspension of the At Sea Observer Program no biological samples were collected from the commercial fishery in 2023. Several indices of relative abundance for North Pacific Spiny Dogfish in BC waters have declined over the last decade despite no directed fishery in recent years (since 2014). Dr. Lindsay Davidson is a postdoc leading a research project (with Drs. Sean Anderson, Philina English, Jackie King, and Paul Grant, and NOAA collaborators Drs. Cindy Tribuzio, Vladlena Gertseva, and Ian Taylor) examining these declines and evaluating if the declines are across jurisdictions and examining the evidence for possible explanations including climate, predator-prey interactions, seasonal distribution shifts, population declines from historical harvesting, or changes to survey timing.

Other Shark Species

Other species of shark are sampled opportunistically during annual groundfish multispecies trawl and longline surveys. In 2023, three Blue Sharks and one Brown Cat Shark were sampled. Due to the suspension of the At Sea Observer Program no biological samples were collected from the commercial fishery. Commercial fishery encounters included Blue Sharks, Brown Cat Sharks, Pacific Sleeper Sharks, Salmon Sharks, Tope Sharks, and a Basking Shark. 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).

Assessment

North Pacific Spiny Dogfish

North Pacific Spiny Dogfish, hereafter 'Spiny Dogfish' were last assessed by the Committee on the Status of Wildlife in Canada (COSEWIC) in 2011 and the last scientific advisory report was completed in 2011 (Galluci et al 2011). Dogfish are scheduled to be "batched in" as a Major Stock under the Fish Stocks provisions of the *Fisheries Act*. An assessment is currently underway for the outside stock with plans to complete the inside assessment the following year.

In 2011, the Committee on the Status of Wildlife in Canada (COSEWIC) assessed the conservation status of 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. In the report, COSEWIC stated that overfishing was unlikely to be occurring based on DFO data but was concerned the quota set for Spiny Dogfish would not afford adequate protection should the catch of Spiny Dogfish increase. Spiny Dogfish have been pending a Species at Risk Act listing decision by the Governor in Council since 2011 and recently public consultations have been opened to get feedback on listing Spiny Dogfish ().

The Spiny Dogfish COSEWIC status report is available at North Pacific Spiny Dogfish (Squalus suckleyi) - Species search - Species at risk registry (canada.ca).

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 (COSEWIC) has assessed the conservation status of several 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. Shark species yet to be assessed include the Salmon Shark and Pacific Sleeper Shark.

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

Management

North Pacific Spiny Dogfish

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 Spiny Dogfish. Commercial TACs and landings for 2023 are provided in Appendix 2, Table 1. To support groundfish research and account for unavoidable mortality incurred during the 2023 Groundfish surveys, research catches are allocated before defining the TAC. See Appendix 2, Table 2 for details.

Other Shark Species

Currently, there is no directed commercial fishery for other sharks 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 and Chimeras (Batoidea and Holocephali)

Research

Data collection continued in 2023 through trawl, small-mesh bottom trawl, and longline surveys. Most individual skates encountered on groundfish research surveys are sampled (length, weight if feasible, sex) and released alive, if possible. In 2023, seven Aleutian Skates, 120 Big Skates, 147 Sandpaper skates, 479 Longnose Skates, and 2,771 Spotted Ratfish were sampled. Due to the suspension of the At Sea Observer Program no biological samples were collected from the commercial fishery in 2023, In the commercial fishery, Abyssal Skate, Alaska Skate, Aleutian Skate, Big Skate, Broad Skate, Longnose Skate, Roughtail Skate, Sandpaper Skate, and Spotted Ratfish were encountered.

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.

The Big Skate, Longnose Skate, and Sandpaper Skate have all been assessed at Not at Risk by COSEWIC in 2007. Skate species still to be assessed are those that are less common in British Columbia including the Aleutian Skate, Abyssal Skate, Alaska Skate, Roughtail Skate, and Broad Skate. Finally, the Spotted Ratfish is not assessed. A coastwide assessment of Spotted Ratfish has been requested to contribute to the implementation of the bycatch policy within the sustainable Fisheries Framework, but this work has been deferred indefinitely.

Management

Spotted Ratfish, Big Skate, and Longnose Skate comprise most of the non-shark (batoid) catch (landings + discards from the commercial fisheries). Big and Longnose Skates are currently managed as part of the Integrated Fisheries Management Plan (IFMP) with sector and area TACs. Big and Longnose Skates are IVQ (individual vessel quota) species. Commercial TACs and landings for 2023 are provided in Appendix 2, Table 1. To support groundfish research and account for unavoidable mortality incurred during the 2023 Groundfish surveys, research catches are allocated before defining the TAC. See Appendix 2, Table 2 for details. There are no management measures in place for all other species of skate.

Spotted Ratfish have no management measures in place nor are they part of a direct fishery. They are discarded bycatch mostly in the 5CDE management areas (Anderson et al., 2021).

Literature Cited:

Anderson, S.C., Keppel, E.A., Edwards, A.M. 2021. A data synopsis for British Columbia groundfish: 2021 data update. DFO Can. Sci. Advis. Sec. Res. Doc. 2022/020. vii + 257 p.

Galluci, V., Taylor, I., King, J., McFarlane, G.A., and McPhie, R. 2011. Spiny Dogfish (*Squalus acanthias*) assessment and catch recommendations for 2010. DFO Can. Sci. Advis. Sec. Res. Doc. 2011/034. xii + 69 p.

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

Research

Data collection continued in 2023 through trawl and longline surveys. Due the suspension of the At Sea Observer Program no biological samples have been collected from the commercial fishery since 2019.

Assessment

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). Since the 2018 assessment, data from Areas 5AB and 5CD have been combined into a single stock assessment. Area 4B is not assessed as there is no directed commercial fishery there.

Pacific Cod is considered a "data-moderate" stock as they are extremely difficult to age. The last assessments of Pacific Cod stocks in both Areas 3CD and 5ABCD were done in 2020 using the same delay-difference model and assumptions as in previous assessments. The Science Response (SR 2021/002) is available at https://www.dfo-mpo.gc.ca/csas-sccs/Publications/ScR-RS/2021/2021_002-eng.html. Full documentation of the stock assessment models (Res Doc 2020/70) is available at https://www.dfo-mpo.gc.ca/csas-sccs/Publications/ResDocs-DocRech/2020/2020_070-eng.html. In the 2020 update, there was an estimated 2-10% probability that the 3CD stock would fall into the Critical Zone in 2022 under a range of 2021 catch levels. There was an estimated < 0.01% probability that the 5ABCD stock would fall into the Critical Zone in 2022.

The 2020 assessment updates were done following an approximate 75% drop in the 3CD synoptic survey index in 2018, accompanied by three years of commercial catches well below average. The 2021 and 2022 3CD index points were similarly low. In contrast, the 5AB and 5CD survey indices showed an increasing trend over the same period. Given the decreases in the 2018, 2021, and 2022 West Coast Vancouver Island survey indices, an update to the 3CD stock assessment was done in 2023 (SR 2024/003 in press), using data up to the end of the 2022 fishing year. Given the lack of commercial biological samples since 2019, the commercial mean weight index to which the model is fit was, for the first time, developed with the aid of a generalized linear model to predict the final years of the commercial mean weight index from the survey mean weight index. The model predicted a 23% probability of the stock being below the LRP at the beginning of 2023. Note that this update was a a stock status update only because management advice was not requested in 2023.

In the ongoing absence of an at-sea commercial biological sampling program, the authors of the 2023 update recommended resources be allocated to investigating and comparing other approaches for assessing Pacific Cod stocks, especially given the uncertainties inherent in the model. The authors also recommended allocating resources to better understanding the biology

of Pacific Cod stocks and investigating alternative hypotheses for changes in abundance of Pacific Cod in BC waters.

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 2023 are provided in Appendix 2, Table 1. To support groundfish research and account for unavoidable mortality incurred during the 2023 Groundfish surveys, research catches are allocated before defining the TAC Appendix 2, Table 2. Following the 2020 assessment update, the commercial TAC in Area 3CD was reduced to 300 metric tonnes. In addition, winter spawning closures are in effect in both Areas 3CD and 5CD.

E. Walleye Pollock

Research

There was no work conducted directly on Walleye Pollock in 2023 but ongoing data collection continues through the Groundfish Synoptic Surveys, port sampling (a new biosampling program was implemented in 2023 for rockfish species and Arrowtooth Flounder, with expansion to other species later), and recreational creel surveys.

Assessment

The most recent stock assessment (2017) is publicly available on the CSAS website: Research Document 2021/004, Science Advisory Report 2018/020, Proceedings 2021/048.

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 2023). Commercial TACs and landings for 2023 are provided in Appendix 2. To support groundfish research and account for unavoidable mortality incurred during the 2023 Groundfish surveys, research catches are allocated before defining the TAC.

F. Pacific Whiting (Hake)

Research

There are two commercially harvested and managed stocks of Pacific Hake in Canada. 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.

Offshore Hake

Triennial (until 2001), then biennial acoustic surveys, covering the known extent of the Pacific Hake stock have been run since 1995. An acoustic survey, ranging from California to northern British Columbia is currently run in odd-numbered years, to continue the biennial time series.

The last survey used in the assessment model took place in 2021. A survey index point is estimated, and the entire survey index series is used in the assessment model. Maturity, weight-at-age, and age data are also input data in the assessment model.

There were biological samples taken from both the Freezer trawler hauls and the Shoreside trips. Freezer trawler samples acquired through vessel crew freezing bags of hake, with labels to describe the haul number, date, and location. These samples are processed onshore by Archipelago Marine Research (AMR). A drop in sampling due to removal of at-sea observers from the Freezer trawler fleet in 2020-2021 resulted in this novel sampling technique.

Strait of Georgia Hake

There has been a biennial acoustic survey for Pacific Hake in the Strait of Georgia since 2011, although numerous years have recently been missed. The survey was completed in February-March 2023 and another is planned for 2024. Methods will be developed to calculate a biomass estimate for these surveys, which will then be used as the primary index of abundance for a stock assessment.

Assessment

Offshore Hake

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 2023 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 2023 model had the same model structure used in 2022, 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 in 2022 was age-2's, followed by age 6's which represent the large cohorts for 2020 and 2016 respectively (Berger et al. 2023).

Literature Cited

Berger, A.M., C.J. Grandin, K.F. Johnson and A.M. Edwards. 2023. Status of the Pacific Hake (whiting) stock in U.S. and Canadian waters in 2023. Prepared by the Joint Technical Committee of the U.S. and Canada Pacific Hake/Whiting Agreement, National Marine Fisheries Service and Fisheries and Oceans Canada. 208 p.

Strait of Georgia Hake

There has not been an assessment of Pacific Hake in the Strait of Georgia, although one is planned for 2024-25 following the development of an acoustic biomass estimate. Ages have been completed and the modeling is about to begin.

Management

Canadian commercial TACs and landings for 2022 are provided in Appendix 2, Table 1. To support groundfish research and account for unavoidable mortality incurred during the 2022 Groundfish surveys, research catches are allocated before defining the TAC. See Appendix 2, Table 2 for details.

Offshore Hake

Management of Pacific Hake has been under a treaty (The Agreement) between Canada and the United States since 2011. The stock is managed by the Joint Management Committee (JMC) which is made up of fisheries managers and industry representatives from both the U.S. and Canada. These managers receive advice from the JTC and the Scientific Review Group (SRG), which is a committee responsible for the scientific review of the assessment.

The final decision on catch advice for the 2023 fishing season was made at the Joint Management Committee (JMC) meeting in March of 2022. A coastwide TAC of 545,000 t was chosen, which when split with the U.S. gave Canada a TAC of 142,354 t.

The final assessment document and other treaty-related documents are posted at: https://www.fisheries.noaa.gov/west-coast/laws-and-policies/pacific-hake-whiting-treaty.

Strait of Georgia Hake

Strait of Georgia Pacific Hake is managed by Total Allowable Catch (TAC) and Individual Transferable Quota (ITQ) as part of the integrated groundfish fisheries. Pacific Hake is typically targeted using midwater trawl gear and while historical catches in the Strait are highly variable, catch levels in the last five years have ranged from approximately 5,000 – 7,000 metric tonnes.

G. Grenadiers

Research

There is no directed work conducted on Grenadiers although opportunistic sampling occurs during the Multispecies Synoptic Bottom Trawl surveys. Giant Grenadiers, Pacific Grenadiers and Popeye are routinely encountered during the WCHG survey. Giant Grenadiers and Pacific Grenadiers are encountered during the Sablefish trap survey.

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.

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 trawl fisheries and in the Sablefish trap fishery. 100% of the catch is discarded.

H. Rockfish

Research

Biological samples are collected on an ongoing basis from annual trawl, longline, and trap surveys. Due the suspension of the At Sea Observer Program no biological samples were collected from the commercial fishery in 2023.

Inshore Rockfish

Dr. Dana Haggarty continues to collaborate with other scientists at DFO, Dr. Matthew Siegle, Dr. Philina English, Dr. Sarah Dudas, and Dr. Stephan Gauthier, as well as external Scientists: Dr. Francis Juanes (UVic), Dr. William Halliday (Wildlife Conservation Society Canada), and Dr. Francis Mouy (NOAA) to develop passive acoustic monitoring (PAM) of rocky reef fishes. Based on the successes of a SPERA funded project, they were awarded Canadian Science Research Funding for three years of study. Xavier Mouy continues to develop and refine an automatic detector of fish (and hopefully rockfish) calls. Doctoral student, Darienne Lancaster, co-supervised by Drs. Francis and Haggarty at UVic continues to collect passive and active acoustic data of rockfishes. Darienne had a successful second field season in Nootka Sound, BC, and is currently analyzing passive acoustic, active acoustic and video data.

Outside Yelloweye Rockfish in BC is known to be a “choke” or “pinch-point” species whose abundance limits the Pacific Halibut fishery, including the Indigenous fishery of five Nuu-chah-nulth First Nations on the west coast of Vancouver Island, “Five Nations” who hold constitutional Indigenous rights to operate a commercial, community fishery. A 2009 court decision limited these Indigenous rights to within 9 nautical miles of the coast; community members interpreted this limit as the government not fully recognizing the knowledge and authority of the traditional leadership. It also raised concerns about the potential for an increase in unintended rockfish catches. DFO scientists Drs. Philina English, Sean Anderson, Robyn Forrest and Dana Haggarty collaborated with researchers from Ha’oom Fisheries Society, an organization that supports the Five Nations community fishery, Jess Edwards and Candice Picco, to examine bycatch rates of Yelloweye Rockfish. Using both scientific survey and commercial catch data and guided by the insights and advice of Indigenous people, they investigated the effects of fishing depth and limitations on the number of potential fishing locations on the predicted catch of yelloweye and halibut. They found evidence that fishing at depths deeper than 175 m, which occur outside to the 9 nautical mile boundary, would provide more opportunities for catching halibut while avoiding yelloweye, than are currently available within this relatively shallow near-shore area. Their approach to this fisheries rights and management issue is an example of how Western conservation scientists can engage in co-production of knowledge with Indigenous peoples to balance Indigenous rights and species conservation more effectively. The work was published in late 2023 in the journal of People and Nature.

English, P. A., Picco, C. M., Edwards, J. C., Haggarty, D. R., Forrest, R. E., & Anderson, S. C. 2023. Spatial restrictions hinder avoidance of choke species in an Indigenous rights-based fishery. People and Nature, 00, 1–16. https://doi.org/10.1002/pan3.10554

Offshore Rockfish

The Offshore Rockfish Program (ORP) in 2023 continued with one DFO research biologist (BI-03) working in collaboration with an independent scientist contracted by the Canadian Groundfish Research and Conservation Society (CGRCS, a non-profit society composed of participants in the British Columbia commercial groundfish trawl fishery). A new research biologist (BI-02) joined the ORP on November 6, 2023. The program's focus remained stock assessment of shelf and slope rockfish, with occasional effort directed to flatfish species. To facilitate stock assessment, the ORP maintains a suite of PBS R software packages on GitHub and CRAN. The Groundfish Surveys Program coordinates all sample collections (otoliths, genetic tissues, morphology measurements, etc.) and the Sclerochronology Lab develops ageing protocols and methods, in addition to performing production ageing for BC finfish stock assessments.

Assessment

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) and DFO was therefore required to complete a Recovery Potential Analysis (RPA), which was published in February 2023 (DFO 2023a). It drew from the results presented in the 2019 rebuilding plan analysis (Cox et al. 2020). The results of Cox et al. (2020) have been extended in a new Science Response (DFO 2023b) that include a new index-based Management Procedure based solely on the Hard Bottom Longline Survey, and results for three alternative Target Reference Points. Given current stock status that is estimated to be in the healthy zone (above the USR of 0.8*BMSY with >50% probability), OYE has exited the Rebuilding Plan.

Inside Yelloweye Rockfish

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) and DFO was therefore required to complete a Recovery Potential Analysis (RPA) which was published in February 2023 (DFO 2023a). It drew from the results presented in the 2020 rebuilding plan analysis (Haggarty et al 2022).

The results of the two rebuilding plan reviews support a high probability that both Inside and Outside Yelloweye Rockfish stocks are above their respective Limit Reference Points (LRPs) of 40% B_{MSY}. This differs from previous assessment that found Yelloweye Rockfish stocks to be below their LRPs (Outside stock: Yamanaka et al. 2018; Inside stock: Yamanaka et al. 2012). Much of this discrepancy can be attributed to the use of surplus production models by

Yamanaka et al., while the most recent analyses presented in the rebuilding plans use age-structured models. Another significant difference between previous work and the more recent rebuilding plans is that we have moved towards using a Management Strategy Evaluation approach that follows the Management Procedure Framework for Groundfish (Anderson et al. 2021). Inside Yelloweye are also included in the Recovery Potential Analysis published last year (DFO 2023a).

Quillback Rockfish

The Inside and Outside management units of Quillback Rockfish were last assessed in 2010 (Yamanaka et al. 2011) after the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated them as threatened in November 2009. We provides new science advice for Inside and Outside Quillback on harvest levels for the Groundfish Management Unit to support fisheries decision-making. We held a series of workshops in early 2021 to discuss the decision context and to develop objectives to be used for the Quillback Rockfish stocks in a Management Procedure (MP) framework analysis (Haggarty et al 2022). The Regional Peer Review meeting for the inside stock was held December 6-7, 2022, and for the outside stock May 29-30, 2023. The inside stock status was evaluated with regard to a Limit Reference Point (LRP) and Upper Stock Reference (USR) of 0.4 BMSY and 0.8 BMSY, respectively. The 2021 spawning biomass was estimated to be 88% of BMSY (with an interquartile range of 46-147% credible interval (CI)), above the LRP with a 79% probability, and above the USR with a 52% probability, averaged across three Oms (DFO 2023c). The 2021 outside Quillback spawning biomass was estimated to be 189% of BMSY (standard deviation (SD) = 13%), and above both the LRP and USR with a 99% probability, averaged across three reference Oms (DFO 2023d). Although the Science Advisory Reports (SARs) are both published and available, the Research Documents have not yet been published (but are anticipated to be available summer 2024).

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. Survey trends are monitored in the GF Synopsis (Anderson et al 2022) and by groundfish staff (Figure 8).

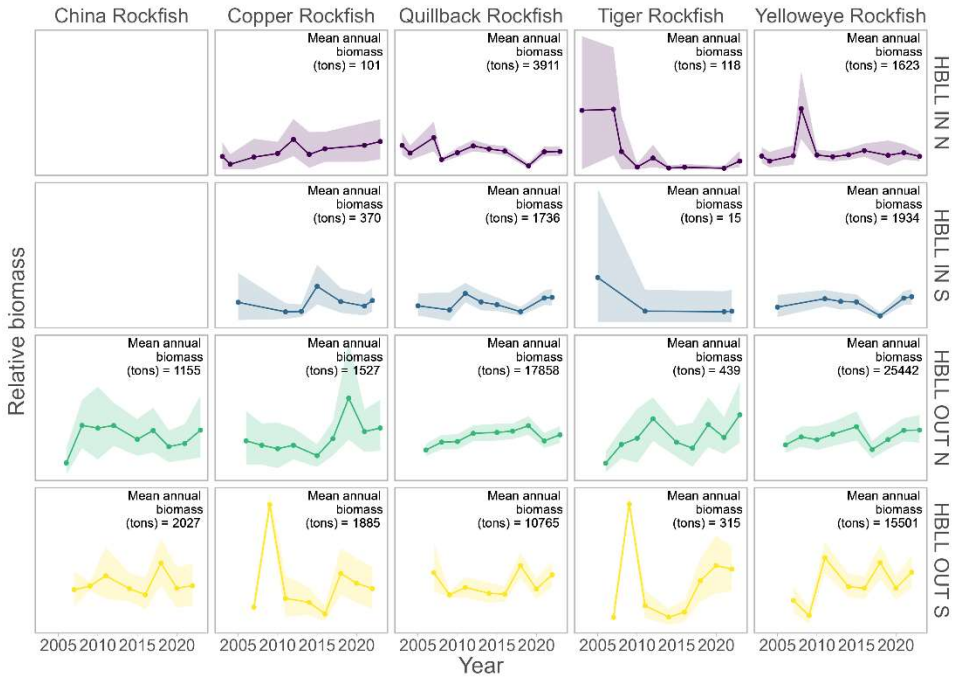

Figure 8. Relative biomass of Inshore Rockfish Species from the design-based survey index on the Inside and Outside Hard Bottom Longline Surveys (HBLL) conducted in Northern (N) and Southern (S) waters. Dots represent mean estimates of relative biomass and shaded ribbons around the dots and lines represent 95% bootstrap confidence intervals.

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Offshore Rockfish

Bocaccio

Bocaccio was assessed in 2019 (Research Document 2022/001, Science Advisory Report 2020/025, Proceedings 2021/014), and a very large 2016 cohort was predicted to elevate the stock from the DFO Critical Zone to the Healthy Zone by 2023. An update of the stock assessment model using new survey and commercial CPUE indices was performed in 2021 (Science Response 2022/001), which verified the recovery of this species: B_{2022}/B_{MSY} = 1.499 (0.625, 3.416). A second update was requested for 2023 but was delayed until 2024.

Canary Rockfish

In 2007, Canary Rockfish along the Pacific coast of Canada was designated as 'Threatened' by COSEWIC. A stock assessment in 2022 determined that stock status was Healthy (i.e., probability of 1 that $B_{2023} > 0.8B_{MSY}$).

The most recent stock assessment is publicly available on the CSAS website:
(Research Document 2023/070, Science Advisory Report 2023/002, Proceedings 2023/006).

Darkblotched Rockfish

In 2009, Darkblotched Rockfish along the Pacific coast of Canada was designated as 'Special Concern' by COSEWIC. The last review of this species occurred in 2008 (Research Document 2008/056, Proceedings 2009/007). Currently, there is no stock assessment planned.

Pacific Ocean Perch

Pacific Ocean Perch (POP) is divided into three stocks along the BC coast: Queen Charlotte Sound (QCS, comprising PMFC areas 5ABC), west coast Vancouver Island (WCVI, 3CD), and

west coast Haida Gwaii (WCHG, 5DE). Previous assessments occurred in 2017 for 5ABC, 2012 for 3CD, and 2012 for 5DE.

In 2023, a POP stock assessment evaluated a BC coastwide population with three subareas, each with separate fisheries in 5ABC, 3CD, and 5DE. The fisheries were dominated by trawl gear (99%) with minor removals by other gear types (e.g., longline). Midwater trawl catches of POP were most prevalent in 3CD, but only after 2007. Midwater trawl activity in 5ABC was moderate to low, and in 5DE was minimal. For this stock assessment, bottom and midwater trawl records were combined.

The POP stock assessment adopted NOAA's Stock Synthesis 3 platform, using an annual catch-at-age model tuned to six fishery-independent trawl survey series, annual estimates of commercial catch since 1935, and age composition data from survey series (29 years of data from five surveys) and the commercial fishery (43 years of data from three fisheries). The model started from an assumed equilibrium state in 1935; the survey index data covered the period 1967 to 2022 (although not all years were represented).

A two-sex model, which estimated M for each sex and the stock-recruitment steepness parameter h, was implemented in a Bayesian framework using the Markov Chain Monte Carlo (MCMC) 'No U-Turn Sampling' (NUTS) procedure. In addition to natural mortality and steepness, the parameters estimated by this model included average recruitment over the period 1935-2014, recruitment distribution parameters to allocate coastwide recruitment, and selectivity for the 5ABC commercial fleet (shared with 3CD and 5DE) and five surveys using age frequency (AF) data. The survey scaling coefficients (q) were determined analytically.

The base run spawning biomass relative to B_0 (depletion) at the start of 2024 (median with 0.05 and 0.95 quantiles) was estimated at 0.50 (0.33, 0.77) in 5ABC, 0.71 (0.36, 1.3) in 3CD, and 0.72 (0.43, 1.3) in 5DE. Spawning biomass relative to B_{MSY} (status) was estimated to be 2.0 (1.1, 3.5) in 5ABC, 2.8 (1.3, 5.8) in 3CD, and 2.9 (1.5, 5.7) in 5DE. The stock status results suggested that the 2024 POP spawning population was positioned well in the Healthy zone (see next paragraph) in each of the subareas (Figure 1). Estimates of natural mortality M were 0.053 (0.044, 0.061) for females and 0.059 (0.051, 0.069) for males; the estimate for steepness h was 0.75 (0.47, 0.94).

In Canada, the Sustainable Fisheries Framework (SFF) identifies default reference points, a limit reference point (LRP=$0.4B_{MSY}$) and an upper stock reference point (USR=$0.8B_{MSY}$), which are used to delimit three zones: 'Critical' – zone below the LRP, 'Cautious' – zone between the LRP and the USR, and 'Healthy' – zone above the USR. Generally, stock status is evaluated as the probability of the spawning female biomass in year t being above the reference points, i.e., $P(B_t > 0.4B_{MSY})$ and $P(B_t > 0.8B_{MSY})$. The SFF also stipulates that, when in the Healthy zone, a Removal Reference (either instantaneous fishing mortality, F_t, or annual exploitation rate, u_t) must be at or below that associated with MSY under equilibrium conditions (e.g., u_{MSY}), i.e., $P(u_t < u_{MSY})$.

The base run model estimated the probability of being in the Healthy zone, $P(B_{2024} > 0.8B_{MSY})$ at 0.996 for subarea 5ABC, 0.993 for subarea 3CD, and 0.999 for subarea 5DE. The probability of being in the Cautious zone was 0.004 for 5ABC, 0.007 for 3CD, and 0.001 for 5DE. The

probability of being in the Critical zone was <0.001 for all subareas. The probability of the exploitation rate being less than that at MSY, P($u_{2023} < u_{MSY}$), was 0.954 for 5ABC, 0.976 for 3CD, and 0.998 for 5DE.

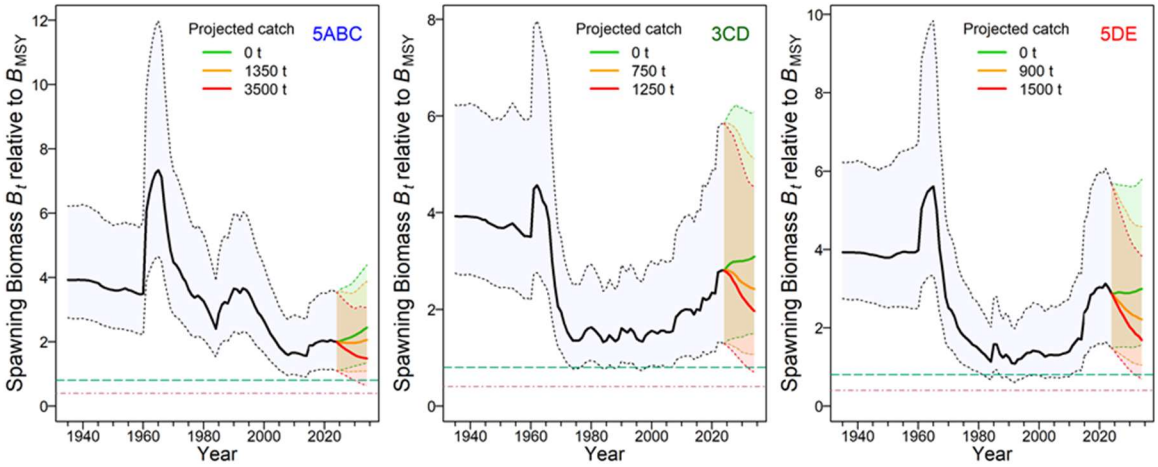

Figure 1. Estimates of spawning biomass B_t relative to B_{MSY} for three subareas from the model posteriors (2,000 samples) of the POP base run. The median biomass trajectory appears as a solid curve surrounded by a 90% credibility envelope (quantiles: 0.05, 0.95) in black and delimited by dashed lines for years t=1935-2024; projected biomass using constant catch appears in green (no catch), orange (average catch for the last two years), and red (maximum catch policy explored) for years t=2025-2034 (10 years). Horizontal lines indicate the LRP ($0.4B_{MSY}$, dot-dash) and USR ($0.8B_{MSY}$, dash).

Redbanded Rockfish

The most recent stock assessment (2014) is publicly available on the CSAS website: Research Document 2017/058, Proceedings 2015/032.

Redstripe Rockfish

The most recent stock assessment (2018) is publicly available on the CSAS website: Research Document 2021/014, Science Advisory Report 2018/049, Proceedings 2022/014.

Rougheye/Blackspotted Rockfish

In April 2007, COSEWIC assessed the Rougheye/Blackspotted Rockfish (REBS) complex as 'Special Concern'. In 2009, REBS was added to SARA's Schedule 1 as Special Concern. A stock assessment in 2020 determined that both northern and southern stocks of REBS were Healthy (i.e., probability of 1 that $B_{2021} > 0.8B_{MSY}$ for REBS N and probability of 0.74 that $B_{2021} > 0.8B_{MSY}$ for REBS S).

The most recent stock assessment (2020) is publicly available on the CSAS website: Research Document 2022/020, Science Advisory Report 2020/047, Proceedings 2022/004.

Shortraker Rockfish

The most recent stock assessment (1998) is publicly available on the CSAS website: Research Document 1999/184.

Silvergray Rockfish

The most recent stock assessment (2013) is publicly available on the CSAS website: Research Document 2016/042, Science Advisory Report 2014/028.

Widow Rockfish

A stock assessment in 2019 determined that stock status was Healthy (i.e., probability of 0.98 that $B_{2019} > 0.8B_{MSY}$).

The most recent stock assessment (2019) is publicly available on the CSAS website: Research Document 2021/039, Science Advisory Report 2019/044, Proceedings 2021/049.

Yellowmouth Rockfish

In 2010, Yellowmouth Rockfish along the Pacific coast of Canada was designated as 'Threatened' by COSEWIC. A stock assessment in 2021 determined that stock status was Healthy (i.e., probability of 1 that $B_{2022} > 0.8B_{MSY}$).

The most recent stock assessment (2021) is publicly available on the CSAS website: Research Document 2022/010, Science Advisory Report 2022/001, Proceedings 2022/003.

Yellowtail Rockfish

The most recent stock assessment (2014) is publicly available on the CSAS website: Science Advisory Report 2015/010, Proceedings 2015/020.
The BC stock is slated for stock assessment in 2024.

Management

Inshore Rockfish

Inside Yelloweye Rockfish still falls under a rebuilding plan that is documented in Appendix 9 of the 2023 IFMP. Most inshore rockfish are managed with Total Allowable Catches (TACs) under the Individual Transferable Quota system.

Commercial TACs and landings for 2023 are provided in Appendix 2, Table 1 of this document. To support groundfish research and account for unavoidable mortality incurred during the 2023 Groundfish surveys, research catches are allocated before defining the TAC. See Appendix 2, Table 2 for details.

Recreationally, the retention of Yelloweye Rockfish in inside and outside waters is prohibited. In outside waters, recreational fishers are limited to three rockfishes daily, only one of which may

be a China, Tiger, or Quillback Rockfish; possession limits are twice the daily limits, and the season runs from May 1 – September 30. In inside waters (4B), recreational fishers can take one rockfish daily (not Yelloweye Rockfish or Bocaccio), possession limits are twice the daily limit and the season runs from May 1 – September 30. 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.”

Offshore Rockfish

Commercial TACs and landings for 2023 are provided in Appendix 2, Table 1. To support groundfish research and account for unavoidable mortality incurred during the 2023 Groundfish surveys, research catches are allocated before defining the TAC. See Appendix 2, Table 2 for details.

Current management of Pacific groundfish stocks can be found in the Integrated Fisheries Management Plan (IFMP 2023).

I. Thornyheads

Research

Both Longspine and Shortspine Thornyhead do not have an acceptable protocol for ageing otoliths. Research (e.g., using stable isotope ^{18}O) is ongoing in the Sclerochronology Laboratory at PBS.

Assessment

Longspine Thornyhead (LST) was designated ‘Special Concern’ by COSEWIC in 2007. An assessment has been requested but not yet scheduled. Attempts to sample LST from a deep stratum (800-1300 m) in the WCVI synoptic survey have thus far been unsuccessful.
Coastwide Shortspine Thornyhead was assessed in 2015 using a delay-difference model.

The most recent stock assessment (2015) is publicly available on the CSAS website:
(Research Document 2017/015, Science Advisory Report 2016/016, Proceedings 2016/040).

Management

Longspine and Shortspine Thornyhead are both IVQ species. Commercial TACs and landings for 2023 are provided in Appendix 2, Table 1. To support groundfish research and account for unavoidable mortality incurred during the 2023 Groundfish surveys, research catches are allocated before defining the TAC. See Appendix 2, Table 2 for details.

Current management of Pacific groundfish stocks can be found in the Integrated Fisheries Management Plan (IFMP 2023).

J. Sablefish

Management of Sablefish in BC is guided by a Management Strategy Evaluation (MSE) process that has been jointly developed by Fisheries and Oceans Canada (DFO) and the BC Sablefish

fishing industry. Annual total allowable catches (TACs) for BC Sablefish have been set in a transparent and sustainable manner using simulation-tested management procedures (MPs) since 2011.

Research

Collection of biological data continued in 2023 through trawl and trap surveys. With the suspension of the At Sea Observer program due to COVID-19, there has been no commercial sampling from the trawl fishery since March 2020. However, commercial sampling has continued in the directed trap and longline fisheries through a voluntary biosampling program supported by industry. A head-only biosampling program has been used since 2018 in which commercial fishers follow specific instructions to collect specimens at stepped intervals of their overall cumulative catch for the year (i.e., every 50,000 lbs). Males and females are marked at by cutting the operculum, and then the heads are frozen to be sampled on shore for head morphometric measurements (used to infer fork length) and otolith sampling. Analyses used to support the development of the head-only biosampling program were published this year (Lacko et al. 2023).

A new research project was initiated in 2023 to investigate ageing requirements for the Sablefish operating model. The work looked at how potential changes in the number of Sablefish otoliths aged annually, as well as the allocating of ageing effort among age data sources, affected operating model performance with respect to bias and precision of estimated model parameters. This evaluation was undertaken in the context of the full Sablefish management system by using closed-loop feedback projections that applied the current Sablefish management procedure (MP) to simulated data each year to determine annual catch levels. Results will be published as a DFO Science Response in 2024 (DFO, in review).

Assessment

Sablefish stock status is regularly evaluated as part of the MSE process. An operating model (i.e., representation of alternative hypotheses about 'true' Sablefish population dynamics; OM) is used to both estimate stock status and simulate data for prospective testing of management procedure performance relative to stock and fishery objectives.

A revised version of the BC Sablefish OM was developed in 2022 that used data up to the end of 2021 (DFO 2023a; Johnson et al., in press). Stock status in 2022 was assessed via a weighted average of five operating model scenarios representing uncertainty about productivity and recent (2021) female spawning stock biomass. BC Sablefish female spawning stock biomass for 2022 (B_{2022}) was estimated to be well above the level of female spawning stock biomass associated with maximum sustainable yield (B_{MSY}). The weighted average estimate of B_{2022} is above B_{MSY} with 92% probability (median value of 1.32 times B_{MSY}). The estimated harvest rate (U) of legal-sized Sablefish in 2021 is below the harvest rate at MSY (U_{MSY}) with 94% probability (median value of 0.72 times U_{MSY}).

As part of the 2022 OM update, closed-loop simulations were used to evaluate whether several alternative management procedures (MPs) were able to meet operational fishery objectives under the revised OM scenarios. As a result of this evaluation, a new management procedure was selected for BC Sablefish for the 2023-24 fishing year (DFO 2023b).

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. Potential consequences of the mismatch between Sablefish stock structure and management for the coastwide North Pacific Sablefish stock are addressed in Kapur et al. (in press).

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Management

The MP that is currently in place for the BC Sablefish fishery was evaluated as part of the 2022 OM update (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 each year to calculate a recommended catch limit of legal Sablefish. The harvest control rule selected used for annual application starting in 2023-24 has a maximum target harvest rate of 6.4%. The intention of the Sablefish MSE process is to apply the current MP to updated monitoring data each year to produce annual catch limits. The current MP will be used until the next round of OM update and MP evaluation in ~ 2026-2027, barring unexpected signals in the survey data. Application of the Sablefish MSE's management procedure to develop an annual catch limit recommendation for the 2023-24 Sablefish fishery was documented through a CSAS Science Response (DFO 2023b), while application for the upcoming 2024-25 fishery will be published on the CSAS website in the coming months.

Commercial TACs and landings for 2022 are provided in Appendix 2, Table 1. To support groundfish research and account for unavoidable mortality incurred during the 2022 Groundfish surveys, research catches are allocated before defining the TAC. See Appendix 2, Table 2 for details.

K. Lingcod

Research

Data collection continued in 2023 through trawl and longline surveys and recreational creel surveys. With the suspension of the At Sea Observer program in 2020, there was no commercial sampling. Additional biological samples (length, weight, sex, maturity, and fins for ageing) were collected on the Outside HBLL survey done in collaboration with industry. We are currently preparing fins for ageing to inform survey selectivity in our next stock assessment. We are also collaborating with the Sclerochronology lab at PBS by collecting paired otolith and fin rays on our surveys to compare ageing structures.

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 have been processed and an assessment is underway and planned to be reviewed at CSAS in 2024-25. Inside Lingcod were last assessed in 2014.

Management

Commercial TACs and landings for 2023 are provided in Appendix 2, Table 1. To support groundfish research and account for unavoidable mortality incurred during the 2023 Groundfish surveys, research catches are allocated before defining the TAC. See Appendix 2, Table 2 for details.

Atka Mackerel

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

L. Flatfish

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 2023 through surveys. With the suspension of the At Sea Observer program due to COVID-19, there was no commercial sampling after March 2020. A pilot project to collect commercial at-sea samples biological sampling in ports is currently being developed for Arrowtooth Flounder.

Assessment

Arrowtooth Flounder

In the past 15 years, markets were established for B.C. Arrowtooth Flounder fillets that were frozen at sea. This resulted in increased catch, which peaked in 2014. The stock was last assessed in 2022 with a two-sex, two-fleet Bayesian age-structured assessment model fit to catch, survey index, and age-composition data from the 1996-2021 for a single coastwide stock. Catch data prior to 1996 were not used due to unknown levels of releasing at sea prior to the introduction of at-sea observers. Reference points based on maximum sustainable yield (MSY) were strongly impacted by the relationship between the estimates of maturity and commercial age selectivity; reference points were instead calculated with respect to unfished biomass (B_{0hake}). The model estimated a decline in spawning stock biomass from shortly after 2010 until around 2020 and suggested this decline was partly a result of increased fishing mortality and partly a result of low recruitment over the last decade. The stock was estimated to be above its Limit Reference Point with high probability but near its Upper Stock Reference point as of 2022. A Reference Removal Rate was estimated that would be expected to take the stock to its Upper Stock Reference in the long run (50 years).https://waves-vagues.dfo-mpo.gc.ca/Library/365131.pdf

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. Work is currently underway to deliver an updated stock assessment in 2024-25.

Southern Rock Sole

Southern Rock sole was last assessed in 2013. No request for updated advice has been received.

Dover Sole

Dover sole was last assessed in 1999. Aging of otoliths up to 2016 was completed in 2020 in anticipation of an updated assessment.

English Sole

English sole was also last assessed in 2007. No request for updated advice has been received.

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 2023 are provided in Appendix 2, Table 1. To support groundfish research and account for unavoidable mortality incurred during the 2023 Groundfish surveys, research catches are allocated before defining the TAC. See Appendix 2, Table 2 for details.

M. Pacific Halibut & IPHC Activities

Catch and biological data were collected in 2023 on trawl and longline surveys. With the suspension of the At Sea Observer program (ASOP) due to COVID-19, there has been no commercial biological sampling since April 2020. Current trawl-based halibut mortality is estimated using area-based average weights that were determined using historical ASOP data. DFO along with industry reps and service providers have developed a dockside biological sampling program to address gaps created from the suspension of ASOP; halibut length sampling will be considered along with other species in its development. In 2023, DFO collaborated with the Pacific Halibut Management Association to collect biological samples from the IPHC's Fishery Independent Setline Survey (FISS) during offloads. Sampling was completed by technicians from Archipelago Marine Research. Complete catch data by set was also recorded by skippers in logbooks and uploaded to GFFOS. There was a total of 174 sets in Canadian waters with almost 600 rockfish sampled dockside. All set species catch was submitted by the vessels with 439 Yelloweye Rockfish, 95 Quillback Rockfish and 64 Rougheye/ Blackspotted Rockfish samples attached at the fishing set level using a unique colour/ number tag system.

Commercial TACs and landings for 2023 are provided in Appendix 2.

N. Other Groundfish Species

Nothing to report at this time.

IV. Ecosystem Studies

A. 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 described the approach to a wider audience (Anderson et al. 2020). An updated synopsis with data up to 2021

was published in 2022 as a Science Response (DFO 2022). The authors expect to publish an update in 2023 as a DFO Technical Report. The synopsis code and link to the latest version are available on GitHub.

B. Groundfish Species Distribution Modeling

Species distribution models were made for numerous Canadian Groundfish using data from synoptic trawl and longline fishery-independent surveys Species (Thompson et al. 2023a). They demonstrated a method for integrating presence–absence data across surveys and gear types that allows them to predict the coastwide distributions of 65 groundfish species in British Columbia. The model leverages data from multiple surveys to estimate how species respond to environmental gradients while accounting for differences in survey catchability. They found that this method had two main benefits: (1) it increases the accuracy of predictions in data-limited surveys and regions while having negligible impacts on accuracy when data are already sufficient, and (2) it reduces uncertainty, resulting in tighter confidence intervals on predicted occurrences. These benefits are particularly relevant in areas of our coast where our understanding of habitat suitability is limited due to a lack of spatially comprehensive long-term groundfish surveys. The authors also coded a Shiny App to plot the species distribution of species of interest.

Similar techniques were applied to International Pacific Halibut Commission longline survey data stretching from Alaska to California in order to assess the potential distributional changes of the species under future climate change scenarios (Thompson et al. 2023b). The results of this modeling showed that Pacific halibut appear sensitive to changes in dissolved oxygen, yet relatively tolerant of increases in temperature. The climate projections resulted in decreases in dissolved oxygen near the seafloor in shallow waters which is likely to decrease the overall abundance of smaller halibut by the middle of the century. In contrast, larger halibut, which inhabit deeper waters showed a mixed response to future climate change, but this mostly reflected uncertainty around trends in oxygen concentration at mid-depths (300-600 m). A complementary analysis was published in by Franco et al (2022) and indicates that the projected decrease in suitable habitat for halibut will likely continue until the end of the 21st century. The Thompson et al (2023b) paper was part of a collection of papers on Pacific halibut that arose from a 2018 PICES workshop held in Victoria BC. The full issue can be found here.

C. Pacea

Drs. Andrew Edwards and Travis Tai at PBS developed an R package of Pacific ecosystem information to help facilitate an ecosystem approach to fisheries management. "*We wrangle the data so you don't have to.*" *pacea* stands for PACific Ecosystem Approach, and is pronounced 'pac-ee-a', with pac as in Pacific. pacea is a R package containing a variety of data sets and model output which is available on Github (https://github.com/pbs-assess/pacea). They wrangle the data sets behind the scenes to get them into usable formats in R, and provide helpful plotting functions. All data sets include documentation regarding the original sources and authors, who should be cited and consulted as appropriate. Pacea currently contains:

- Daily sea surface temperature based on data from 19 buoys (updated monthly);

- outputs from the spatial British Columbia continental margin (BCCM) model, the coupled physical-biogeochemical model by Peña et al. (2019). Variables are for 40,580 spatial cells across Canada's Pacific Exclusive Economic Zone, and are given as 27 years of monthly means (from 1993 to 2019) for: dissolved oxygen concentration; pH, salinity, temperature, depth-integrated phytoplankton, depth-integrated primary production.

- NOAA's spatial Optimum Interpolation Sea Surface Temperature (OISST) record, that incorporates observations from different platforms (satellites, ships, buoys, and Argo floats), provided as weekly and monthly means from Sep 1981 to Feb 2024 (updated monthly);

- 9 climatic and oceanographic indices, such as the Pacific Decadal Oscillation and those related to El Niño (updated monthly).

- Plotting and helper functions are provided, and demonstrated in the detailed vignettes. All data and model outputs are fully documented and referenced.

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V. Other related studies

A. State of the Pacific Ocean Report

Anderson, English, and Dunic contributed a chapter to the 2023 State of the Pacific Ocean report and presented on the work at the annual meeting. This involved synthesizing the most recent stock status for all assessed stocks since 2010, fitting a state-space time series model to trends in stock status to derive an overall average trend, and combining assessed status time series with recent geostatistical survey indices to provide insight into recent stock trends since stocks were last assessed. The state-space time series modelling indicated that average BC groundfish stock status declined from 1950 to around 2000, and following management changes, has remained relatively stable since. The geostatistical survey modelling revealed several findings. First, survey indices increased for ~70% of stocks over the last two decades, remained neutral for ~15%, and declined for ~15% of stocks. Second, over the last 5-7 years, all assessed shelf rockfish (Bocaccio, Canary, Redstripe, Silvergray, Widow, Yellowtail) and several slope rockfish increased in surveyed biomass. Over the last 5-10 years, survey indexes also increased for several flatfish (Petrale, English, Rex, and Dover Sole) but declined for Arrowtooth Flounder. Third, despite low levels of fishing mortality compared to historical levels, survey indices for North Pacific Spiny Dogfish stocks had the steepest declines across all stocks.

Hook Competition

Competition for bait on a finite number of hooks leads to biased estimates of relative abundance. If 1000 baited hooks are deployed and all the hooks catch a fish it is important to account for the fish that would have been caught if more hooks had been used. Additionally, fish that are not as quick to get to the baits as the fish that were caught can affect relative abundance estimates. Watson et al. (2023) developed a new statistical method for dealing with this long-standing problem. This method treats some observations as right-censored, such that observed catch counts are considered as a lower bound on what would have been observed in the absence of hook competition, outperformed previous methods. By using simulation experiments and applying it to data from Canadian waters, from the International Pacific Halibut Commission fishery-independent setline survey, they found that it can greatly change estimates of fish abundance. It can halve them or even double them compared to existing methods. Template R code is provided for users to apply the method to their own data.

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VI. Publications

A. Primary Publications

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B. Other Publications

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Appendix 1: Groundfish Trawl Biological Sampling Program (GTBSP)

In 2023, Archipelago Marine Research, the Canadian Groundfish Research and Conservation Society (CGRCS), the Deepsea Trawlers Association (DSTA), and Fisheries and Oceans Canada (DFO) developed a preliminary shore-based groundfish trawl biological sampling program (GTBSP) for Option A trawl vessels operating in the Pacific region of Canada. The GTBSP initially focused on the collection of rockfish biological samples because rockfish retention is mandatory in the trawl fishery. The program was simulation tested on landings in Ucluelet and later expanded to rockfish landed in Port Hardy and Prince Rupert. This is a pilot program designed to collect data from the commercial trawl fishery. The data collected in the pilot project will be reviewed at CSAS in 2025-26.

The GTBSP was implemented in the field for landings of fresh whole rockfish in Ucluelet on March 20, 2023 and later for Port Hardy and Prince Rupert starting on June 19, 2023. The sampling design for Port Hardy and Prince Rupert differed slightly from the design established for Ucluelet based on the species composition of rockfish catch and frequency of groundfish trawl landings with rockfish in these ports.

GTBSP Protocol – Ucluelet

Protocol below has been simplified. Contact Archipelago for full details.

- Rockfish biological samples will be collected at one fresh offload per week during weekdays (or weekends if sampling opportunities were sparse during the week).
- The offload selected for sampling is the first one that lands sufficient rockfish (>1000 kg of all rockfish species combined) that fished in one GMU area or two adjacent areas (4B excluded). Archipelago sampling staff review hail information provided by each incoming vessel to determine if it meets the above criteria (herein called ‘target vessel’). If the first target vessel offloading during the week was sampled during the prior week, select the second target vessel of the week.
- Archipelago staff collect samples from 4 target rockfish species (5 if time permits) based on abundance from a pre-selected group of 16 species identified by the simulation study. The sample size for each species is 25 fish (minimum of 10 fish).
- In Ucluelet, Yellowtail Rockfish (YTR) and Widow Rockfish (WWR) are sampled every second week (if they occur in the top 4 or 5 by abundance) to distribute sample collection to other rockfish that are less abundant.
- The GTBSP technical working group (TWG) meets regularly to review the results of the sampling program to determine if samples collected are representative of the catch by species landed and adjust the species selection protocol if required.

The protocol varies somewhat for the other two ports because different sets of rockfish species are landed there. Contact Archipelago for details.

Arrowtooth Flounder Biological Sampling Program (AFBSP)

In 2023, Archipelago Marine Research, the Canadian Groundfish Research and Conservation Society (CGRCS), the Deepsea Trawlers Association (DSTA), and Fisheries and Oceans Canada (DFO) developed a new Arrowtooth Flounder biological sampling program (AFBSP) for

Option A trawl receiving tank vessels (RTV) that freeze product during operations in the Pacific region of Canada. The program was simulation tested before its implementation on November 1, 2023. RTVs capture the majority of Arrowtooth Flounder (ARF) along the BC coast; however, a sampling protocol has also been developed for shoreside vessels.

AFBSP Protocol – RTV

Protocol below has been simplified. Contact Archipelago for full details.

- Take biological samples of ARF from the 3rd and 9th directed ARF tow of a trip. If 3rd and 9th tows are not directed, sample the next following tow that is directed. A directed tow must contain at least 10,000 lbs of ARF.
- Once the first two samples are taken, collect an ARF sample from the first directed tow in each new groundfish management area for the remainder of the trip.
- Sample approximately 50 ARF specimens below deck from the conveyor belt before any sorting has occurred. At collection intervals of 30, 60, and 90 minutes, stop the conveyor belt and remove ~17 ARF and place them into baskets or totes.
- Freeze sampled ARF whole in blocks. The number of blocks will depend on the size of fish encountered and the size of each block.
- Once frozen, place samples in sealed bags. Use a marker to write vessel name, date, and time of the last fish collected on the outside of each bag. If known, write the tow number that the sample was collected from on each bag.
- The skipper should record that an ARF biological sample was collected, and its estimated weight, in designated fields of the Observers Logbook and Trawler observer log application.
- Bags containing frozen samples should be stored separately from the vessel's product until the end of the trip.
- ARF samples are handed over to the dockside monitor during the trip offload.

Another protocol exists for Shoreside vessels. Contact Archipelago for details.

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Appendix 2: BC commercial groundfish TACs, landings, and research allocations for 2023.

Table 1. British Columbia Groundfish Total Allowable Catch (TAC) and commercial landings in metric tonnes (t) for the 2023 fishing year. Except where noted, TACs are from the 2023 Groundfish Integrated Fisheries Management Plan (https://waves-vagues.dfo-mpo.gc.ca/library-bibliotheque/41098067.pdf). Landings are from the Dockside Monitoring Program.

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	103	9,520	0	14,000	103
Big Skate	914	168	117	19	1,031	187
Longnose Skate	138	59	263	57	401	116
Pacific Cod	1,250	594	0	5	1,250	599
Walleye Pollock	4,935	5,438	0	0	4,935	5,438
Pacific Hake [1]	7,000 gulf & 105,000 offshore	30,340	0	0	112,000	30,340
Rockfishes						
Rougheye/Blackspotted Rockfish Complex	614	477	463	253	1,077	729
Pacific Ocean Perch	5,192	2,953	1	0	5,193	2,954
Redbanded Rockfish	295	145	295	229	590	374
Shortraker Rockfish	126	28	111	145	237	173
Silvergray Rockfish	1,945	1,704	254	34	2,199	1,738
Widow Rockfish	2,500	2,403	46	0	2,546	2,403
Yellowtail Rockfish	5,440	4,458	60	3	5,500	4,461
Quillback Rockfish	4	2	147	92	151	94
Bocaccio	1,799	1,426	0	24	1,799	1,451
Canary Rockfish	1,316	1,201	186	11	1,502	1,212
Redstripe Rockfish	1,550	692	43	0	1,593	692
Yellowmouth Rockfish	2,419	1,535	81	4	2,500	1,539
Yelloweye Rockfish	4	13	136	172	140	185
Copper, China, &Tiger Rockfish	1	1	60.3	45	61.3	46

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	104	34	162	770	266
Longspine Thornyhead	405	0	20	0	425	0
Sablefish	251	247	2,616	3,933	2,867	4,180
Lingcod	2,572	917	1,168	1,196	3,740	2,112
Flatfishes						
Arrowtooth Flounder	4,500	3,283	0	0	4,500	3,283
Petrale Sole	900	794	0	1	900	795
Southern Rock Sole	1,552	159	0	0	1,552	159
Dover Sole	3,073	957	0	0	3,073	957
English Sole	822	248	0	0	822	248
Pacific Halibut [2,3]	454	8	2,257	3,781	2,711	3,788

[1] Hake TAC provided by Lindsay Richardson-Deranger.

*[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 2023. 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 2023 Groundfish Integrated Fisheries Management Plan (https://waves-vagues.dfo-mpo.gc.ca/library-bibliotheque/41098067.pdf).

Species or Species Group	Trawl surveys (t)	Longline surveys (t)	Sablefish surveys (t)	Total (t)
Sharks And Skates				
North Pacific Spiny Dogfish	3.9	0.0	0.0	3.9
Big Skate	1.0	0.0	0.0	1.0
Longnose Skate	1.0	0.0	0.0	1.0
Pacific Cod	3.1	1.9	0.0	5.0
Walleye Pollock	5.0	0.0	0.0	5.1
Pacific Hake	7.2	0.0	0.0	7.2
Rockfishes				
Rougheye/Blackspotted Rockfish Complex	0.9	22.6	0.0	23.5
Pacific Ocean Perch	23.3	0.0	0.0	23.3
Redbanded Rockfish	2.6	11.6	0.0	14.2
Shortraker Rockfish	0.1	5.4	0.0	5.5
Silvergray Rockfish	11.8	12.7	0.0	24.5
Widow Rockfish	0.2	0.0	0.0	0.2
Yellowtail Rockfish	3.3	2	0.0	5.3
Quillback Rockfish	0.6	5.8	0.0	6.4
Bocaccio	1.5	0.0	0.0	1.5
Canary Rockfish	2.6	8.9	0.0	11.4
Redstripe Rockfish	4.5	0.0	0.0	4.5
Yellowmouth Rockfish	7.2	3.0	0.0	10.2
Yelloweye Rockfish	0.4	11.7	0.0	12.1
Copper, China, And Tiger Rockfish	0.2	2.8	0.0	3.0
Thornyheads				
Shortspine Thornyhead	2.0	0.9	0.0	2.9
Longspine Thornyhead	0.0	0.0	0.0	0.0

Table 2. Continued.

Species or Species Group	Trawl surveys (t)	Longline surveys (t)	Sablefish surveys (t)	Total (t)
Sablefish	13.2	0.5	100.0	113.7
Lingcod	1.2	4.0	0.0	5.2
Flatfishes				
Arrowtooth Flounder	23.8	0.0	0.0	23.8
Petrale Sole	1.4	0.0	0.0	1.5
Southern Rock Sole	1.7	0.0	0.0	1.7
Dover Sole	8.1	0.0	0.0	8.1
English Sole	7.9	0.0	0.0	7.9
Pacific Halibut [1]	2.3	27.2	0.0	29.5

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