CANADA

British Columbia Groundfish Fisheries and Their Investigations in 2018

April 2019

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I. Agency Overview

Fisheries and Oceans Canada (DFO), Science Branch, operates three principal facilities in the Pacific Region: the Pacific Biological Station (PBS), the Institute of Ocean Sciences (IOS), and the West Vancouver Laboratory (WVL). These facilities are located in Nanaimo, Sidney and West Vancouver, British Columbia (BC), respectively. Dr. Carmel Lowe is the Regional Director of Science. The Divisions and Sections are as follows:

Division Heads in Science Branch reporting to Dr. Lowe are:

Canadian Hydrographic Service	Mr. David Prince
Ocean Science	Ms. Kim Houston
Aquatic Diagnostics, Genomics & Technology	Ms. Lesley MacDougall
Ecosystem Science	Dr. Eddy Kennedy
Stock Assessment and Research	Dr. John Holmes

Section Heads within the Aquatic Resource Research and Assessment Division (ARRAD) are:

Groundfish	Mr. Greg Workman
Marine Invertebrates	Ms. Lynne Yamanaka
Quantitative Assessment Methods	Dr. Robyn Forrest
Fisheries and Assessment Data	Mr. Bruce Patten
Salmon Assessment	Ms. Mary Thiess

Science Branch in the Pacific Region underwent a major re-organization during 2016 in an effort to better position itself to address its evolving and expanding mandate and distribute staff more evenly amongst divisions. Of particular note is the creation of the Ecosystem Science Division (ESD) with a mandate to focus on Ocean Act priorities (Marine Spatial Planning, Ocean Protection Program, Ecosystem Effects, etc), consolidation of all the fisheries related science in the Aquatic Resource Research and Assessment Division (ARRAD, Recently renamed Stock Assessment and Research Division (StAR)), and consolidation of Science “Services” in the Aquatic Diagnostics, Genomics & Technology Division (ADGT) (Schlerochronology Lab, Genetics, Animal health, Aquarium services). Groundfish research and stock assessment are now conducted amongst the Offshore, Fisheries and Assessment Data, and Quantitative Methods Sections within ARRAD. Groundfish specimen ageing is conducted in the Applied Technologies Section in ADGT. Acoustic fisheries research and surveys are led by the Ecology and Biogeochemistry Section in the Ocean Sciences Division.

The Canadian Coast Guard operates DFO research vessels. These research vessels include the *J.P. Tully, Vector*, and *Neocaligus*. The principle vessel used for groundfish research for the last 31 years, the *WE Ricker,* was officially decommissioned in October of 2017. The replacement vessel for the *W.E. Ricker,* the *Sir John Franklin* is currently undergoing sea trials with delivery anticipated mid-summer of 2019. At sea operations for groundfish surveys during 2017-2019 will be conducted aboard chartered commercial fishing vessels.

The Pacific Region Headquarters (RHQ) of Fisheries and Oceans Canada is located in Vancouver, British Columbia. Management of groundfish resources is the responsibility of the Pacific Region Groundfish Regional Manager (Mr. Adam Keizer) within the Fisheries and Aquaculture Management Branch (FAM). Fishery Managers receive assessment advice from StAR through the Canadian Centre for Scientific Advice Pacific (CSAP) review committee which is headed by Mr. John Candy. Historically Groundfish held at least two meetings per year, in which stock assessments or other documents underwent scientific peer review (including external reviewers who are often from NOAA). The resulting Science Advisory Report

summarizes the advice to Fishery Managers, with the full stock assessment becoming a Research Document. Both documents can be viewed on the Canadian Stock Assessment Secretariat website: http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm. The future frequency of review meetings and production of stock assessment advice for fisheries managers will depend on departmental, branch and regional priorities potentially resulting in less frequent advice.

The Trawl, Sablefish, Rockfish, Lingcod, North Pacific Spiny Dogfish, and Halibut fishery sectors continue to be managed 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. Details for the February 2018 Groundfish Integrated Fisheries Management Plan can be viewed at http://www.pac.dfo-mpo.gc.ca/fm-gp/ifmp-eng.html#Groundfish.

Allocations of fish for financing scientific and management activities are identified in the Groundfish Integrated Fisheries Management Plan. Joint Project Agreements (JPAs) were developed for 2018-19 between Fisheries and Oceans Canada and several partner organizations to support groundfish science activities through the allocation of fish to finance the activities. These JPAs will be updated for 2019-20.

II. Surveys

Groundfish Surveys Program Overview

The Fisheries and Oceans, Canada (DFO) Groundfish section of the Stock Assessment and Research Division includes a surveys program. The cornerstone of the surveys program is a suite of surveys using bottom trawl, longline hook, and longline trap gear that, in aggregate, provide comprehensive coverage for all offshore waters of Canada's Pacific Coast (Figure 1). All the surveys follow random depth-stratified designs and have in common full enumeration of the catches (all catch sorted to the lowest taxon possible), size composition sampling for most species, and more detailed biological sampling of selected species. Most of the surveys are conducted in collaboration with the commercial fishing industry under the authorities of various Collaborative Agreements. In addition to these surveys, the Groundfish section conducts a hydroacoustic assessment of Pacific Hake and collects additional information from a DFO Small-Mesh Bottom Trawl Survey and the International Pacific Halibut Commission (IPHC) Setline Survey (Figure 2).

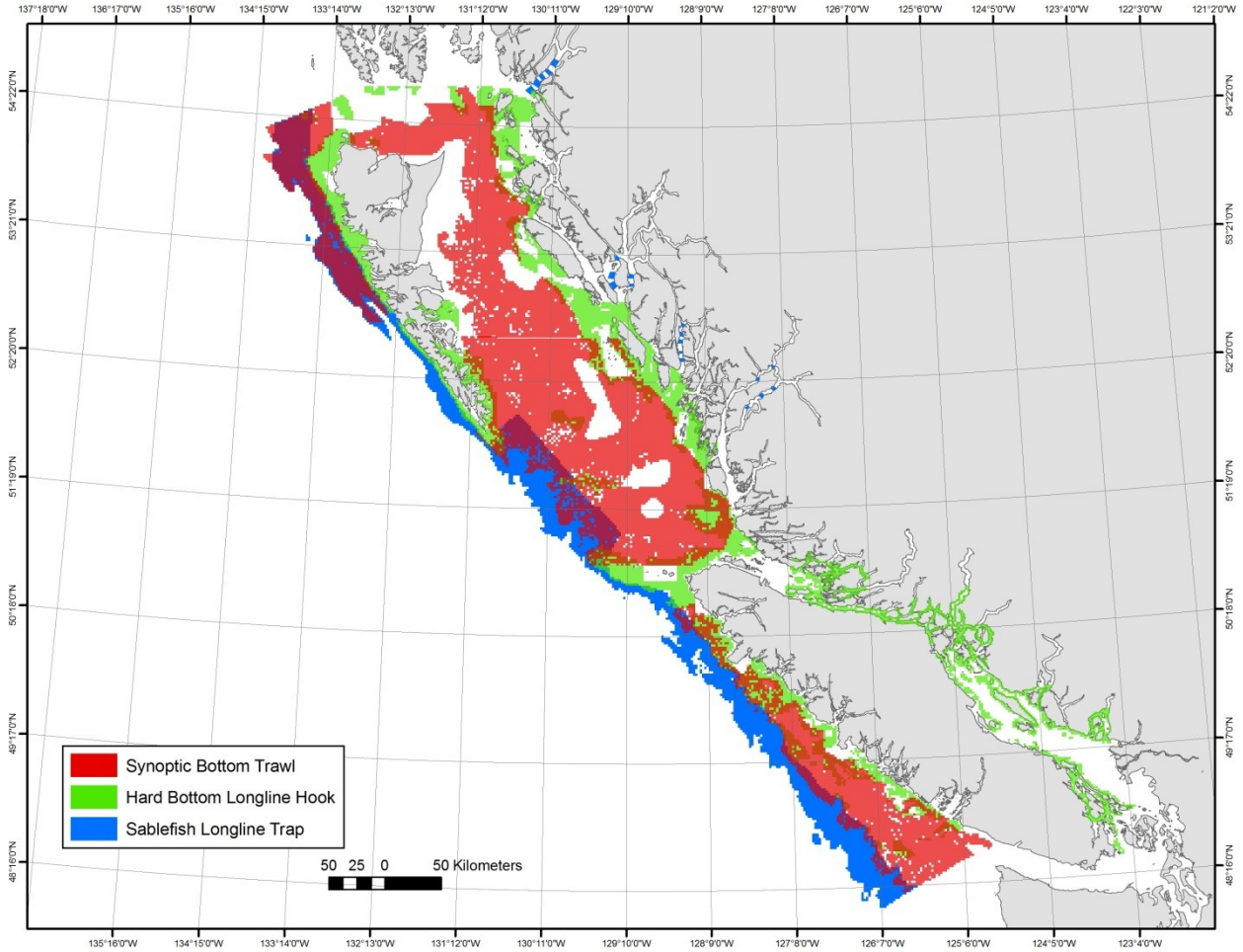


Figure 1. Random depth-stratified survey coverage.

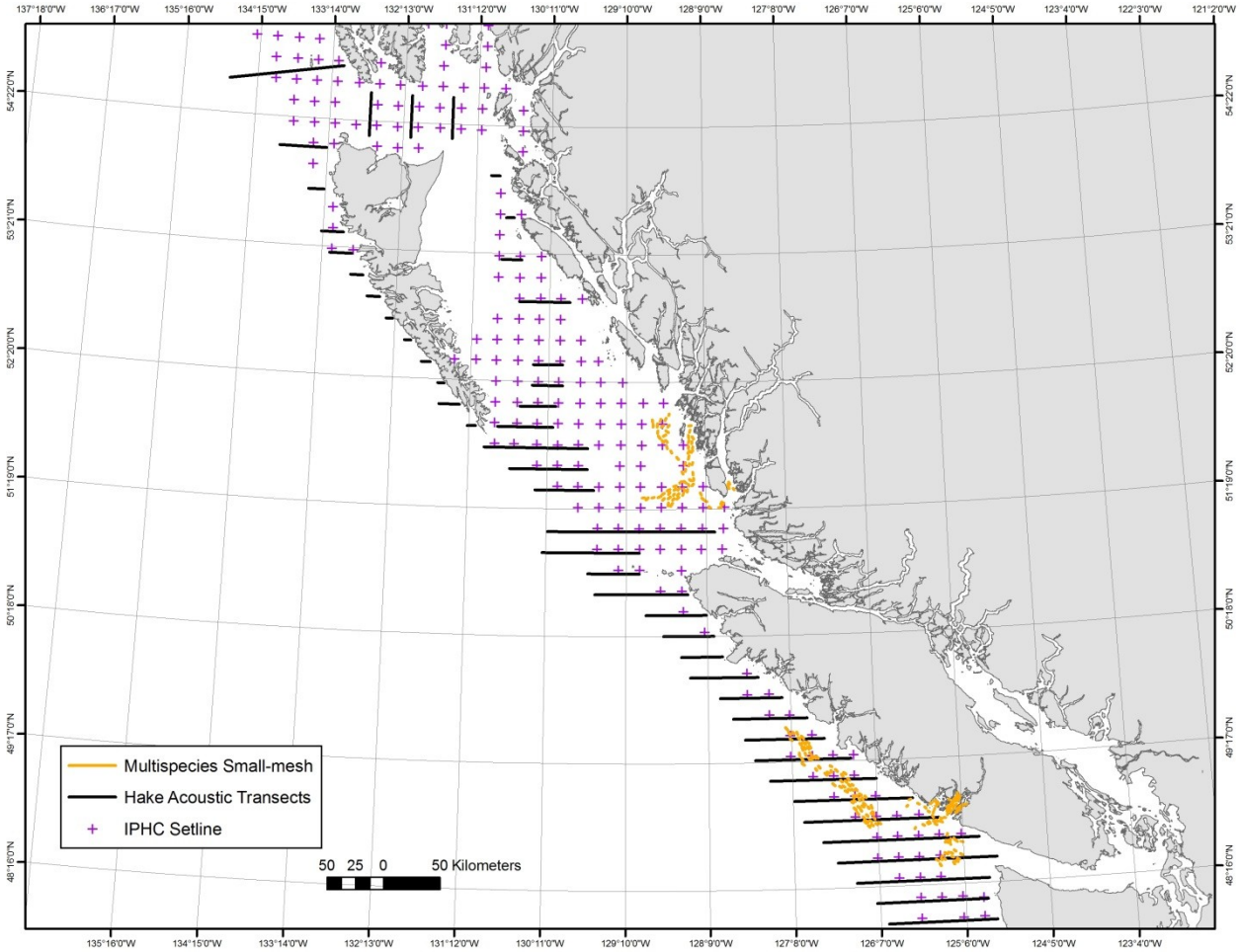


Figure 2. Other non-random-depth-stratified surveys that form part of the Groundfish survey program including the Multispecies Small-mesh Bottom Trawl Survey, the Pacific Hake Hydroacoustic Survey, and the International Pacific Halibut Commission (IPHC) Setline Survey.

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

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

In addition to the bottom trawl and hook and line surveys, an annual, coast-wide longline trap survey targeting sablefish is conducted in collaboration with the commercial fishing industry. We call this survey the Sablefish Research and Assessment Survey. The commercial sablefish industry supplies the chartered commercial fishing vessel and the survey is conducted with a combination of DFO staff and industry-hired sea-going technicians. This survey covers the depth range of 150 m to 1500 m for the entire outer BC coast as well as a number of central coast inlets.

In addition to the bottom trawl, hook and line, and trap surveys an annual hydroacoustic survey is conducted for Pacific Hake. We call this the Hake Hydroacoustic Survey. The survey is conducted as part of the Pacific Whiting Treaty and typically alternates year to year between research and assessment activities. The survey is conducted in collaboration with NOAA using both the NOAA research vessel BELL SHIMADA and the Canadian Coast Guard research trawler.

Each year, Groundfish section staff also participate in a fixed-station survey of commercially important shrimp grounds onboard the Canadian Coast Guard research trawler. We call this survey the Multispecies Small Mesh Bottom Trawl Survey. Groundfish program staff participate in the survey to provide assistance in enumerating the catch while also collecting biological samples from selected fish species.

During their survey, the IPHC only fully enumerates the catch for, and collects biological samples from Pacific Halibut. In an effort to acquire more data on hook and line groundfish species, particularly rockfish, the commercial fishing industry sponsors an additional technician aboard each of the IPHC chartered survey vessels. The extra technician fully enumerates the catch of all species and collects biological samples from all species of rockfish.

This report summarizes the 2018 surveys (Figure 3) including the Multispecies Synoptic Bottom Trawl surveys conducted off the West coast of Vancouver Island and the west coast of Haida Gwaii, the Hard Bottom Longline Hook Survey was conducted in the southern parts of both the “inside” and “outside” waters, the coast-wide Sablefish Research and Assessment Survey, the Multispecies Small Mesh Bottom Trawl Survey off the west coast of Vancouver Island, and the IPHC setline survey. For details on the surveys conducted in 2018, please see Appendix 1. As of the writing of this report the data from the Hard Bottom Longline Hook Survey “Outside” and the IPHC survey is not available nor summarized here.

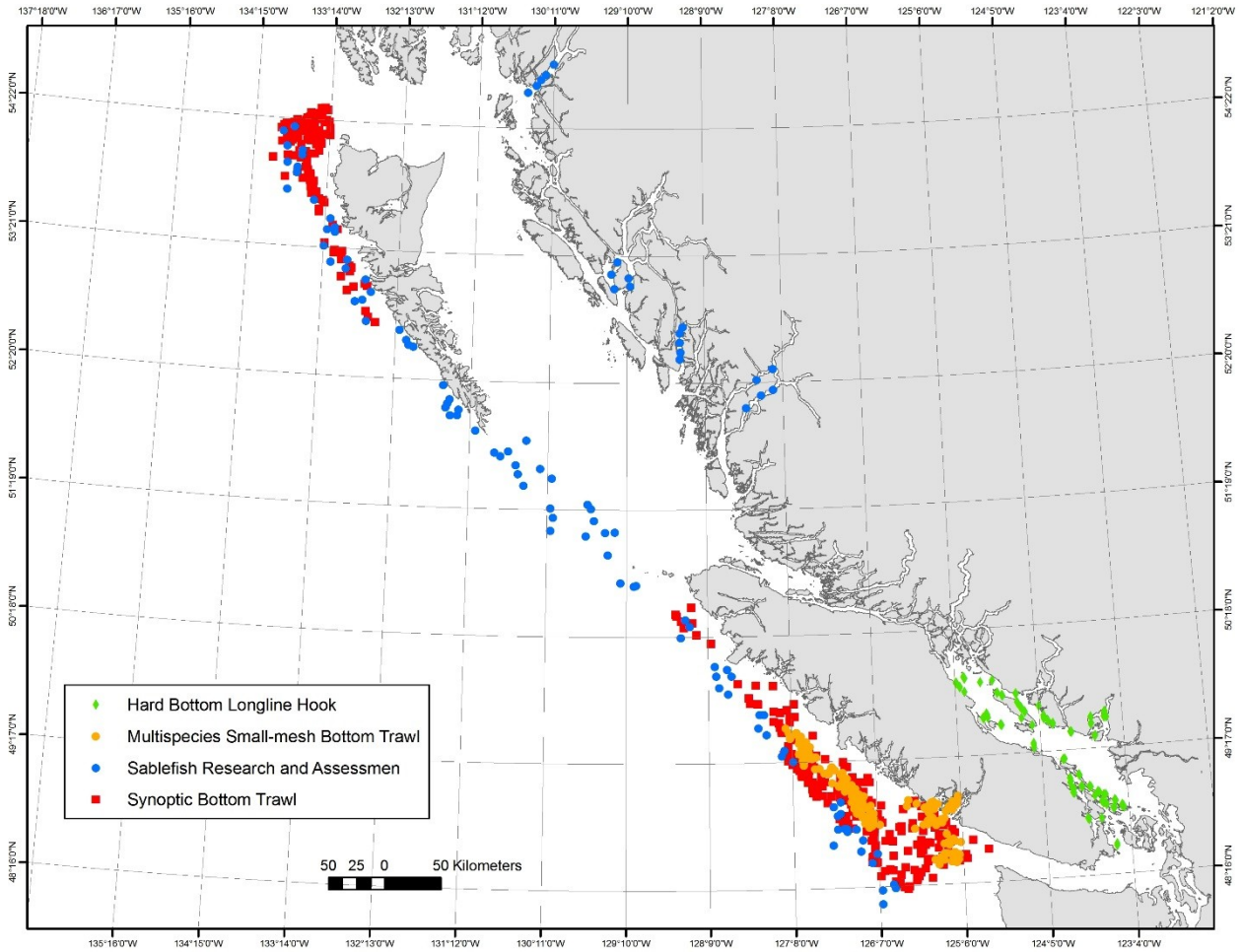


Figure 3. Fishing locations of the 2018 Groundfish surveys. The outside HBLL and IPHC surveys are not presented as the data are not yet available.

Multispecies Synoptic Bottom Trawl Surveys

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

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

There are four core surveys, two of which are conducted each year. The Hecate Strait survey and the Queen Charlotte Sound survey are conducted in odd-numbered years while the West Coast Vancouver Island survey and the West Coast Haida Gwaii (formerly Queen Charlotte Islands) survey are conducted in even-numbered years (Figure 4).

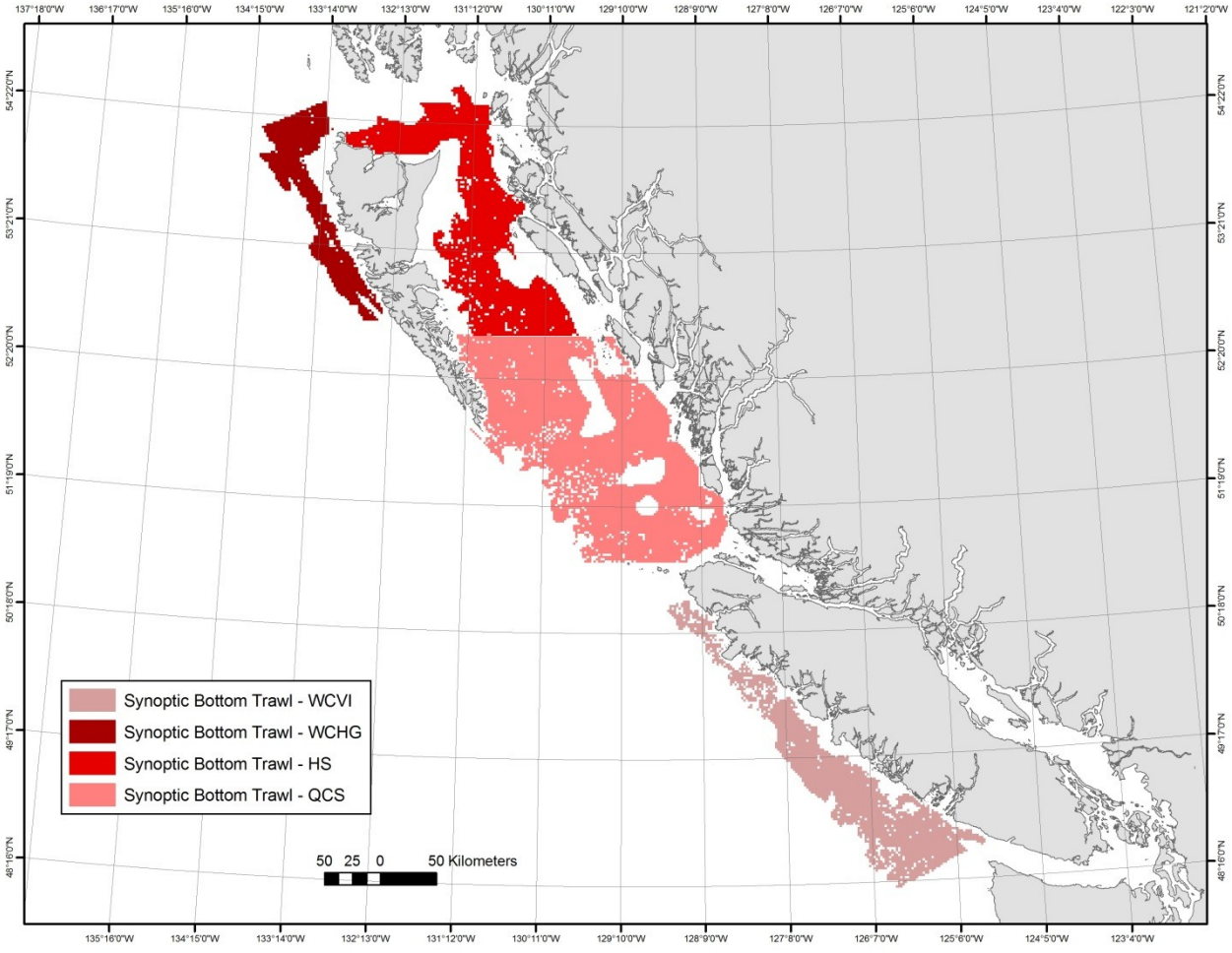


Figure 4. Multispecies Synoptic Bottom Trawl Survey coverage.

In addition to the four core surveys, a Strait of Georgia survey was initiated in 2012 with the intention of repeating the survey every 3 years. The first scheduled repeat of the survey was in 2015 but it was not possible to conduct the survey during March. Nonetheless, research vessel time was available during May and it appeared that the time period would remain available in future years. Unfortunately, due to changing priorities, the May time period will not be available in future years. As such, the intent was to conduct a survey in March of 2017 and continue biennially, in odd numbered years. Unfortunately the research vessel was not operational in 2017 and the survey is now on hiatus due to staffing constraints.

The synoptic bottom trawl surveys are conducted on both chartered commercial vessels and government research vessels. The Hecate Strait survey, the West Coast Vancouver Island survey, and the Strait of Georgia survey are all conducted on a Canadian Coastguard research trawler while the Queen Charlotte Sound survey and the West Coast Haida Gwaii are conducted on chartered commercial fishing vessels.

The four core synoptic surveys (Hecate Strait, Queen Charlotte Sound, West Coast Vancouver Island, and West Coast Haida Gwaii) are all fished using an Atlantic Western bottom trawl. In contrast, the SOG survey is fished using a much smaller Yankee 36 bottom trawl. The decision to use the smaller trawl makes direct comparisons between the areas difficult but allowed us to conduct the survey in the available days. The use of the smaller trawl allows more blocks to be fished each day as the net is faster to deploy and retrieve and catches tend to be smaller.
In 2017 the Hecate Strait and Queen Charlotte Sound surveys were conducted. Both surveys were conducted on chartered commercial vessels because the Canadian Coastguard research trawler W.E. Ricker was not operational.

Hard Bottom Longline Hook Surveys

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

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

The “outside” area covers the entire British Columbia coast excluding inlets and the protected waters east of Vancouver Island. The northern region of the outside survey area includes the mainland coast north of Milbanke Sound, Dixon Entrance, and both sides of Haida Gwaii while the southern region includes the mainland coast south of Milbanke Sound, Queen Charlotte Sound, and the north and west coasts of Vancouver Island. The northern region of the outside area was surveyed during even numbered years from 2006 to 2012 and the southern region was surveyed in odd years from 2007 to 2011. The survey had a one year hiatus in 2013 but resumed in 2014 in the southern region. The current schedule is to survey the northern region in odd numbered years and the southern region in even numbered years.

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

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

In 2017 the northern region of the outside area was surveyed. The intent was to survey the southern region of the inside area but unfortunately, due to crewing limitations, the inside survey was not conducted.

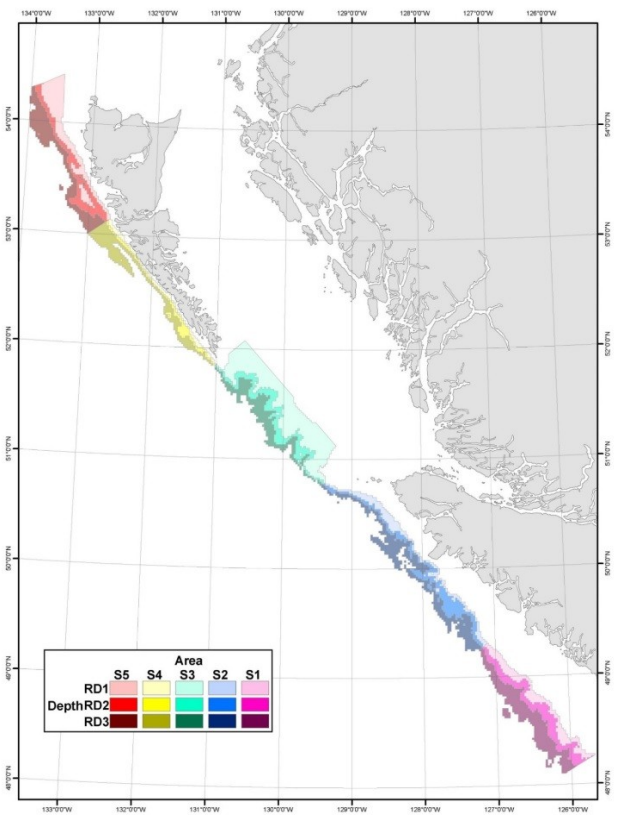
Sablefish Research and Assessment Survey

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

A pilot stratified random design was introduced for the 2003 survey with the dual purposes of random release of tagged fish and development of a second stock abundance index. The offshore survey area was divided into five spatial strata (Figure 5). Each spatial stratum was further divided into 2 km by 2 km blocks and each block was assigned to one three depth strata. Each year, blocks are randomly selected within each combination of spatial and depth strata. From 2003 through 2010, the selected blocks were allocated equally among the strata. An analysis was conducted for the 2011 survey to estimate the optimal allocation of blocks and that allocation was used in both 2011 and 2012. In 2013 the number of blocks in the survey was reduced in an effort to reduce the overall cost of the survey. The allocation from 2013 has been used for all subsequent surveys.

The 2018 Sablefish research and assessment survey was comprised of two main components:

1. A Randomized Tagging Program that releases tagged Sablefish at randomly selected fishing locations in offshore waters. Theses sets also produce a time series of catch rate and biological data that can be used for assessing changes in stock abundance.
2. An Inlets Program that releases tagged Sablefish from fixed-stations at four mainland inlet localities (Figure 6). These sets also provide a time series of catch rate and biological data that can be used for assessing changes in stock abundance.



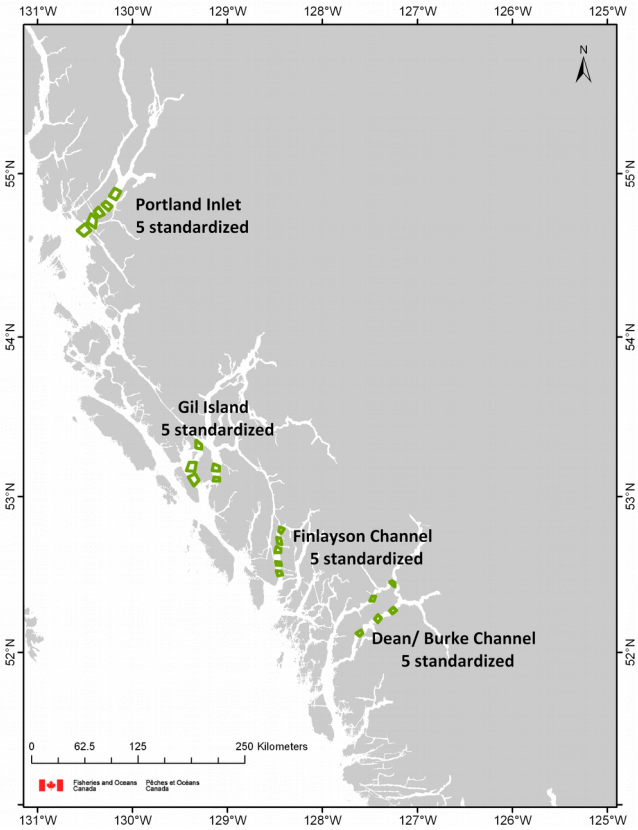


Figure 5. Sablefish Research and Assessment Survey randomized tagging program design showing the boundaries of each of the spatial and depth strata.
Figure 6. Sablefish Research and Assessment Survey Inlets program locations.

Multispecies Small-mesh Bottom Trawl Survey

An annual fixed-station survey of commercially important shrimp grounds off the West Coast of Vancouver Island was initiated in 1973. In 1998, areas in Eastern Queen Charlotte Sound were added to the survey. Given that the survey is conducted using a shrimp bottom trawl without an excluder device, groundfish can make up a significant portion of the catch in many of the tows. Catch rate indices generated by the survey have been used to track the abundances of several groundfish stocks. Although catch rates are useful indicators of stock status, additional information such as the size and age composition of the catch improves the usefulness of the indices. Consequently, a program was initiated in 2003 to collect biological samples from all groundfish species caught during the survey. Groundfish staff provide assistance in catch sorting and species identification and also collect biological samples from selected fish species. From 2010 through 2013, the goal was to collect biological information from as many different species in each tow as possible - as opposed to detailed information from only a few species. As such, two groundfish program staff members were deployed and the biological sampling effort was focused on length by sex data in favour of collecting ageing structures. Starting in 2014, only one groundfish staff member participated in the survey and the biological sampling program was reduced so that a single person could accomplish all the work. In addition, the sampling program was rationalized to only include species where the survey is expected to provide a useful index of abundance.
Starting in 2013, the West Coast Vancouver Island portion of the survey also included locations in Barkley Sound that were surveyed by the CCGS Neocaligus in previous years. In 2014, the Queen Charlotte Sound portion of the survey was not conducted due to the limited number of vessel days available for the program. The Queen Charlotte Sound area was also not visited in 2015 due to staffing limitations. In 2017, only the West Coast Vancouver Island area was surveyed.

International Pacific Halibut Commission Fishery-independent Setline Survey

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

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

In 2018, the FISS survey underwent an experimental, one-time expansion with an additional 135 stations added to the grid. These expansion stations sampled previously unsurveyed habitat, notably in waters within and near the Strait of Georgia, and in the shallow waters in Hecate Strait east of Haida Gwaii, as well as up various channels and inlets (Figure X).

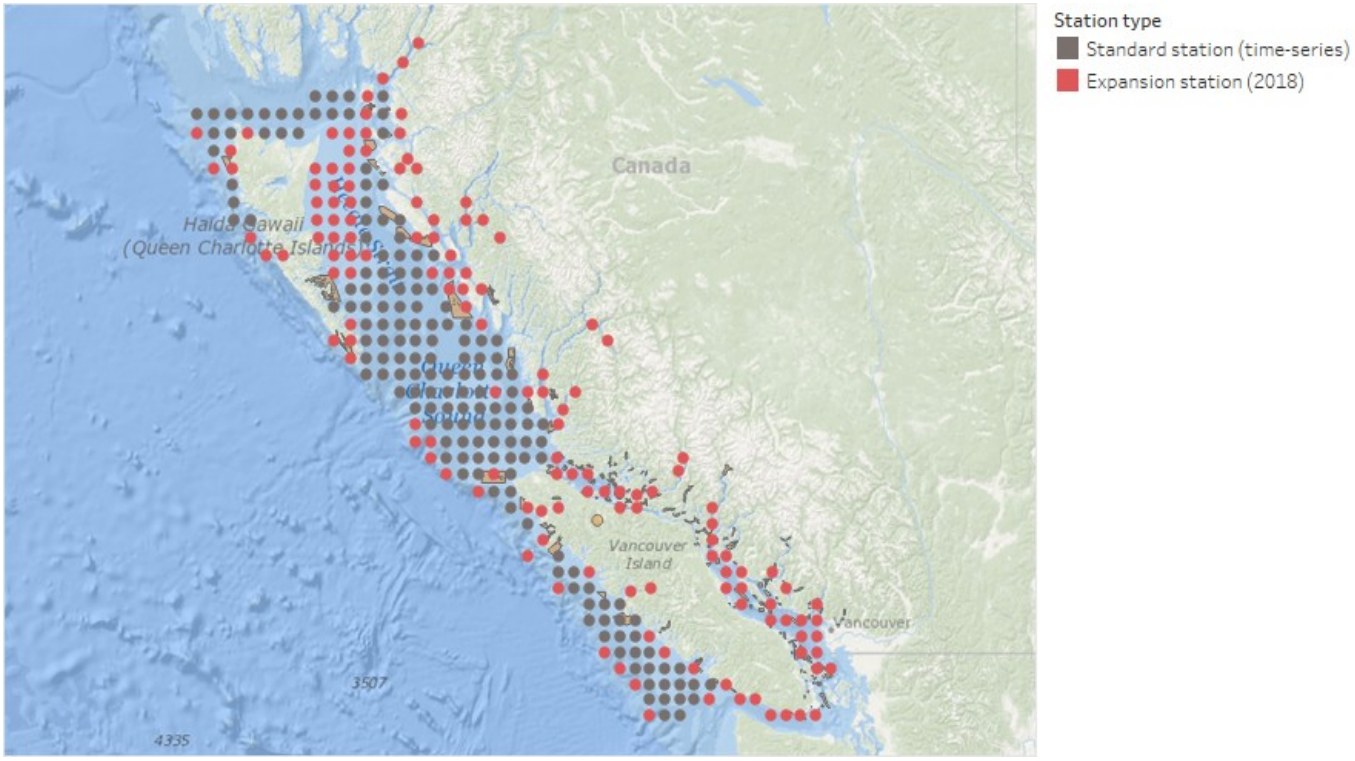


Figure 7. Standard and expansion stations for the IPHC Longline Survey in BC.

III. Reserves

The Government of Canada has the mandate to protect 10% of federal waters in marine protected areas (MPAs) by 2020 to fulfill its international commitment under the Aichi Biodiversity Convention (Target 11). Canada surpassed its interim milestone of 5% by 2017 by protecting 7.75% by the end of 2017 (http://www.dfo-mpo.gc.ca/oceans/conservation/2017-eng.html). In order to achieve the marine conservation targets, a number of initiatives are underway in British Columbia (Error: Reference source not found).

DFO along with the Province of British Columbia and 16 First Nations, are co-leading the development of a network of MPAs for the Northern Shelf Bioregion (http://mpanetwork.ca/bcnorthernshelf/). The Marine Protected Area Technical Team (MPATT) has compiled ecological, cultural and human use data to be used in an iterative planning process with ongoing stakeholder input to identify potential areas for the MPA network in NSB. A draft MPA network scenario was released for comment by stakeholders on the advisory committee on February 28, 2019, with initial reviews by June 30 and MPATT accepting feedback until Jan 31. The scenario is expected to change as a result of comments and has not been publically released.

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 that MPA network, as will the Gwaii Haanas National Marine Conservation Area Reserve (GHNMCAR) and Haida Heritage Site. Parks Canada and the Archipelago Management Board have introduced new zoning to the GHNMCA 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 come into effect on May 1, 2019. The two RCAs that were formerly within the GHNMCA boundaries will be rescinded and replaced with the new zoning, although one small RCA remnant may remain in Crescent Inlet. Parks Canada is still also working on the Southern Gulf Islands NMCA.

Another major initiative is the designation of the Offshore Pacific Seamounts and Vents Closure. The Area of Interest (AOI) was designated in 2017 and an offshore groundfish fishing closure was put into place to protect seamount and vent communities (Error: Reference source not found) (DFO 2019). The Endeavour Hydrothermal Vents MPA, designated under Canada's Ocean Act in 2003, is within the Offshore AOI. The Endeavour MPA was designated to ensure the protection of hydrothermal vents, and the unique ecosystems associated with them. The regulation to establish the MPA prohibits the removal, disturbance, damage or destruction of the venting structures or the marine organisms associated with them while allowing for scientific research that will contribute to the understanding of the hydrothermal vents ecosystem (http://www.dfo-mpo.gc.ca/oceans/mpa-zpm/endeavour-eng.html). They are on track to make this into an MPA within 2 years.

Following the closure of seamounts in the large offshore area, the Haida First Nation and Government of Canada increased protection within the SGaan Kinghlas-Bowie Seamount (SKB) MPA by closing it to all bottom-contact commercial fishing (January 2018, https://www.newswire.ca/news-releases/haida-nation-and-canada-increase-protection-at-the-sgaan-kinghlas---bowie-seamount-marine-protected-area-670142283.html). The SKB 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 (http://www.dfo-mpo.gc.ca/oceans/mpa-zpm/bowie-eng.html).

The other 162 Rockfish Conservation Areas (RCAs) designated as fishery closures between 2004-2007 (Yamanaka and Logan 2010), remain in place and are being evaluated as "other effective area-based conservation measure" to achieve the Aichi Target 11. A review of the RCA locations was completed this year (DFO 2019) and a risk assessment is also being completed and will be re-reviewed at CSAP in May 2019. Sponge reef fishery closures in the Strait of Georgia are also being considered as other effective measures. 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). Eight additional sponge reefs closures in Howe Sound were announced by DFO on April 1, 2019 with the same prohibitions as the other sponge closures with the additional prohibition of the use of downrigger gear in recreational salmon fishing due to the potential risk of damage to these shallow reefs.

The Scott Islands marine National Wildlife Area (NWA), the first protected marine area established under the Canada Wildlife Act, was established on June 27th, 2018. It conserves a vital marine area for millions of seabirds on the Pacific coast. Fishing activity is currently not prohibited in the NWA (https://www.canada.ca/en/environment-climate-change/services/national-wildlife-areas/locations/scott-islands-marine.html).

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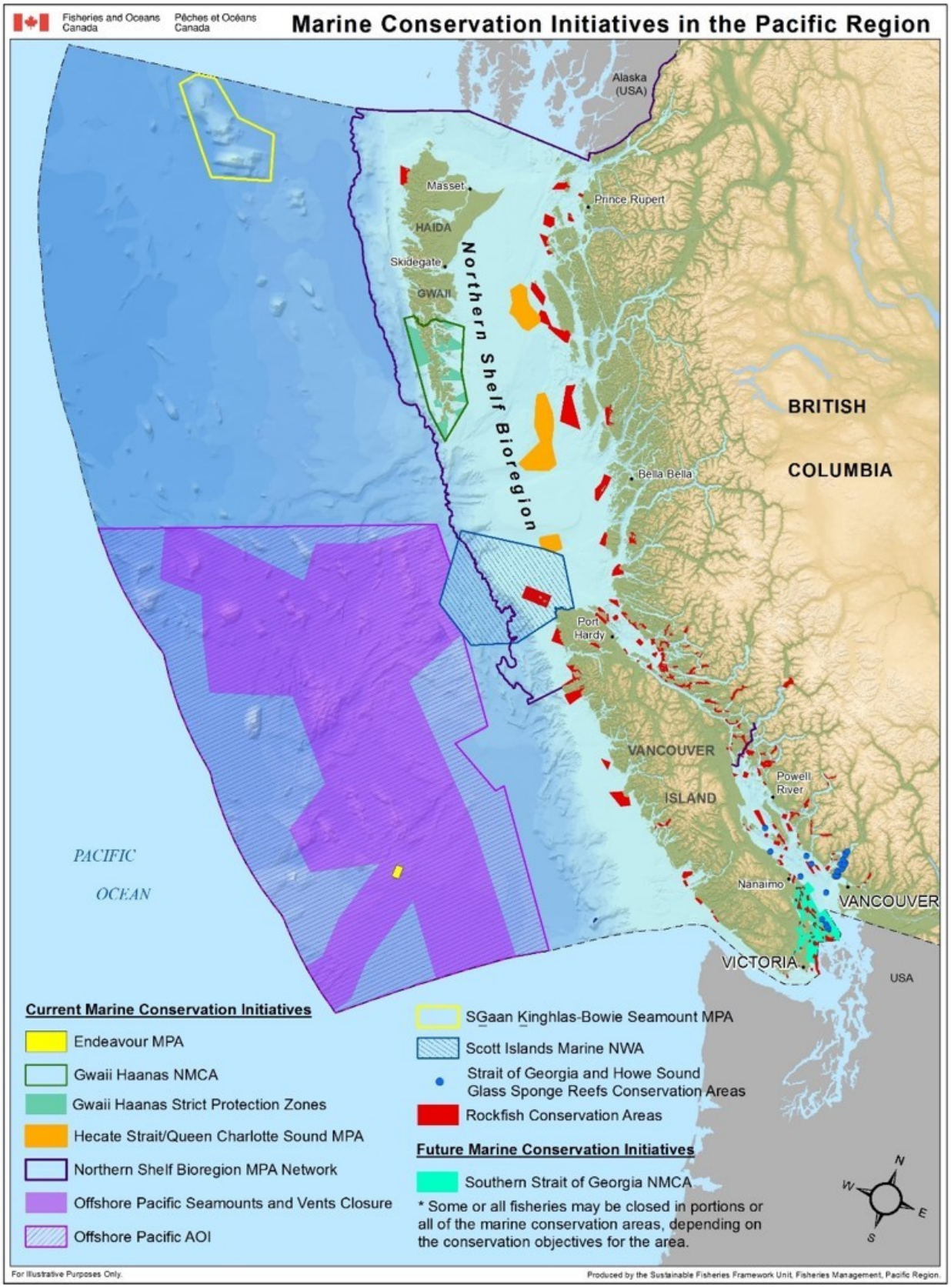


Figure 8. Map of Marine Conservation Target initiatives in British Columbia.

Review of Agency Groundfish Research, Assessment and Management

A. Hagfish

1. Research

No new research in 2018.

2. Assessment

Nothing to report.

3. Management

There is currently no fishery for Hagfish in BC.

B. Dogfish and other sharks

1. Research

Ongoing data collection continued in 2018 through the Groundfish Synoptic Surveys, at-sea observer sampling, and recreational creel surveys. Anecdotal information continued to be collected through the Shark Sightings Network.

2. Assessment

Dogfish were last assessed in 2010, as two distinct stocks, an inshore stock residing within the waters of the Strait of Georgia and an offshore stock occupying all outer coast waters of British Columbia, no new assessment has been requested nor is one planned.

The committee of the status of Endangered Wildlife in Canada (COSEWIC) contracted an author to prepare an updated status report Tope (Soupfin) shark. A draft of that report was reviewed by DFO Science, the final report will be reviewed by the COSEWIC Marine fish Committee during 2019. Tope were designated as Special Concern by COSEWIC in April of 2007 and subsequently listed under the Species At Risk Act (SARA) in March of 2009 as Special Concern, this is their first re-assessment by COSEWIC.

3. Management

Dogfish are managed as part of the integrated mixed species multi-gear groundfish fishery under the Integrated Fisheries Management Plan (IFMP). The current TAC for Dogfish-Outside (all waters except the Strait of Georgia) is 12000 t, for Dogfish – Inside the TAC is 2000 t, the TACs are split between the Trawl (32%) and directed Dogfish (68%) fishery fleets. There is currently no targeted fishing for Dogfish as markets have essentially collapsed with the directed dogfish fleet harvesting 0% of its TAC in 2018 and the trawl fleet intercepting only 2.7% of its TAC. All fishery induced mortality at this time is as bycatch in directed fisheries for other species with little to none of the catch being retained or landed.

For other shark species not managed using a TAC under the IFMP there is a Shark Code of Conduct intended to increase the likelihood of sharks surviving release at sea. Of the fourteen shark species in Canadian Pacific waters, three are listed under the Species At Risk Act (SARA). The Basking Shark (*Cetorhinus maximus*) is listed as Endangered, and the Bluntnose Sixgill Shark (*Hexanchus griseus*) and Tope Shark (*Galeorhinus galeus*) are species of Special Concern. The primary threats to shark species have been identified as bycatch and entanglement. As such, commercial fishing licences have been amended to

include a Condition of License for Basking Sharks that specifies mitigation measures in accordance with SARA permit requirements.

Additionally, two 'Code of Conduct for Shark Encounters' documents have been developed to reduce the mortality of Basking Shark, as well as other Canadian Pacific shark species such as Bluntnose Sixgill and Tope Shark resulting from entanglement and bycatch in commercial, aquaculture, and recreational fisheries.

These documents have been posted online and can be found at the following URL links.

Code of Conduct for Basking Sharks:

http://www.pac.dfo-mpo.gc.ca/fm-gp/species-especes/shark-requin/conduct_basking_conduite_pelerin-eng.html

Code of Conduct for Sharks:

http://dfo-mpo.gc.ca/species-especes/publications/sharks/coc/coc-sharks/index-eng.html

C. Skates

1. Research

Ongoing data collection continued in 2017 through surveys, port sampling, at-sea observer sampling, and recreational creel surveys.

2. Assessment.

Skates were last assessed in 2015. No new assessment is currently planned.

3. Management

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

Big and Longnose skates are managed as part of the integrated mixed species multi-gear groundfish fishery under the Integrated Fisheries Management Plan (IFMP). Big and Longnose skates are IVQ (individual vessel quota) species with 2018/19 TACs (total allowable catch) of 1,032 t and 458 t respectively coastwide. Commercial TACs for various groundfish species are allocated between Management Areas and the different groundfish sectors, the allocation for Big and Longnose skate exemplify the complexity of such a system.

Species		**Commercial Sector**						
		T (Trawl)	L (Halibut)	LC (LingCod)	ZN Inside (Rockfish)	ZN Outside (Rockfish)	K (Sablefish)	DF (Dogfish)
Longnose Skate	3CD	62.83%	14.19%	0.00%	0.00%	1.50%	11.26%	10.22%
	5AB	32.83%	48.49%	0.01%	0.00%	8.61%	9.47%	0.57%
	5CDE	20.28%	59.80%	0.00%	0.00%	8.53%	10.55%	0.84%

Big Skate	3CD	24.55%	26.72%	0.00%	0.00%	1.93%	4.16%	42.63%
	5AB	91.48%	5.97%	0.01%	0.00%	1.20%	0.72%	0.62%
	5CDE	92.07%	6.34%	0.00%	0.00%	0.56%	0.95%	0.08%

To support groundfish research and account for unavoidable mortality incurred during the 2018 Groundfish Trawl multi-species surveys, 0.2 and 1.0 t respectively were accounted for before defining the Groundfish Trawl TACs.

D. Pacific cod

1. Research

Ongoing data collection continued in 2017 through the surveys, port sampling, at-sea observer sampling, and recreational creel surveys. Collection of DNA was initiated during 2015 in the spawning areas of Hecate Strait (PSMFC Area 5D) and continued in 2016 and 2017.

2. Assessment

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

Pacific Cod is BC are difficult to age, making statistical catch-age models inappropriate for this species. Therefore, stocks in Areas 5ABCD and 3CD were assessed using Bayesian delay-difference models. The models were fit to fishery-independent indices of abundance, mean annual weight in the commercial catch, and new standardized commercial catch-per-unit-effort (CPUE) indices that were developed using Tweedie generalized linear mixed effect models (GLMMs). Updated estimates of growth parameters were also incorporated into the models.

Due to uncertainty in model parameters, biological reference points based on equilibrium assumptions (e.g., maximum sustainable yield (MSY)) were not used. Instead, following the approach in previous stock assessments for Area 5CD, reference points were based on estimated historical biomass. For both stocks, the recommended upper stock reference (USR) is the average estimated biomass between 1956 and 2004; and the recommended limit reference point (LRP) is an agreed-upon undesirable low biomass state to be avoided (B2000 in Area 5ABCD; B1986 in Area 3CD). The recommended limit removal rate (LRR) is the average estimated fishing mortality between 1956 and 2004.

For each of the two assessed stock areas, advice is provided as a decision table that summarizes the probability of breaching reference points over a range of fixed catch levels for a one-year projection using a model-averaging approach. The model- averaged decision tables were constructed using unweighted posterior samples from a reference case model and six sensitivity cases for each stock, to encompass the range of parameter uncertainty in the assessments.

For Area 5ABCD, model-averaged biomass at the beginning of 2019 (B2019) was projected to be 0.60 (0.39-1.01) of unfished biomass (B0). For Area 3CD, model-averaged B2019 was projected to be 1.13 (0.78-1.73) of B0. Proportions denote median (and 2.5 - 97.5 percentiles).

3. Management

Pacific Cod is managed as part of the integrated mixed species multi-gear groundfish fishery under the Integrated Fisheries Management Plan (IFMP). Pacific Cod is an IVQ (individual vessel quota) species with a 2018/19 TAC (total allowable catch) of 1,450 t coastwide (500 t in Area 3CD, 250 t in 5AB, and 700 t in 5CDE). Commercial total allowable catch for various groundfish species are usually allocated between the different groundfish sectors; however, Pacific Cod was entirely (100%) allocated to the Trawl sector.

To support groundfish research and account for unavoidable mortality incurred during the 2018 Groundfish Trawl multi-species surveys, 2.7 t were accounted for before defining the Groundfish Trawl TACs.

E. Walleye pollock

1. Research

There is no directed work being conducted on Walleye Pollock but ongoing data collection continued in 2018 through the Groundfish Synoptic Surveys, port sampling, at-sea observer sampling, and recreational creel surveys.

2. Assessment

The BC Walleye Pollock assessment of 2017 was sent for publication in 2018. Two stock were identified: BC North (PMFC 5CDE) and BC South (PMFCs 5AB+3CD + minor areas 12 & 20) based on significant differences in mean weight (fish were generally twice the size in the north as they were in the south). A delay-difference production model was used to assess each stock in a Bayesian framework, using data from fishery-independent surveys, a CPUE series derived from commercial bottom trawl catch rates, and an annual mean weight series derived from unsorted commercial catch samples. Composite reference (model averaged) scenarios (Figure E .1) were used to represent each stock based on natural mortality and knife-edge combinations which generated reasonable estimates of fishing mortality ($F<2$).

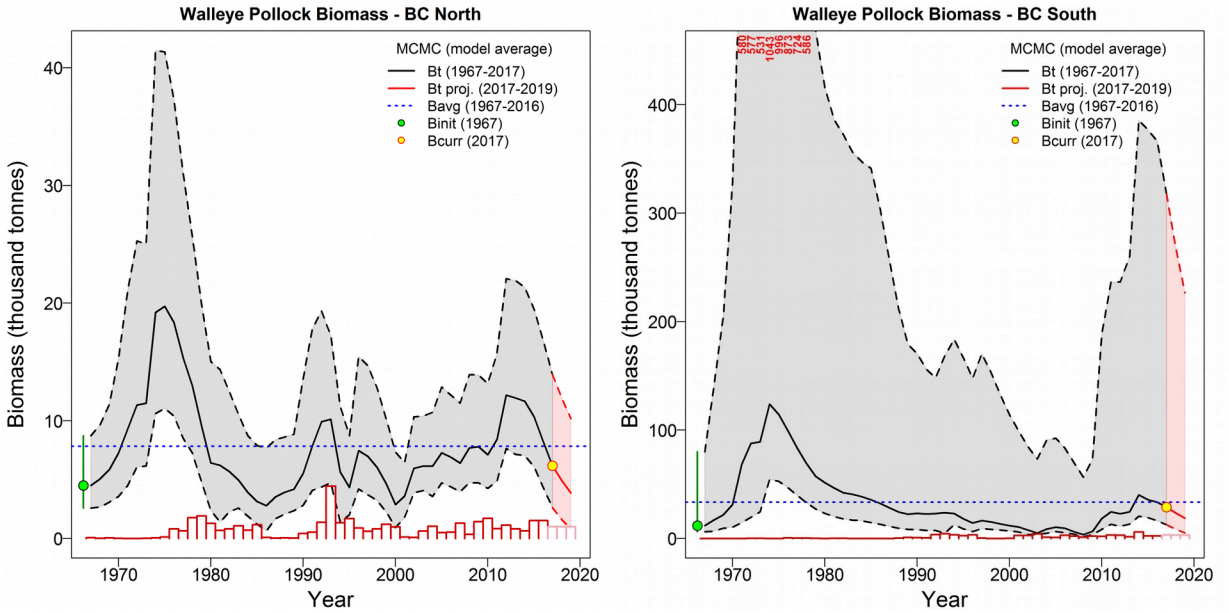


Figure E.1. Median estimates (solid black line) and 90% credibility intervals (black dashed lines, grey fill) for the model-average B_t (biomass in year t in tonnes) for Walleye Pollock. Also shown are the initial biomass B_{1967} (green circle), current biomass B_{2017} (yellow circle), two-year projections $B_{2018\text{-}19}$ (pink fill), the median of average biomass B_{avg} (blue dotted line), the historical catch (red bars) and the catch strategy (pink bars, 1000 t).

3. Management

Walleye Pollock is an IVQ (individual vessel quota) species with a 2018 TAC (total allowable catch) of 4,225 t coastwide, which is unchanged from 2017 (1,115 t in the Strait of Georgia, 1,790 t in 5AB + area 12, and 1,320 t in 5CDE). Area 3CD + area 20 did not receive an official TAC. Commercial total allowable catch for various groundfish species are usually allocated between the different groundfish sectors; however, Pollock was entirely (100%) allocated to the Trawl sector.

To support groundfish research and account for unavoidable mortality incurred during the 2018 Groundfish Trawl multi-species surveys planned, 1.2 t were accounted for before defining the Groundfish Trawl TACs.

Advice to managers (as decision tables) from the stock assessment used historical reference points: Bavg, the average spawning biomass from 1967-2016, was used as a proxy for BMSY, and Bmin, the minimum spawning biomass from which it subsequently recovered to Bavg, was used in place of 0.4BMSY. Twice Bmin was used in place of 0.8BMSY. Three models were used for the model average in BC North and six models contributed to the model average for BC South (Figure E .2).

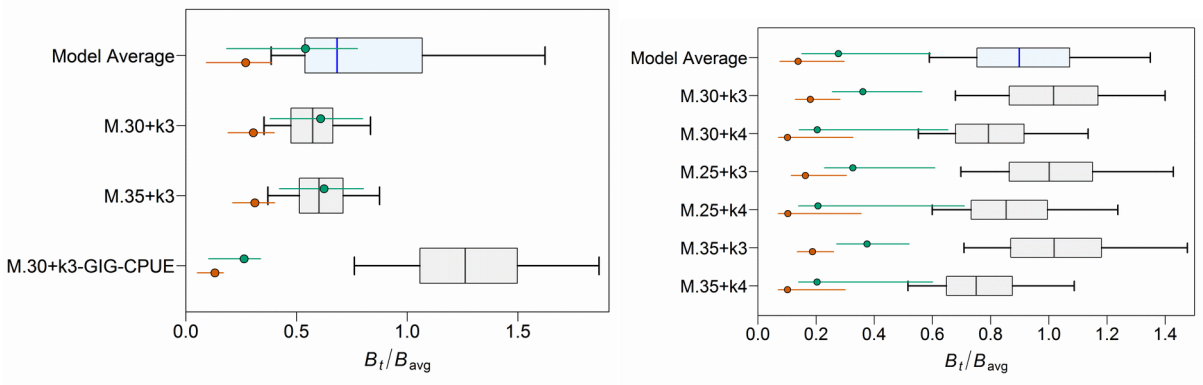


Figure E.2. Status (left: BC North, right: BC South) of the current stock B_{2017} relative to B_{avg} with the circles showing median biomass reference points (B_{min}/B_{avg} [red], $2B_{min}/B_{avg}$ [green]), where B_{avg} is a proxy for B_{MSY}, B_{min} is the limit reference point (LRP), and $2B_{min}$ is the upper stock reference point (USR). The 90% credibility range is shown for the LRP and USR. Stock status is shown for the Model Average Composite scenario comprising pooled model runs. Box plots show the 5, 25, 50, 75 and 95 percentiles from the MCMC posteriors. M = instantaneous natural mortality(y^{-1}); k = age (y) at knife-edge recruitment

Vessels on dedicated offshore Pacific Hake trips without an at-sea observer on board were permitted a by-catch allowance of Walleye Pollock restricted to thirty (30) percent of the offshore Hake trip landings. Any catch (other than Hake) in excess of the set allowance was relinquished. All by-catch was deducted from the vessel's IVQ holdings. Fishers who retained more than the by-catch allowance while on dedicated Hake trips were obliged to carry at-sea observers for those trips.

F. Pacific whiting (hake)

1. Research

In British Columbia there are two commercially harvested and managed stocks of Pacific Hake. The offshore stock is the principle 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 larger enough for processing.

Triennial (until 2001), then biennial acoustic surveys, covering the known extent of the Pacific Hake stock have been run since 1995. An acoustic survey, ranging from California to northern British Columbia is currently run in odd years, to continue the biennial time series. The last survey used in the assessment model took place in 2017.

An exploration of the use of sail drones was done during the summer of 2018, with multiple sail drones running along the same transect lines as the U.S. and Canadian ships. Initial results show promise in acquisition of clean acoustic data by sail drones, but they are limited to two frequencies whereas the ships have five. There is also currently a limitation of non-real-time data access because the drones need to come within range of a cell phone tower to download their data. Use of the sail drones in future surveys to gather acoustic data for use in Pacific hake backscatter calculations would still require the use of one or more catcher vessels, for opportunistic sampling of notable aggregations.

2. Assessment

As in previous years, and as required by The Agreement, The 2018 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 (SS3.30). The 2019 model had the same model structure used in 2018, with updates to catch and age compositions. Standard sensitivities requested by the Scientific Review Group were done and showed little difference from the reference model.

The largest cohort caught in the Canadian fishery was age-8's, followed by age 4's which represent the large cohorts for 2010 and 2014 respectively. There was a larger proportion than usual of Age 2's caught this year which could mean a larger than average recruitment of 2016 fish.

There has not been an assessment of Pacific Hake in the Strait of Georgia, although the recent increases in catch may warrant one.

3. Management

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 total Canadian TAC for 2018 was the same as it was in 2017 at 156,067 t. The shoreside/freezer trawler sectors caught 54,447 t and 38,241 t respectively which was 61.1% of the total Canadian TAC. The Joint Venture (JV) fishery received a quota of 15,000 t in 2018, and caught 2,724 t. The majority of the Canadian Pacific Hake catch for the 2018 season was taken from the west coast of Vancouver Island.

The final decision on catch advice for the 2019 fishing season was made at the Joint Management Committee (JMC) meeting in Vancouver, B.C. on Mar. 4 – Mar. 5, 2019. For the third year in a row, a coastwide TAC of 597,500 t was agreed upon for 2019. As laid out in the treaty, Canada will receive 26.12% of this, or 156,067 t. Managers will choose how to allocate this between the domestic and joint venture fisheries as the season progresses.

The final assessment document and other treaty-related documents are posted at:

http://www.westcoast.fisheries.noaa.gov/fisheries/management/whiting/pacific_whiting_treaty.html

Publications:

Berger, A.M., A.M. Edwards, C.J. Grandin, and K.F. Johnson. 2019. Status of the Pacific Hake (whiting) stock in U.S. and Canadian waters in 2019. 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. 249 p.

G. Grenadiers

1. Research

There is no directed work being conducted on Grenadiers but ongoing data collection continued in 2018 through surveys and at-sea observer sampling.

2. Assessment

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

3. Management

There are no management objectives or tactics established for these species. These species are caught primarily as bycatch in the deep water rockfish (Rougheye/Shortraker/Thornyhead) and Dover Sole fisheries, 100% of the catch is discarded, Only about 10 t each of Pacific and Giant Grenadier are caught and discarded annually.

H. Rockfish

1. Research

The department (DFO) assesses populations of rockfish (Sebastes) species both inshore (shallow regions near shore that are accessible by many fisher groups) and offshore (BC's continental shelf and slope often only accessible by the commercial industry). DFO also tackles a variety of other issues: COSEWIC (Committee on the Status of Endangered Wildlife in Canada) listing requirements, oceanographic exploration, software development for the R statistical platform (https://github.com/pbs-software), and scientific research in marine ecological modelling. In stock assessment, DFO collaborates with outside contractors from agencies like the Canadian Groundfish Research and Conservation Society and The School of Resource and Environmental Management (REM) at Simon Fraser University (SFU).

The Groundfish Surveys program at the Pacific Biological Station (PBS, Nanaimo BC) conducts a suite of synoptic surveys that covers most of BC's ocean bottom ecosystems. The survey team gathers information on abundance and biology (lengths, weights, maturity, otoliths, etc.).

a) Inshore Rockfish

The Inside Hard Bottom Longline (HBLL) Survey took place August 7-31, 2018 and surveyed the southern region from Campbell River to Victoria. The timing of the survey was changed and shortened by Coast Guard due to crewing issues, so blocks in Desolation Sound were not fished and will be added to the 2019 survey of the northern region. Quillback and Yelloweye Rockfishes survey trends are still declining in the Strait of Georgia (Figure 8); however, a full analysis will have to take into account the missed blocks in the NE section of the survey frame.

The Offshore Hard Bottom Longline Survey (HBLL) conducted collaboratively with industry (the Pacific Halibut Management Association) was completed in August 1-September 15 2018, in the southern region. See the survey section (II) and Appendix 1 for further details. Yelloweye Rockfish catches were reported by skippers to be good in many areas.

DFO collaborated with WDFW and NOAA on an ROV survey for inshore rockfish in the Strait of Georgia on board the CCGS Vector, October 22-Nov 6, 2018. ROV transects were completed using the WDFW's Falcon ROV the Yelloweye, inside and outside of RCA. Most transects locations were randomly selected to be within modeled high probability rockfish habitat. Visual survey data are currently being annotated by WDFW and DFO (Figure 3).

Dana Haggarty is collaborating with Dr. Sarah Dudas and Dr. Stephanie Archer on a project funded by DFO's SPERA (Strategic Program for Ecosystem Based Research and Advice) fund to develop the novel method of passive acoustic monitoring (PAM) for fish using Pacific Herring as a model species because their sound production is described and their biomass is regularly estimated in relatively well-defined spatial areas during their spawning season. To pilot this approach they have deployed acoustic recorders at herring spawning sites in the Strait of Georgia and will combine acoustic data with visual survey data to build a correlation between spawning biomass and herring calls. They are also developing PAM methods for three rockfish species: Copper, Yelloweye, and Quillback Rockfishes by describing the relationship between abundance and call frequency using paired visual and audio surveys. They are testing the PAM methods by assessing temporal patterns in habitat use by deploying hydrophones in and adjacent to the Northumberland Channel RCA for one year. This project will also evaluate the impact of ship noise on the sensitivity of PAM.

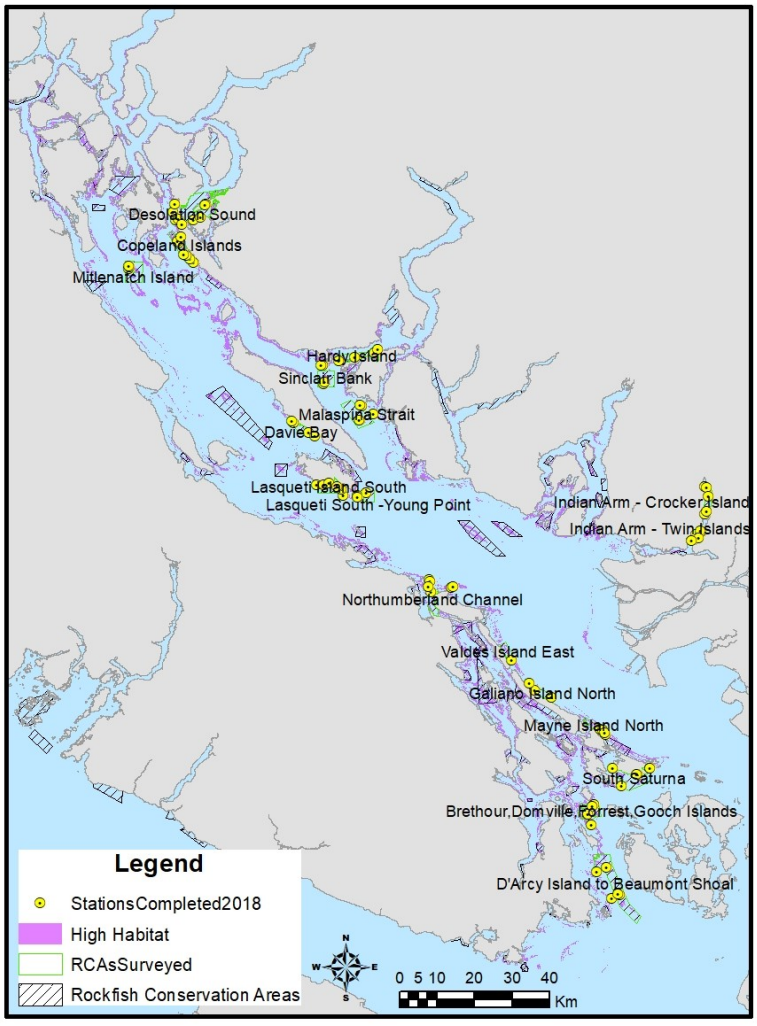


Figure 3. Map of ROV survey locations in the Strait of Georgia, October 22-November 6, 2018.

b) Slope Rockfish

At the request of the PBS Ageing lab, advanced requests for ageing were submitted for Yellowmouth Rockfish (commercial: coastwide 2010-17; surveys: QCS synoptic 2009-17, WCHG synoptic 2012-16, WCVI synoptic 2012-14) and Pacific Ocean Perch (commercial : 3CD 2010-17, 5ABC 2015-17, 5DE 2011-17; surveys: HS synoptic 2005-17, QCS synoptic 2017, WCHG synoptic 2012-16; WCVI synoptic 2012-16).

Genetic work on separating the Rougheye/ Blackspotted Rockfish complex was initiated in 2010 and is planned to continue in 2018. Tissues samples are processed annually; aging of specimen sampled for DNA was initiated in 2017 in anticipation of completing an assessment by 2020.

2. Assessment

a) Inshore Rockfish

The most recent stock assessment for Inside (Yamanaka et al. 2011) and Outside Yelloweye Rockfish (Yamanaka et al. 2018) placed the stocks in the critical zone and therefore both stocks require rebuilding plans. Although the need for rebuilding plans are currently required by DFO policy, this requirement is about to be formalized in amendments to *Canada's Fisheries Act* put forward in *Bill C-68*. Both populations have rebuilding plans that are not compliant with DFO policy that requires monitoring, re-assessment and rebuilding projections over 1.5-2 generations (~60-90 years for Yelloweye Rockfish). DFO is collaborating with industry (the Pacific Halibut Management Association) to study Outside Yelloweye Rockfish Rebuilding with the development of operating models to describe the current state of the stock and closed loop simulations to examine the performance of harvest control rules to achieve rebuilding targets. Dr. Ashleen Benson, Dr. Sean Cox, and Beau Doherty from Landmark Fisheries Consulting are doing the modeling work. A steering committee and technical team are developing the rebuilding objectives and contributing to the work. This project will be reviewed by CSAS in October, 2019. A similar process is taking place for the inside population; however, the inside Yelloweye Rockfish population is more data limited and industry partners are absent. National-level funding to support work on rebuilding plans was secured to allow us to work with Dr. Tom Carruthers and Dr. Quang Huynh from UBC to use the Data Limited Methods Tools (DLMTools, https://www.datalimitedtoolkit.org/) in a similar simulation testing of management procedures to examine rebuilding.

Literature Cited:

Yamanaka, K.L., McAllister, M.M., Etienne, M., Edwards, A.M., and Haigh, R. 2018. Stock Assessment for the Outside Population of Yelloweye Rockfish (Sebastes ruberrimus) for British Columbia, Canada in 2014. DFO Can. Sci. Advis. Sec. Res. Doc. 2018/001. ix + 150 p.

Yamanaka, K. L., McAllister, M.M., Olesiuk, P.F. Etienne, M., Obradovich, S.G. and Haigh, R.. (2011). Stock Assessment for the inside population of yelloweye rockfish (Sebastes ruberrimus) in British Columbia, Canada for 2010. DFO Can. Sci. Advis. Sec. Res. Doc.**:** xiv + 131 p.

b) Slope Rockfish

a) Pacific Ocean Perch

Pacific Ocean Perch in PMFC area 5ABC was assessed in 2017 using a catch-at-age model tuned to two fishery-independent trawl survey series, annual estimates of commercial catch since 1940, and age composition data from the two survey series (11 years of data) and the commercial fishery (34 years of data). The model starts from an assumed equilibrium state in 1940, and the survey data cover the period 1967 to 2016 The two-sex model was implemented in a Bayesian framework (using the Markov Chain Monte Carlo search procedure) under a scenario that estimates both sex-specific natural mortality (M) and steepness of the stock-recruit function (h). The base model run suggests that strong recruitment in the early 1950s sustained the foreign fishery, and that a few strong year classes spawned in the late 1970s and 1980s sustained the domestic fishery into the 1990s. The spawning biomass (mature females only) at the beginning of 2017, B_{2017}, is estimated to be 0.27 (0.18, 0.42) of unfished biomass (median and 5th and 95th quantiles of the Bayesian posterior distribution). B_{2017} is estimated to be 1.03 (0.54, 1.96) of the spawning biomass at maximum sustainable yield, B_{MSY}.

b) Redstripe Rockfish

Two stocks of Redstripe Rockfish (BCN and BCS) were assessed in 2018 using a catch-at-age model tuned to fishery-independent trawl survey series (two in BCN, four in BCS), bottom trawl CPUE series, annual estimates of commercial catch since 1940, and age composition data from survey series (BCN: 5 years of data from 2 surveys; BCS: 14 years from 3 surveys) and the commercial fishery (BCN: 12 years of data; BCS: 24 years). The model starts from an assumed equilibrium state in 1940, and the survey data cover the period 1967 to 2018. The two-sex models were implemented in a Bayesian framework (using the Markov Chain Monte Carlo procedure) under a scenario that estimates both natural mortality (M) and steepness of the stock-recruit function (h). The base model runs for BCN and BCS suggest that low exploitation in the early years, including that by foreign fleets, coupled with several strong recruitment events (in 1982 and 1996 for BCN and in 1974 and 2001 for BCS) have sustained the population to the present. The spawning biomass (mature females only) at the beginning of 2018 for BCN and BCS is estimated to be 0.91 (0.69, 1.13) and 0.62 (0.47, 0.81) of unfished biomass (median and 5th and 95th quantiles of the Bayesian posterior distribution), respectively. For BCN and BCS, this biomass is estimated to be 3.16 (2.02, 4.00) and 2.43 (1.51, 3.77) of the spawning biomass at maximum sustainable yield, B_{MSY}, respectively.

c) Rougheye/Blackspotted Rockfish

An assessment on the Rougheye/Blackspotted (REBS) complex was initiated by a Ph.D. student in REM at SFU in collaboration with DFO. There are genetic data to delineate stocks; however, this initial assessment will treat REBS in PMFC area 5DE as Blackspotted Rockfish and REBS in PMFC areas 3CD+5AB as Rougheye Rockfish.

3. Management

a) Inshore Rockfish

Management, in consultation with the commercial industry, stepped down Outside Yelloweye Rockfish Total Allowable Catch (TAC) from 290 t to 100 t by the 2018/19 fishing year. An industry proposal for a more spatially explicit quota apportionment was adopted by management, which shifts the current apportionment slightly to better match higher TACs with

areas of higher survey CPUE. There is also recreational non-retention of Yelloweye Rockfish now exists coast-wide in BC. The mandatory use of descending devices by recreational fishers came into effect on April 1, 2019 with the following condition of license:

> "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. No person shall catch and retain in a day in Management Areas 1 to 11, 21 to 27, 101 to 111, 121 to 127, 130, 142 and Subareas 20-1 to 20-4 and 12-14 more than three (3) rockfish, of which only one (1) may be a Quillback Rockfish, a China Rockfish, or a Tiger Rockfish. Note: Not one of each species, but only one of the three. No person shall catch and retain in any tidal waters the following species of rockfish: Bocaccio Rockfish (zero retention); Yelloweye Rockfish (zero retention)."

Yelloweye Rockfish was listed as Special Concern under the SARA in 2011 and DFO is currently developing a SARA management plan. Yelloweye Rockfish is up for reassessment by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in November 2019. A pre-COSEWIC document for inside and outside Yelloweye Rockfish was completed in 2017 (Keppel and Olsen, 2017). This document collates all available biological and abundance information relating to Yelloweye Rockfish that DFO possesses. It was reviewed under CSAS November 8th, 2017, finalized and then presented to the COSEWIC author who will complete the Yelloweye Rockfish assessment report. Yelloweye Rockfish will likely be re-assessed by COSEWIC in the spring of 2019.

Keppel, E. and N. Olsen. 2017. Pre-COSEWIC review of Yelloweye Rockfish (*Sebastes ruberrimus*) along the Pacific coast of Canada: biology, distribution and abundance trends. CSAP Working Paper 2016SAR11.

Subsequent to public consultations in 2012, the Minister of Environment has not made a decision on whether to list Quillback Rockfish as *Threatened* under Canada's *Species At Risk Act* (SARA). Quillback Rockfish remain unlisted in 2019. Quillback Rockfish is up for reassessment by the COSEWIC by November 2019 but have been pushed off the schedule until at least 2020

f) Slope Rockfish

d) Pacific Ocean Perch

Pacific Ocean Perch is an IVQ (individual vessel quota) species with a 2018 trawl TAC (total allowable catch) of 5,192 t coastwide (750 t in 3CD, 1,687 t in 5AB, 1,544 t in 5C, and 1,200 t in 5DE). Commercial total allowable catch for various groundfish species were allocated between the different groundfish sectors; Pacific Ocean Perch was allocated 99.98% to the Trawl sector and 0.02% (1 t coastwide) to the ZN hook and line sector. To support groundfish research and account for unavoidable mortality incurred during the 2018 Groundfish Trawl multi-species surveys, 73.8 t, was accounted for before defining the Groundfish Trawl TACs.

Advice to managers (presented as decision tables in the assessment) provide probabilities of exceeding limit and upper stock reference points over a five-year projection period across a range of constant catches. The current stock status is typically presented as horizontal barplots,

in this case for the Base Case and seven sensitivity runs (Figure H .1). The DFO provisional 'Precautionary Approach compliant' reference points were used, which specify a 'limit reference point' of 0.4BMSY and an 'upper stock reference point' of 0.8BMSY. The estimated spawning biomass at the beginning of 2017 has a 0.99 probability of being above the limit reference point, and a 0.74 probability of being above the upper stock reference point. Five-year projections using a constant catch of 2500 t/y (near the recent average five-year catch of 2400 t/y) indicate that, in 2022, the spawning biomass has probabilities of 0.97 of remaining above the limit reference point, and 0.71 of remaining above the upper stock reference point.

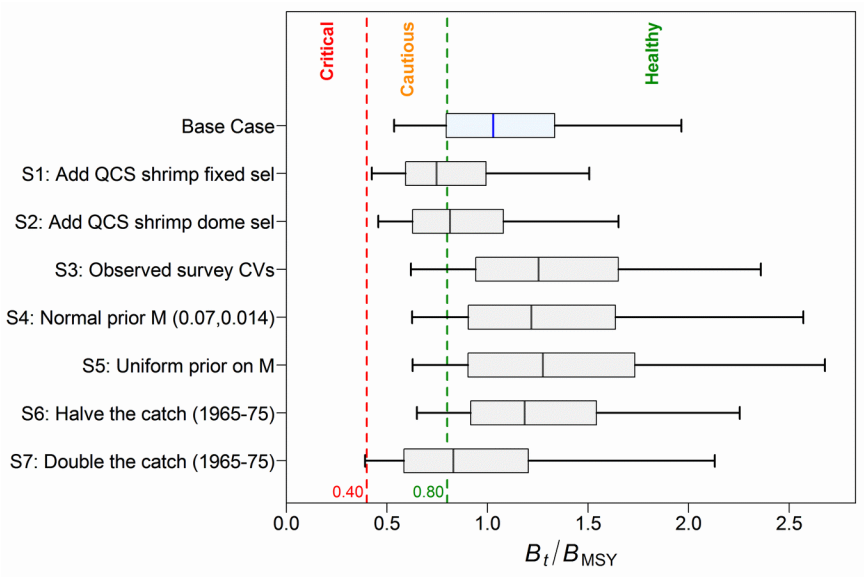


Figure H.1. Status at beginning of 2017 of the 5ABC Pacific Ocean Perch stock relative to the DFO PA provisional reference points of $0.4B_{MSY}$ and $0.8B_{MSY}$ for the base-case stock assessment and seven sensitivity runs: S1=add the QCS shrimp survey using a fixed selectivity curve; S2=add the QCS shrimp survey using a fitted dome-shaped selectivity curve; S3=use the observed survey CVs without adding process error; S4=use a normal prior on M with a mean of 0.07 and a standard deviation of 0.014 (CV=20%); S5=use a uniform prior on M; S6=halve the catch in the years 1965-75 (during peak foreign fleet activity); S7=double the catch in the yeas 1965-75. Boxplots show the 5, 25, 50, 75 and 95 quantiles from the MCMC posterior.

e) Redstripe Rockfish

Redstripe Rockfish is an IVQ (individual vessel quota) species with a 2018 trawl TAC (total allowable catch) of 1521 t coastwide (173 t in 3C, 772 t in 3D5AB, 330 t in 5CD, and 246 t in 5E). Commercial total allowable catch for various groundfish species were allocated between the different groundfish sectors; Pacific Ocean Perch was allocated 97.23% to the Trawl sector and 2.77% (43 t coastwide) to the ZN hook and line sector. To support groundfish research and account for unavoidable mortality incurred during the 2017 Groundfish Trawl multi-species surveys, 15 t, was accounted for before defining the Groundfish Trawl TACs.

Advice to managers (presented as decision tables in the assessment) provide probabilities of exceeding limit and upper stock reference points for five-year projections across a range of constant catches. The current stock status is typically presented as horizontal barplots, in this case for the Base Case and four sensitivity runs (Figure H .2). The DFO provisional 'Precautionary Approach compliant' reference points were used, which specify a 'limit reference point' (LRP) of 0.4BMSY and an 'upper stock reference point' (USR) of 0.8BMSY. The estimated spawning biomass at the beginning of 2018 has a probability of 1 of being above the LRP, and a probability of 1 of being above the USR for both

stocks. Five-year projections using a constant catch of 100 t/y in BCN and 700 t/y in BCS indicate that, in 2023, the spawning biomass has probabilities of 1 (BCN) and 1 (BCS) of remaining above the LRP, and 1 (BCN) and 1 (BCS) of remaining above the USR. The uMSY reference point, however, suggests that catches in excess of 500 t in BCN and 1300 t in BCS will breach the Sustainable Fisheries Framework guidelines on fishing mortality, assuming that the manager wishes to be 95% certain that the harvest rate in 2023 will be less than uMSY.

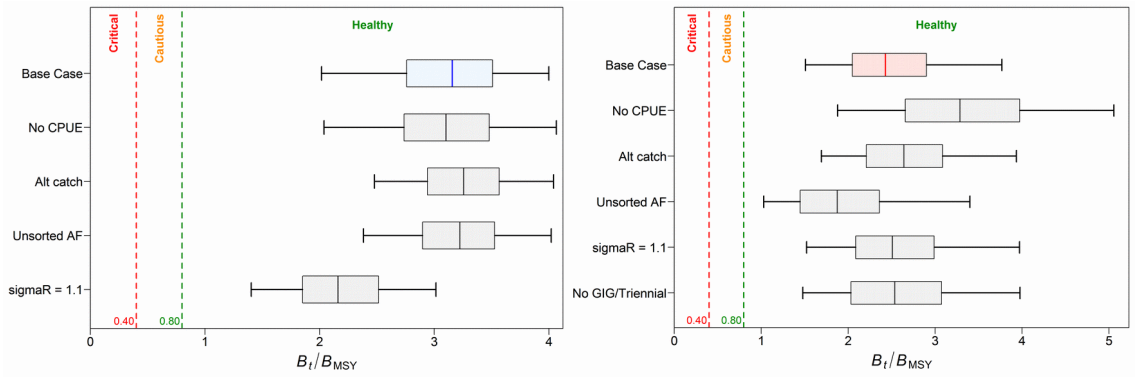


Figure H.2. Stock status at beginning of 2018 of the RSR stocks (left:BCN, right: BCS) relative to the DFO PA provisional reference points of 0.4B_{MSY} and 0.8B_{MSY} for the base case stock assessment and four sensitivity runs (S1=drop commercial trawl CPUE; S2=halve the 1965-75 and 1988-1995 catches; S3=use age frequencies from unsorted samples only; S4=increase standard deviation of σ_R from 0.6 to 1.1; S5=remove GIG Historical and WCVI Triennial surveys). Boxplots show the 0.05, 0.25, 0.5, 0.75 and 0.95 quantiles from the MCMC posterior.

I. Thornyheads

1. Research

No research occurred in 2018.

2. Assessment

No Thornyhead assessments were conducted in 2018. Longspine Thornyhead was designated “Special Concern” by COSEWIC in 2007. It is anticipated that an assessment may be requested in the near future.

3. Management

Longspine and Shortspine Thornyhead are both IVQ species with a 2018 coastwide TAC (total allowable catch) of 425 t and 769 t, respectively. Commercial TACs for these groundfish species were allocated between the different groundfish sectors; Longspine Thornyhead was allocated 95.35% to the Trawl sector, 2.29% to the ZN hook and line sector, and 2.36% to the Halibut sector; Shortspine Thornyhead was allocated 95.40% to the Trawl sector, 2.27% to the ZN hook and line sector, and 2.33% to the Halibut sector.

To support groundfish research and account for unavoidable mortality incurred during the 2018 multi-species surveys, 6.2 t of Shortspine thornyhead and 0.4 t of Longspine thornyhead was accounted for before defining the Groundfish Trawl TACs for Shortspine Thornyhead, and 0.9 t of Shortspine thornyhead was reserved for longline surveys.

J. Sablefish

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

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

1. Research

In addition to the annual Sablefish Research and Assessment Survey (see Appendix 1 for details) , research activities in 2018 included the initiation of an informal collaboration among Sablefish scientists from DFO, NOAA, ADFG and academia on range-wide Sablefish ecology and management. The overarching goal of the collaboration is to develop a range-wide, spatially explicit population dynamics model for Sablefish that can be used to explore questions of biological and management relevance across the eastern North Pacific. In 2018 primary research activities towards this goal included initiating a synthesis of life history characteristics across the Sablefish range, analyses to identify and develop range-wide indices of abundance and the evaluation of movement within and among regions (e.g., Alaska, British Columbia and the US West Coast).

2. Assessment

Sablefish stock status is regularly evaluated via the MSE process. An operating model (i.e., representation of alternative hypotheses about ‘true’ Sablefish population dynamics) is used to simulate data for prospective testing of management procedure performance relative to stock and fishery objectives. The current Sablefish operating model (OM) was revised in 2015/16 to account for potential structural model mis-specification and lack-of-fit to key observations recognized in previous models (DFO 2016). Specific modifications included: (i) changing from an age-/growth- group operating model to a two-sex/age-structured model to account for differences in growth, mortality, and maturation of male and female Sablefish, (ii) adjusting model age- proportions via an ageing error matrix, (iii) testing time-varying selectivity models, and (iv) revising the multivariate-logistic age composition likelihood to reduce model sensitivity to small age proportions. These structural revisions to the operating model improved fits to age-composition and at-sea release data that were not well-fit by the previous operating model. Accounting for ageing errors improved the time-series estimates of age-1 Sablefish recruitment by reducing the unrealistic auto-correlation present in the previous model results. The resulting estimates clearly indicate strong year classes of Sablefish that are similar in timing and magnitude to estimates for the Gulf of Alaska. Two unanticipated results were that

(i) time-varying selectivity parameters were not estimable (or necessarily helpful) despite informative prior information from tagging and (ii) improved recruitment estimates helped to explain the scale and temporal pattern of at-sea release in the trawl fishery. The latter finding represents a major improvement in the ability to assess regulations (e.g., size limits) and incentives aimed at reducing at-sea releases in all fisheries.

The status of the Sablefish stock is judged on the scale of the OM which was last updated in 2016. Based on the 2016 assessment Sablefish lie in the Cautious Zone under the DFO FPA Framework. However, as a result of recent above average recruitment attributed to the 2014 year class, the biomass of Sablefish in BC, as well as Alaska (Hanselman et al. 2017), appears to be increasing. Based on the most recent estimates of Sablefish catch and survey CPUE from the 2018 research and assessment survey, the current point estimate of legal-size Sablefish biomass in BC is 37,415 t

In 2016/17 the updated operating model was used to generate simulated data to test the current and alternative management procedures (MPs). The joint posterior distribution of spawning biomass and stock-recruitment steepness was used to generate five scenarios that captured a range of hypotheses related to current spawning biomass and productivity. The effects of the new recruitment estimates and impacts of sub-legal mortality were much greater than estimated from the 2011 analyses (Cox et al. 2011), and estimated management parameters indicated a less productive stock. Estimates of fishing mortality on sub-legal fish were much higher than those based on the 2011 operating model (DFO 2016).

The evaluation of the existing, and alternative, MPs in 2016/2017 led to the identification of a new preferred MP that is consistent with Canada's Fisheries Decision Making Framework Incorporating the Precautionary Approach, and provides an acceptable balance of the trade-off between conservation and fishery objectives (DFO 2017). This MP is based on a surplus production model fit to time-series observations of total landed catch, and the fishery independent survey CPUE, to forecast Sablefish biomass for the coming year. The surplus production model outputs are then inputs to a harvest control rule to calculate the recommended catch of legal Sablefish in a given year. This MP includes a 5-year phased-in period to a new maximum target harvest rate of 5.5%.

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

Literature Cited:

Cox, S.P., Kronlund, A.R., Lacko, L. 2011. Management procedures for the multi-gear sablefish (*Anoplopoma fimbria*) fishery in British Columbia, Canada. DFO Can. Sci. Advis. Sec. Res. Doc. 2011/063. viii + 45 p.

DFO. 2014. Performance of a revised management procedure for Sablefish in British Columbia. DFO Can. Sci. Advis. Sec. Sci. Resp. 2014/025.

DFO. 2016. A revised operating model for Sablefish (*Anoplopoma fimbria*) in British Columbia, Canada. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2016/015.

DFO. 2017. Evaluating the robustness of management procedures for the sablefish (*Anoplopoma fimbria*) fishery in British Columbia, Canada for 2017-18. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2017/017.

Hanselman, D.H., Heifetz, J., Echave, K.B. and Dressel, S.C., 2014. Move it or lose it: movement and mortality of sablefish tagged in Alaska. Canadian journal of fisheries and aquatic sciences, 72(2), pp.238-251.

Jasonowicz, A.J., Goetz, F.W., Goetz, G.W. and Nichols, K.M., 2016. Love the one you're with: genomic evidence of panmixia in the sablefish (*Anoplopoma fimbria*). Canadian Journal of Fisheries and Aquatic Sciences, 74(3), pp.377-387.

3. Management

In 2013, fishing industry stakeholders proposed a TAC floor of 1,992 t, because lower quotas may increase economic risks. The Sablefish MP first applied in 2010 was therefore revised to implement this TAC floor and simulation analyses were conducted to determine whether the revised management procedure would continue to meet agreed conservation objectives. As a result of lower productivity estimates derived from the revised OM, and subsequent MP simulation testing in 2016/17, the TAC floor could no longer be supported in the harvest control rule because long-term stock growth objectives could not be met in simulations. The current MP was therefore revised so as to not include a TAC floor in addition to phasing in a reduction in the annual harvest ratefrom 9.5% to 5.5% over five years. The resulting proposed TAC for the 2019/20 fishing year is 2,955 t, a ~17% increase over the 2018/19 TAC. However, fishing industry stakeholders proposed a smaller increase in TAC to enhance rebuilding of the stock and so the final proposed TAC for 2019/20 is 2656 t. An update of the MSE simulation work is planned for 2019/20.

K. Lingcod

1. Research

Ongoing data collection continued in 2018 through surveys, port sampling, at-sea observer sampling, and recreational creel surveys. Additional biological samples (Length, Weight, sex, maturity and fins for ageing) were collected on the Inside HBLL S, the Outside HBLL S, and the expanded IPHC survey in 2018.

2. Assessment

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.

3. Management

L. Atka mackerel

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

M. Flatfish

1. Research

Ongoing data collection in support of the flatfish research program, inclusive of Arrowtooth Flounder, Petrale Sole, Dover Sole and Rock Sole continued in 2018 through surveys and at-sea observer sampling.

2. Assessment

Arrowtooth Flounder was last assessed in 2016, the final assessment was finalized and published through the Canadian Science Advice Secretariat (CSAS) in 2017. Recent reports from fishery participants of localized depletion are being investigated.

Dover sole was last assessed in 1999, age matrices have been updated, catch and survey data are available, and an updated assessment is planned for 2020.

Petrale sole was last assessed in 2007. In response to a request for updated harvest advice from fishery managers aging of otoliths was completed in 2018 and an updated assessment is planned for 2019/20. T

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

Rock sole was last assessed in 2016, no request for updated advice has been received but aging of otoliths will be undertaken in 2019 in anticipation of an updated assessment sometime in 2020/21.

In 2017 work was initiated by a graduate student (PhD candidate – Samuel Johnson) at Simon Fraser University under a MITACs accelerate grant on a project to simultaneously assess the five species of commercially harvested flatfish in British Columbia. DFO's primary role in this project is as a provider of data, and secondarily as a potential client. If successful the methods and results of this work will be peer reviewed through the Canadian Science Advisory Secretariat process and if accepted used as harvest advice actionable by DFO Groundfish fisheries managers.

3. Management

Arrowtooth Flounder, Sothern Rock Sole, English Sole, Dover sole and Petrale sole are all managed by annual coastwide or area specific TACs and harvested primarily by the IVQ multi-species bottom trawl fishery. Details of the current management plan are available at http://www.pac.dfo-mpo.gc.ca/fm-gp/ifmp-eng.html#Groundfish.

N. Pacific halibut & IPHC activities

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

O. Other groundfish species

IV. Ecosystem Studies

A. Development of a management procedure framework and data-synopsis report for the provision of harvest advice for B.C.'s groundfish

Many species of groundfish in B.C. are data deficient, such that the available data are inadequate to support complex stock assessment models. However, DFO's Sustainable Fisheries Framework (http://www.dfo-mpo.gc.ca/fm-gp/peches- fisheries/fish-ren-peche/sff-cpd/overview-cadre-eng.htm) requires the provision of science advice on the status of, or risks to, species of groundfish affected by fishing activities.

As summarized in the 2018 TSC report work was initiated on this project in 2015, in 2015 – 2016, a literature search and annotated bibliography was completed, looking at work on tiered approaches in other international jurisdictions. In May 2016, CSAP hosted a workshop focusing on the creation of a Tiered Approach framework for assessing groundfish stocks. The meeting included discussions on a proposed hierarchical system based on data (using a scorecard to assess data availability, quality, and reliability), candidate references points, and candidate performance metrics. Significant time was spent on the issue of data-limited species. Ultimately, the meeting participants identified a preference for applying a modified approach for BC groundfish fisheries. Instead of a traditional tiered approach, the workshop proceedings suggest considering data-richness on a continuous scale and focusing on simulation testing multiple management procedures on a stock-by-stock basis to choose an approach that best meets fisheries risk objectives.

The goal of the project is to develop a framework for applying a management-procedure approach to data-limited groundfish stocks in British Columbia. The framework will formalize the process of testing and selecting management procedures for data-limited groundfish fisheries, which will support the provision of scientific advice to fisheries managers in the context of conservation (sustainable total allowable catches, COSEWIC) and eco-certification (Marine Stewardship Counsel). In addition to this procedural framework, this project aims to produce generic operating models that can be modified on a stock-by-stock basis and generate a reproducible data synopsis of the available data and general index trends for candidate groundfish fish stocks.

A science steering committee was formed in the fall of 2017 to plan the current 'management procedure' phase of the project. The first technical working group meeting was convened on April 27 2018, during subsequent meeting the project was divided into two phases, the first to be a research document with visualizations of nearly all available groundfish data, with the expectation of updating this on an annual basis, and the second a research document and science advisory report outlining an agreed upon management procedure approach for British Columbia groundfish.

In November of 2018 a reproducible "synopsis" report that gives a snapshot of population and fishing trends, growth and maturity patterns, as well as data availability, for 113 species of relevance to the Groundfish Section was reviewed through the regional peer review process.

The Groundfish Section had a number of goals in developing the synopsis report. First, the report aims to facilitate regular review by groundfish scientists and managers of trends in survey indices and stock composition. Second, through the tools developed to produce the report, the project aims to generate standardized datasets and visualizations that will help assessment scientists develop stock

assessments and conduct groundfish research. Third, it aims to increase data transparency between Fisheries and Oceans Canada, the fishing industry, non-governmental organizations, and the public.

The report is structured to facilitate viewing all data for one species simultaneously and to quickly browse the data holdings for multiple stocks. The report starts with clickable indexes sorted by species code, common name, and scientific name. Then, following a series of figure captions, the report visualizes most available survey, fisheries, and biological sample data for each of the 113 species in the same two-page layout for each species (e.g., Figure 2 and 3). The first page for each species includes visualizations showing time series and maps of relative biomass from the surveys, commerical fisheries catch categorized by gear type and region, and standardized commercial catch per unit effort from the commercial bottom-trawl fleet. The second page for each species focuses on biological samples. The page starts with length and age distributions, shows length-age and length-weight growth model fits, and shows age- and length-at-maturity model fits. The second page concludes with graphical tables illustrating the number of fish that have have had their length, weight, age, or maturity assessed as well as the number of available aging structures (usually otoliths) by year across all surveys and commercial samples. The main visualizations are followed by detailed appendices explaining the data processing and model fitting approaches.

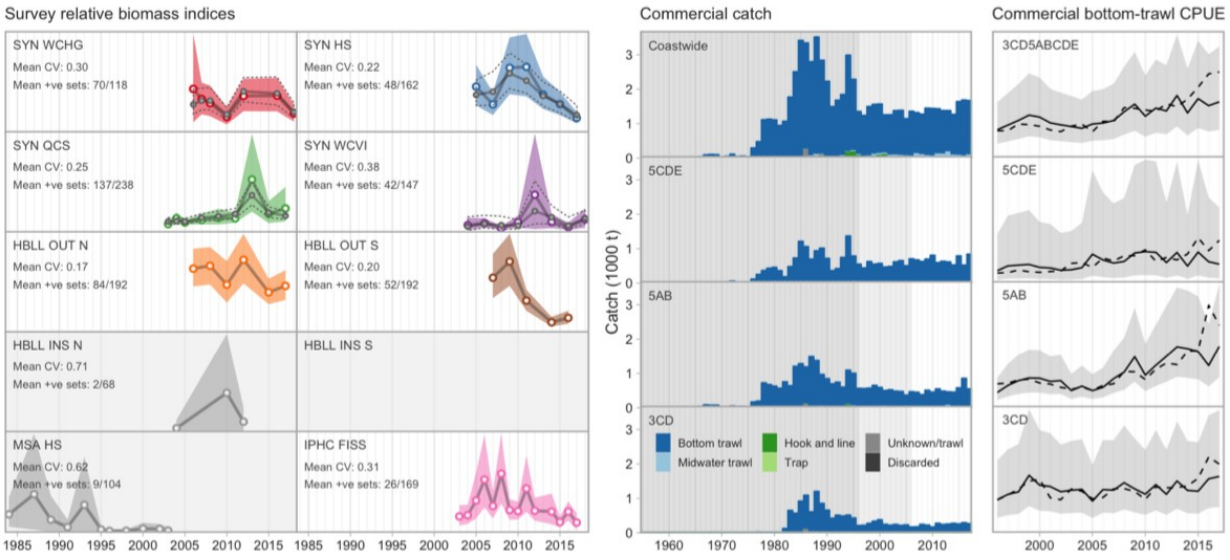
We emphasize that the outputs from the report are not a substitute for stock assessment. For example, survey and commercial index trends do not resolve population scale and the outputs in the report do not resolve conflicts in trends drawn from different sources for the same species. Furthermore, some surveys are not suitable for deriving relative biomass trends for some species, and these types of decisions require knowledge of the individual stocks and survey designs. Also, the outputs in the report are not at a scale appropriate for marine spatial planning. The report includes many other caveats that are important to consider.

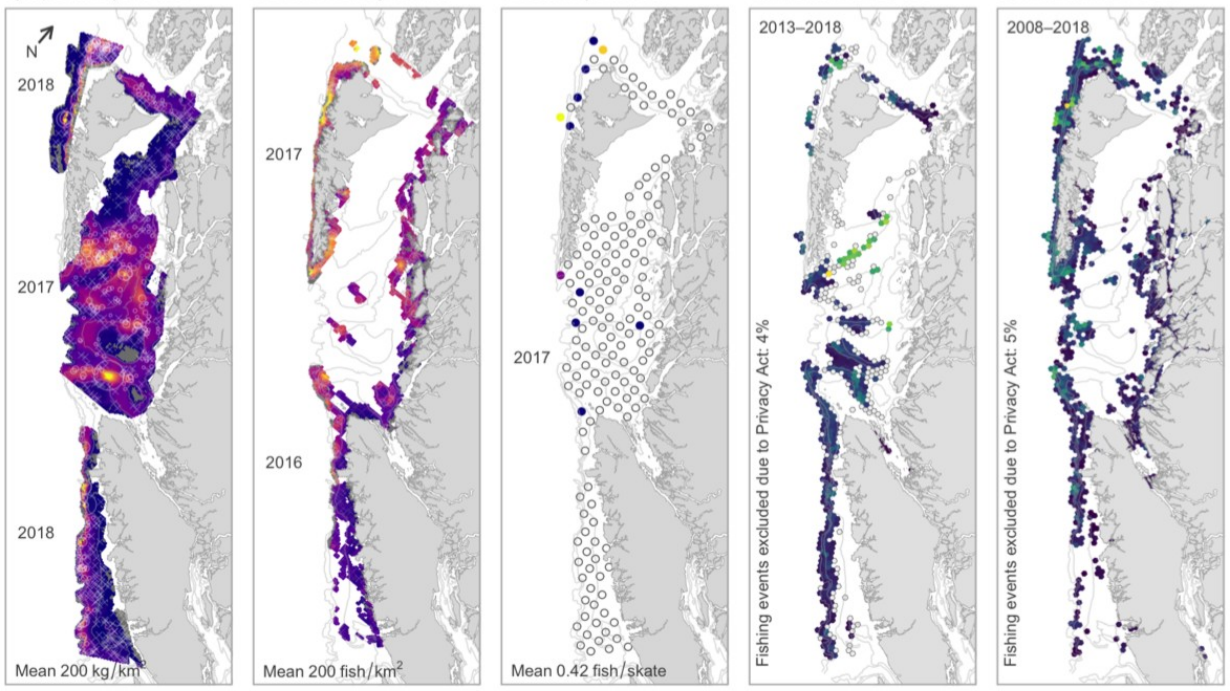
All the data extraction, data manipulation, model fitting, and visualization for the report are automated and reproducible. To accomplish this, the authors developed a series of R packages that are available on GitHub (https://github.com/pbs-assess). The packages include gfplot (for data extraction, manipulation, most model fitting, and visualization), sdmTMB (for geostatistical spatiotemporal modelling of the survey data), gfsynopsis (to call the gfplot functions as needed to generate and stitch together the main figures), and csasdown (building on previous work by other PBS scientists; for generating reproducible CSAS Research Documents with the output from gfsynopsis). The report can theoretically be generated by anyone with access to the groundfish databases housed at PBS. We plan to publish an updated version of the report every one to two years. The report has been accepted as a CSAS Research Document and is currently undergoing finaly formatting and translation. In the meantime, a draft can be downloaded at https://github.com/pbs-assess/gfsynopsis.

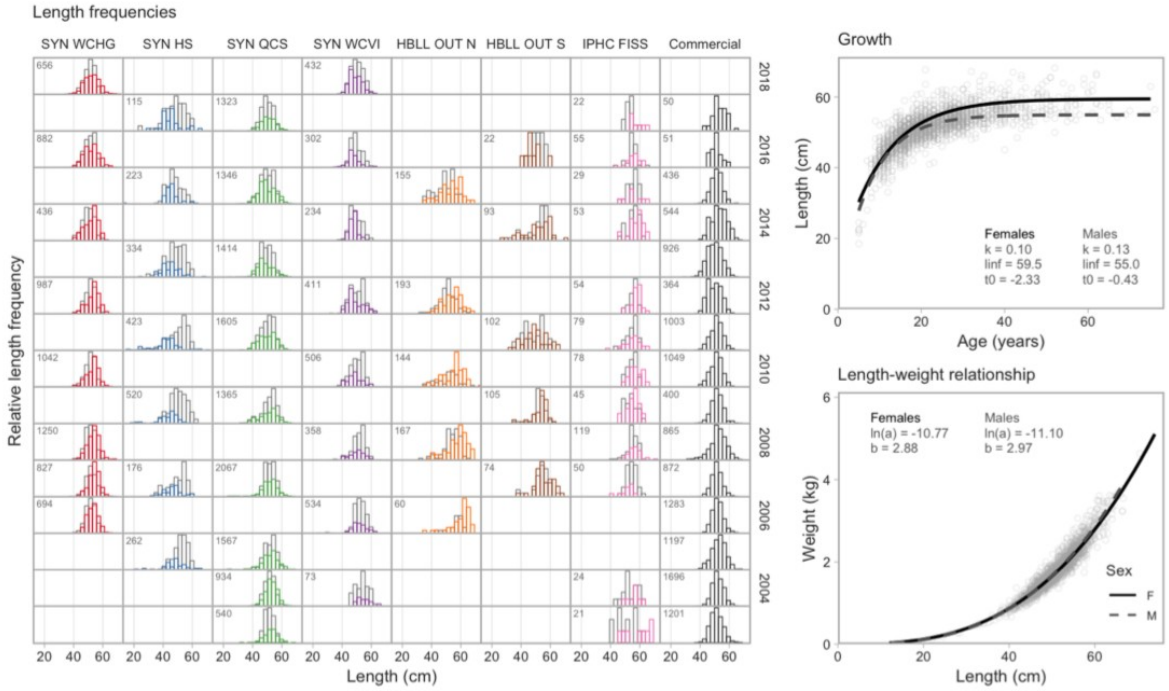
An example species report is presented below for Silvergray rockfish.

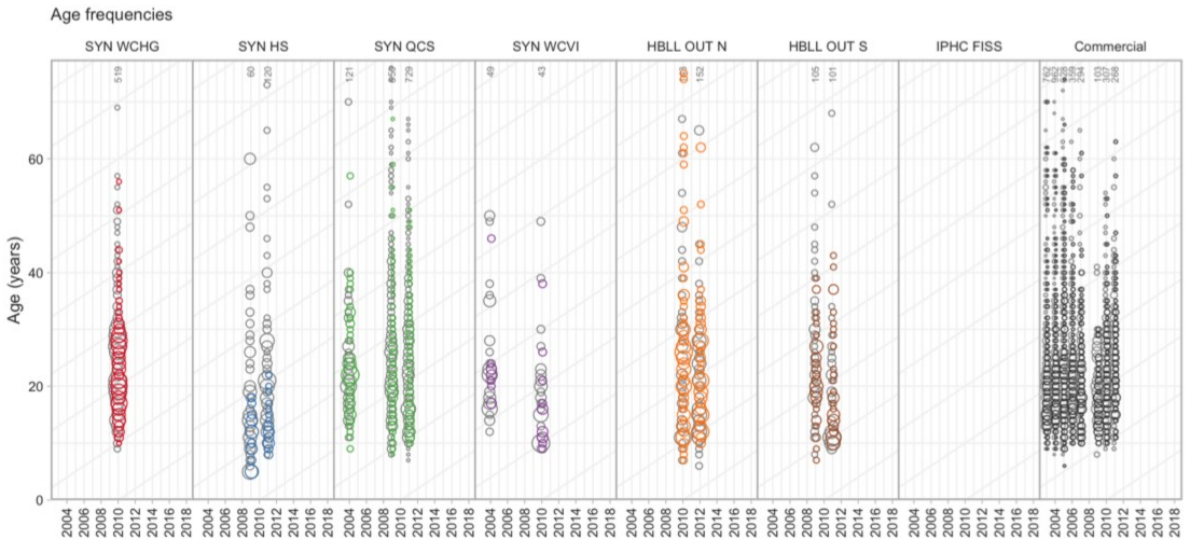
5.49 SILVERGRAY ROCKFISH

Sebastes brevispinis (405)
Order: Scorpaeniformes, Family: Scorpaenidae, FishBase link, WoRMS link
Last Research Document: Starr et al. (2016)
Last Science Advisory Report: Fisheries and Oceans Canada (2014b)






Length frequencies
SYN WCHG
SYN HS
SYN QCS
SYN WCVI
HBLL OUT N
HBLL OUT S
IPHC FISS
Commercial
Relative length frequency
Length (cm)
Growth
Length (cm)
Age (years)
Females
k = 0.10
linf = 59.5
t0 = -2.33
Males
k = 0.13
linf = 55.0
t0 = -0.43
Length-weight relationship
Weight (kg)
Length (cm)
Females
ln(a) = -10.77
b = 2.88
Males
ln(a) = -11.10
b = 2.97
Sex
F
M


Age frequencies
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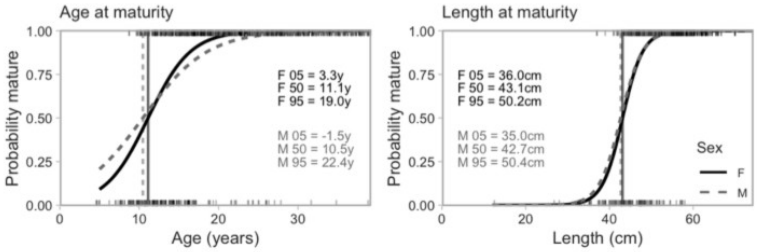
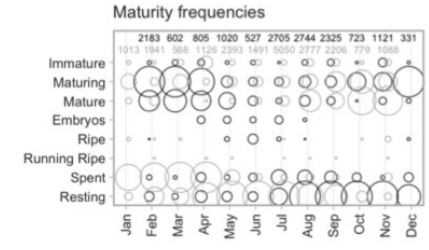
SYN HS
SYN QCS
SYN WCVI
HBLL OUT N
HBLL OUT S
IPHC FISS
Commercial
Age (years)


Age at maturity
Probability mature
Age (years)
F 05 = 3.3y
F 50 = 11.1y
F 95 = 19.0y
M 05 = -1.5y
M 50 = 10.5y
M 95 = 22.4y

Length at maturity
Probability mature
Length (cm)
F 05 = 36.0cm
F 50 = 43.1cm
F 95 = 50.2cm
M 05 = 35.0cm
M 50 = 42.7cm
M 95 = 50.4cm
Sex
F
M


Maturity frequencies
Immature
Maturing
Mature
Embryos
Ripe
Running Ripe
Spent
Resting
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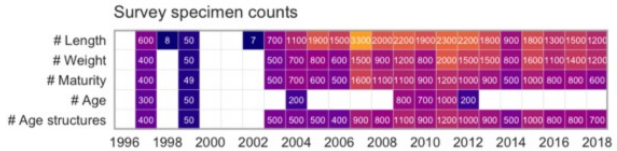
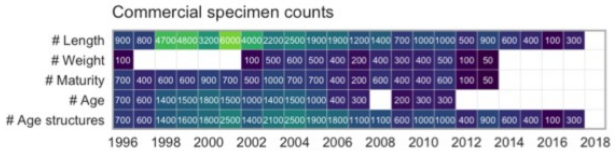
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Survey specimen counts
Length
Weight
Maturity
Age
Age structures


Commercial specimen counts
Length
Weight
Maturity
Age
Age structures

V. Other related studies

Nothing to report at this time.

VI. Groundfish Data Unit

Principal Groundfish Data Unit activities in 2018 included the ongoing population of the groundfish biological samples database (GFBio), scanning and archiving “rescued” data, answering internal and external requests for groundfish data, and working with Groundfish field program staff on various data management issues.

The GFBio database now includes 28,741 trips and approximately 11,484,467 specimens. Data entry activities concentrated on input of recent and historic groundfish research cruises and current-year commercial biological data from at-sea and dockside observers, as well as some non-groundfish survey data from surveys utilizing the GFBioField system.

The Government of Canada is continuing to develop and promote an “Open Data” portal where scientific data will be freely available for download by members of the general public (https://open.canada.ca/en/open-data). Groundfish synoptic trawl surveys datasets are available for 2003 - 2017, with updates to include the 2018 surveys planned for the coming months (https://www.psmfc.org/tsc2/FisheriesAndOceansCanada.html). In 2018, the data unit prepared the groundfish hard bottom longline surveys datasets for release; the datasets and metadata are currently being finalized and will be posted on the portal later this year. This is an ongoing effort, with additional research survey and/or possibly commercial data to be prepared later this year.

VII. Publications

A. Primary Publications

Carrasquilla-Henao, M., Yamanaka, K.L., D.R. Haggarty and F. Juanes. 2018. "Predicting important rockfish (Sebastes spp.) habitat from large-scale longline surveys for southern British Columbia, Canada." Canadian Journal of Fisheries and Aquatic Sciences.

Haggarty, D. and L. Yamanaka. 2018. "Evaluating Rockfish Conservation Areas in southern British Columbia, Canada using a Random Forest model of rocky reef habitat." Estuarine, Coastal and Shelf Science 208: 191-204.

Starr, P. J. and Haigh, R. in press. Redstripe Rockfish (Sebastes proriger) stock assessment for British Columbia in 2018. DFO Can. Sci. Advis. Sec. Res. Doc. 2018/nnn: iii + xxx p.

Starr, P. J. and Haigh, R. in press. Walleye Pollock (Theragra chalcogramma) stock assessment for British Columbia in 2017. DFO Can. Sci. Advis. Sec. Res. Doc. 2018/nnn: iii + xxx p.

Haigh, R., Starr, P. J., Edwards, A. M., King, J. R. and Lecomte, J.-B. 2018. Stock assessment for Pacific Ocean Perch (Sebastes alutus) in Queen Charlotte Sound, British Columbia in 2017. DFO Can. Sci. Advis. Sec. Res. Doc. 2018/038: v + 228 p.

Yamanaka, K.L., McAllister, M.K, Etienne, M.-P., Edwards, A., and Haigh, R. 2018. Assessment for the outside population of Yelloweye Rockfish (Sebastes ruberrimus) for British Columbia, Canada in 2014. Canadian Science Advisory Secretariat, Research Document 2018/001: ix + 150 p.

B. Other Publications

DFO. 2018. A Review of the Use of Recompression Devices as a Tool for Reducing the Effects of Barotrauma on Rockfishes in British Columbia. DFO Can. Sci. Advis. Sec. Sci. Resp. 2018/043. https://waves-vagues.dfo-mpo.gc.ca/Library/40716120.pdf

DFO. 2019. A Regional Assessment of Ecological Attributes in Rockfish Conservation Areas in British Columbia. DFO Can. Sci. Advis. Sec. Sci. Resp. In press.

Dunham, J., Yu, F., Haggarty, D., Deleys, N., Yamanaka, L. 2019. A Regional Assessment of Ecological Attributes in Rockfish Conservation Areas in British Columbia. DFO Can. Sci. Advis. Sec. Res. Doc. In press

Appendix 1

Appendix 1: Details of Fisheries and Oceans, Canada Pacific Region Groundfish Surveys in 2017

Multispecies Synoptic Bottom Trawl Surveys

West Coast Vancouver Island Multi-species Synoptic Bottom Trawl Survey

The West Coast Vancouver Island Multi-species Synoptic Bottom Trawl Survey was conducted on the F/V Nordic Pearl between May 18 and June 14. We assessed a total of 226 blocks (Table 1, Figure 3). Of the 202 total tows conducted, 190 were successful and 12 were failures due to hang ups or insufficient bottom time. Note that some blocks are only successfully fished following more than one attempt.

The total catch weight of all species was 155,085 kg. The mean catch per tow was 787 kg, averaging 26 different species of fish and invertebrates in each. The most abundant fish species encountered were North Pacific Spiny Dogfish (Squalus suckleyi), Sharpchin Rockfish (Sebastes zacentrus), Sablefish (Anoplopoma fimbria), Splitnose Rockfish (Sebastes diploproa), and Canary Rockfish (Sebastes pinniger). The number of tows where the species was captured and total catch weight from usable tows as well as the estimated biomass and relative survey error for the 25 most abundant species are shown in Table 2. Biological data, including individual length, weight, sex, maturity, and age structure were collected from a total of 39,229 individual fish of 50 different species (Table 3).

Table 1. 2018 West Coast Vancouver Island Multi-species Synoptic Bottom Trawl Survey final block summary showing the number of blocks rejected based on fishing master's knowledge or by on-ground inspection, number of failed blocks (due to hang-ups or insufficient bottom time), number of successful tows, and number of un-fished blocks (due to other reasons such as tide, weather, or other vessels in the area) by stratum.

Depth Stratum (meters)	Rejected Prior	Rejected Inspected	Failed	Success	Not Assessed	Total
50 to 125	1	18	3	69	0	91
125 to 200	1	4	2	64	0	71
200 to 330	0	0	0	36	0	36
330 to 500	1	6	0	21	0	28
Total	**3**	**28**	**5**	**190**	**0**	**226**

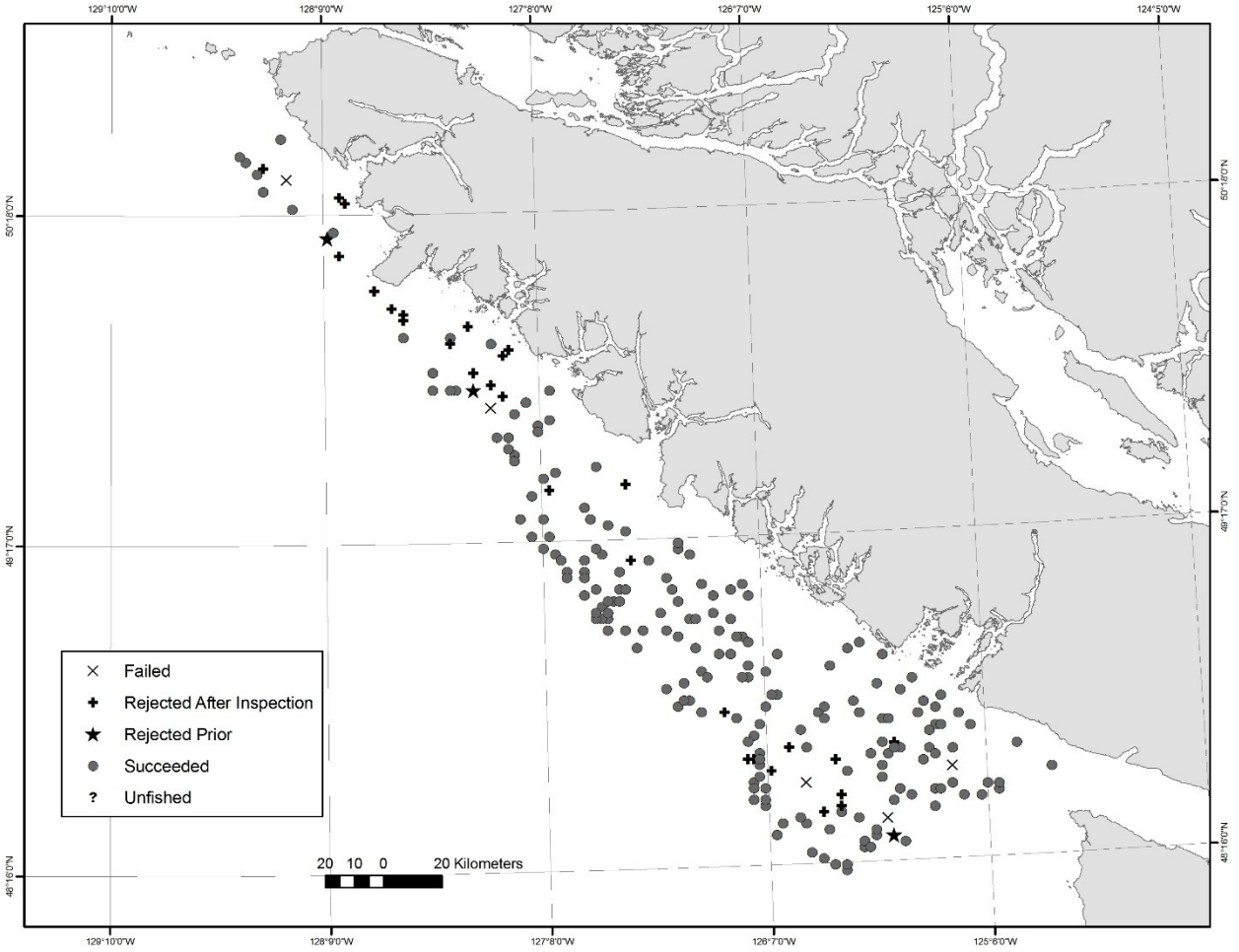


Figure 3. Final status of the allocated blocks for the 2018 West Coast Vancouver Island Multi-species Synoptic Bottom Trawl Survey.

Table 2. Number of catches and total catch weight from usable tows, estimated biomass, and relative survey error for the top 25 species (by weight) captured in the 2018 West Coast Vancouver Island Multi-species Synoptic Bottom Trawl Survey.

Species	Scientific Name	Number of Tows	Catch (kg)	Biomass (t)	Relative Error
North Pacific Spiny Dogfish	*Squalus suckleyi*	132	18750	3835	0.41
Sharpchin Rockfish	*Sebastes zacentrus*	68	16954	3170	0.27
Sablefish	*Anoplopoma fimbria*	139	15917	4747	0.25
Splitnose Rockfish	*Sebastes diploproa*	36	9735	1894	0.47
Canary Rockfish	*Sebastes pinniger*	72	8861	3050	0.60
Rex Sole	*Glyptocephalus zachirus*	183	8705	4264	0.08
Arrowtooth Flounder	*Atheresthes stomias*	170	8283	2749	0.10
Pacific Ocean Perch	*Sebastes alutus*	60	8210	1680	0.28
Redstripe Rockfish	*Sebastes proriger*	50	7180	2747	0.48
Dover Sole	*Microstomus pacificus*	177	6927	3117	0.11
Pacific Hake	*Merluccius productus*	119	5900	2653	0.34
Yellowtail Rockfish	*Sebastes flavidus*	87	4932	2207	0.26
Spotted Ratfish	*Hydrolagus colliei*	179	4139	2300	0.15
Silvergray Rockfish	*Sebastes brevispinis*	54	3875	984	0.39
English Sole	*Parophrys vetulus*	133	3045	1937	0.11
Flathead Sole	*Hippoglossoides elassodon*	117	2667	1622	0.12
Pacific Sanddab	*Citharichthys sordidus*	73	2188	1562	0.16
Greenstriped Rockfish	*Sebastes elongatus*	105	2148	750	0.19
Lingcod	*Ophiodon elongatus*	113	1747	625	0.11
Petrale Sole	*Eopsetta jordani*	124	1416	740	0.15
Shortspine Thornyhead	*Sebastolobus alascanus*	53	1316	276	0.14
Longnose Skate	*Raja rhina*	104	1227	457	0.12
Bocaccio	*Sebastes paucispinis*	55	1225	456	0.57

Pacific Cod	*Gadus macrocephalus*	91	1184	553	0.21
Redbanded Rockfish	*Sebastes babcocki*	59	852	143	0.25

Table 3. Number of fish sampled for biological data during the 2018 West Coast Vancouver Island Multi-species Synoptic Bottom Trawl Survey showing the number of lengths, age structures, and DNA tissue samples that were collected by species.

Species	Scientific Name	Lengths Collected	Age Structures Collected	DNA Tissue Collected
Arrowtooth Flounder	*Atheresthes stomias*	2136	196	0
Aurora Rockfish	*Sebastes aurora*	43	0	0
Big Skate	*Beringraja binoculata*	41	0	0
Bocaccio	*Sebastes paucispinis*	417	409	265
Brown Cat Shark	*Apristurus brunneus*	20	0	0
Canary Rockfish	*Sebastes pinniger*	729	645	0
Curlfin Sole	*Pleuronichthys decurrens*	140	44	0
Darkblotched Rockfish	*Sebastes crameri*	554	0	0
Dover Sole	*Microstomus pacificus*	3153	847	0
English Sole	*Parophrys vetulus*	2231	643	0
Eulachon	*Thaleichthys pacificus*	1085	0	185
Flathead Sole	*Hippoglossoides elassodon*	1729	0	0
Giant Wrymouth	*Cryptacanthodes giganteus*	1	0	0
Green Sturgeon	*Acipenser medirostris*	1	0	0
Greenstriped Rockfish	*Sebastes elongatus*	1285	215	0
Kelp Greenling	*Hexagrammos decagrammus*	26	0	0
Lingcod	*Ophiodon elongatus*	599	489	0
Longnose Skate	*Raja rhina*	369	0	0
North Pacific Spiny Dogfish	*Squalus suckleyi*	1006	0	0
Pacific Cod	*Gadus macrocephalus*	369	236	0
Pacific Hake	*Merluccius productus*	1784	162	0
Pacific Halibut	*Hippoglossus stenolepis*	122	0	0
Pacific Ocean Perch	*Sebastes alutus*	983	614	0
Pacific Sanddab	*Citharichthys sordidus*	1558	0	0
Pacific Tomcod	*Microgadus proximus*	506	0	0

Species	Scientific Name	Lengths Collected	Age Structures Collected	DNA Tissue Collected
Petrale Sole	*Eopsetta jordani*	1070	672	0
Pygmy Rockfish	*Sebastes wilsoni*	121	0	0
Quillback Rockfish	*Sebastes maliger*	40	40	34
Redbanded Rockfish	*Sebastes babcocki*	473	471	0
Redstripe Rockfish	*Sebastes proriger*	649	299	50
Rex Sole	*Glyptocephalus zachirus*	4021	430	0
Rosethorn Rockfish	*Sebastes helvomaculatus*	764	0	0
Rougheye/Blackspotted Rockfish complex	*Sebastes aleutianus/melanostictus* complex	239	230	289
Sablefish	*Anoplopoma fimbria*	1742	870	0
Sandpaper Skate	*Bathyraja interrupta*	52	0	0
Sharpchin Rockfish	*Sebastes zacentrus*	1089	0	0
Shortbelly Rockfish	*Sebastes jordani*	237	120	0
Shortraker Rockfish	*Sebastes borealis*	31	31	0
Shortspine Thornyhead	*Sebastolobus alascanus*	1040	110	0
Silvergray Rockfish	*Sebastes brevispinis*	432	233	0
Slender Sole	*Lyopsetta exilis*	2002	0	0
Southern Rock Sole	*Lepidopsetta bilineata*	496	257	0
Splitnose Rockfish	*Sebastes diploproa*	663	0	0
Spotted Ratfish	*Hydrolagus colliei*	1288	0	0
Stripetail Rockfish	*Sebastes saxicola*	22	0	0
Walleye Pollock	*Gadus chalcogrammus*	838	0	0
Widow Rockfish	*Sebastes entomelas*	40	0	0
Yelloweye Rockfish	*Sebastes ruberrimus*	77	75	121
Yellowmouth Rockfish	*Sebastes reedi*	33	17	0
Yellowtail Rockfish	*Sebastes flavidus*	883	251	0

West Coast Haida Gwaii Multi-species Synoptic Bottom Trawl Survey

The West Coast Haida Gwaii Multi-species Synoptic Bottom Trawl Survey was conducted on the F/V Nordic Pearl between September 2 and 24, 2018. We assessed a total of 132 blocks (Table 4, Figure 4). At the end of the survey, four blocks had not yet been fished but would have required not only another full day of fishing, but also the vessel was full of fish and would have had to travel to port, offload catch, and return to the grounds. As such, the decision was made to leave those four blocks as unassessed. Of the 132 total tows conducted, 119 were successful and 13 were failures due to hang ups or insufficient bottom time. Note that some blocks are only successfully fished following more than one attempt.

The total catch weight of all species was 187,407 kg. The mean catch per tow was 1453 kg, averaging 21 different species of fish and invertebrates in each. The most abundant fish species encountered were Pacific Ocean Perch (Sebastes alutus), Sharpchin Rockfish (Sebastes zacentrus), Rougheye/Blackspotted Rockfish complex (Sebastes aleutianus/melanostictus complex), Silvergray Rockfish (Sebastes brevispinis), Shortspine Thornyhead (Sebastolobus alascanus) and Yellowmouth Rockfish (Sebastes reedi). The number of tows where the species was captured and total catch weight from usable tows as well as the estimated biomass and relative survey error for the 25 most abundant species are shown in Table 5. Biological data, including individual length, weight, sex, maturity, and age structure were collected from a total of 17,511 individual fish of 44 different species (Table 6). Oceanographic data, including water temperature, depth, salinity, and dissolved oxygen were also recorded for most tows.

Table 4. 2018 West Coast Haida Gwaii Multi-species Synoptic Bottom Trawl Survey final block summary showing the number of blocks rejected based on fishing master's knowledge or by on-ground inspection, number of failed blocks (due to hang-ups or insufficient bottom time), number of successful tows, and number of un-fished blocks (due to other reasons such as tide, weather, or other vessels in the area) by stratum.

Depth Stratum (meters)	Rejected Prior	Rejected Inspected	Failed	Success	Not Assessed	Total
180 to 330	1	5	2	67	3	78
330 to 500	2	2	0	31	0	35
500 to 800	1	0	0	10	1	12
800 to 1,300	0	0	0	11	0	11

Total	**4**	**7**	**2**	**119**	**4**	**136**

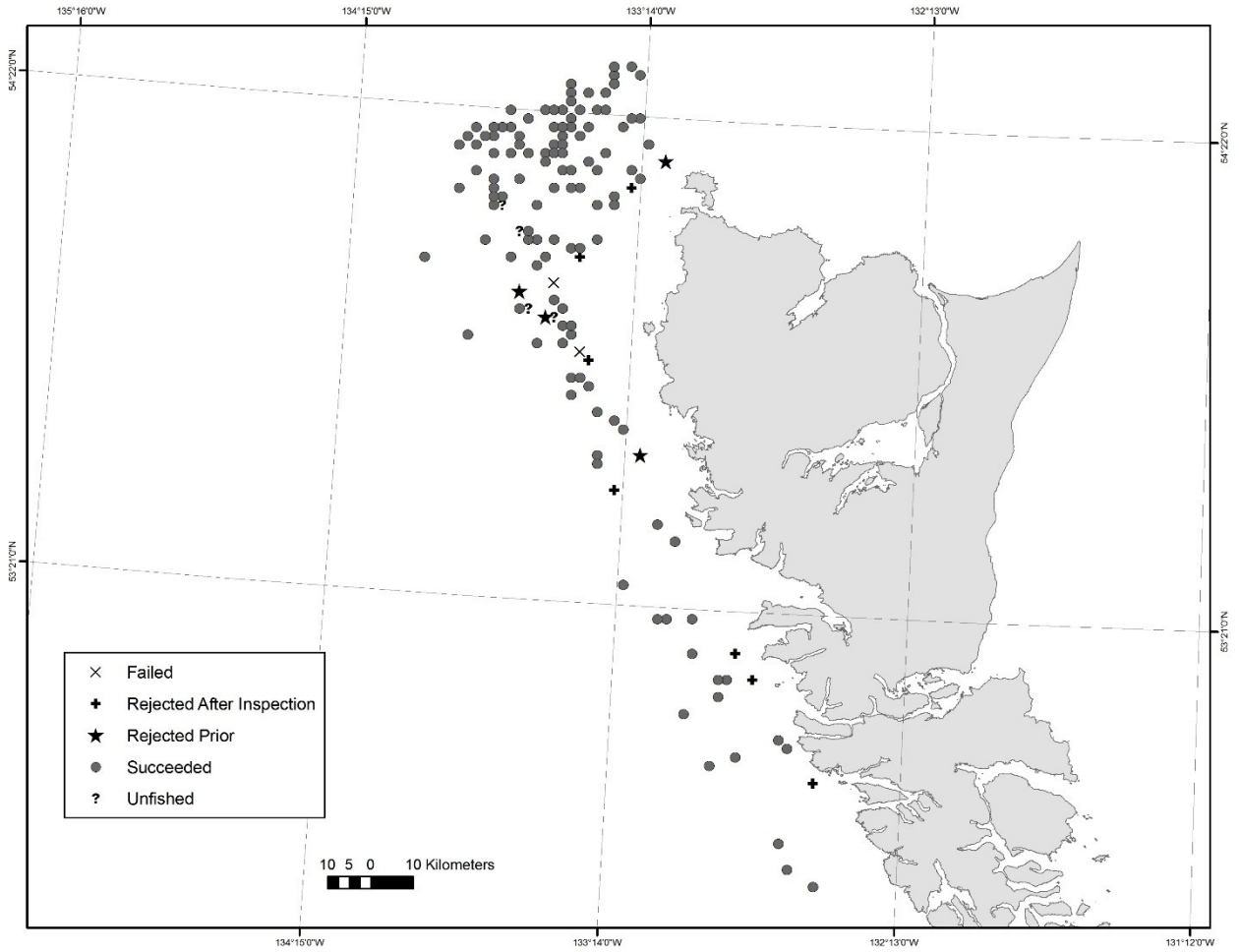


Figure 4. Final status of the allocated blocks for the 2018 West Coast Haida Gwaii Multi-species Synoptic Bottom Trawl Survey.

Table 5. Number of catches and total catch weight from usable tows, estimated biomass, and relative survey error for the top 25 species (by weight) captured in the 2017 West Coast Haida Gwaii Multi-species Synoptic Bottom Trawl Survey.

Species	Scientific Name	Number of Tows	Catch (kg)	Biomass (t)	Relative Error
Pacific Ocean Perch	*Sebastes alutus*	91	116845	19173	0.21
Sharpchin Rockfish	*Sebastes zacentrus*	68	17948	2363	0.34
Rougheye/Blackspotted Rockfish complex	*Sebastes aleutianus/melanostictus* complex	54	10949	2772	0.27
Silvergray Rockfish	*Sebastes brevispinis*	66	5097	676	0.23
Shortspine Thornyhead	*Sebastolobus alascanus*	112	4787	1307	0.08
Yellowmouth Rockfish	*Sebastes reedi*	44	4729	666	0.52
Redstripe Rockfish	*Sebastes proriger*	61	4334	551	0.31
Sablefish	*Anoplopoma fimbria*	104	3725	1742	0.15
Arrowtooth Flounder	*Atheresthes stomias*	83	3251	455	0.51
Splitnose Rockfish	*Sebastes diploproa*	14	1282	165	0.69
Dover Sole	*Microstomus pacificus*	99	1048	321	0.13
Redbanded Rockfish	*Sebastes babcocki*	73	986	152	0.18
Shortraker Rockfish	*Sebastes borealis*	19	821	367	0.55
Canary Rockfish	*Sebastes pinniger*	13	735	91	0.59
Rosethorn Rockfish	*Sebastes helvomaculatus*	65	709	100	0.14
Pacific Hake	*Merluccius productus*	43	649	157	0.21
Longspine Thornyhead	*Sebastolobus altivelis*	23	584	541	0.19
Rex Sole	*Glyptocephalus zachirus*	97	554	103	0.16
Walleye Pollock	*Gadus chalcogrammus*	41	434	94	0.44
Giant Grenadier	*Albatrossia pectoralis*	17	399	446	0.4
Pacific Grenadier	*Coryphaenoides acrolepis*	18	360	474	0.36
Widow Rockfish	*Sebastes entomelas*	28	360	50	0.33
Spotted Ratfish	*Hydrolagus colliei*	69	338	53	0.24
Longnose Skate	*Raja rhina*	31	320	58	0.18
Lingcod	*Ophiodon elongatus*	25	310	48	0.27

Table 6. Number of fish sampled for biological data during the 2018 West Coast Haida Gwaii Multi-species Synoptic Bottom Trawl Survey showing the number of lengths and age structures that were collected by species.

Species	Scientific Name	Lengths Collected	Age Structures Collected	DNA Tissue Collected
Aleutian Skate	*Bathyraja aleutica*	9	0	0
Arrowtooth Flounder	*Atheresthes stomias*	148	66	0
Bocaccio	*Sebastes paucispinis*	21	19	21
Brown Cat Shark	*Apristurus brunneus*	19	0	0
Canary Rockfish	*Sebastes pinniger*	82	72	0
Darkblotched Rockfish	*Sebastes crameri*	34	29	0
Dover Sole	*Microstomus pacificus*	783	289	0
English Sole	*Parophrys vetulus*	27	0	0
Giant Grenadier	*Albatrossia pectoralis*	165	152	0
Greenstriped Rockfish	*Sebastes elongatus*	237	0	0
Harlequin Rockfish	*Sebastes variegatus*	186	0	0
Lingcod	*Ophiodon elongatus*	43	5	0
Longnose Skate	*Raja rhina*	44	0	0
Longspine Thornyhead	*Sebastolobus altivelis*	667	615	0
North Pacific Spiny Dogfish	*Squalus suckleyi*	2	0	0
Pacific Cod	*Gadus macrocephalus*	37	0	0
Pacific Flatnose	*Antimora microlepis*	50	49	0
Pacific Grenadier	*Coryphaenoides acrolepis*	438	0	0
Pacific Hake	*Merluccius productus*	264	0	0
Pacific Halibut	*Hippoglossus stenolepis*	44	0	0
Pacific Ocean Perch	*Sebastes alutus*	2195	1799	0
Petrale Sole	*Eopsetta jordani*	27	15	0
Popeye	*Coryphaenoides cinereus*	341	0	0
Pygmy Rockfish	*Sebastes wilsoni*	25	0	0
Redbanded Rockfish	*Sebastes babcocki*	627	615	50
Redstripe Rockfish	*Sebastes proriger*	969	411	0

Species	Scientific Name	Lengths Collected	Age Structures Collected	DNA Tissue Collected
Rex Sole	*Glyptocephalus zachirus*	850	27	0
Rosethorn Rockfish	*Sebastes helvomaculatus*	1089	0	0
Rougheye/Blackspotted Rockfish complex	*Sebastes aleutianus/melanostictus* complex	757	755	756
Roughtail Skate	*Bathyraja trachura*	6	0	0
Sablefish	*Anoplopoma fimbria*	1126	502	0
Sandpaper Skate	*Bathyraja interrupta*	37	0	0
Sharpchin Rockfish	*Sebastes zacentrus*	1432	0	0
Shortraker Rockfish	*Sebastes borealis*	161	161	50
Shortspine Thornyhead	*Sebastolobus alascanus*	2783	628	0
Silvergray Rockfish	*Sebastes brevispinis*	657	393	50
Slender Sole	*Lyopsetta exilis*	25	0	0
Splitnose Rockfish	*Sebastes diploproa*	129	0	0
Spotted Ratfish	*Hydrolagus colliei*	97	0	0
Walleye Pollock	*Gadus chalcogrammus*	362	0	0
Whitebrow Skate	*Bathyraja minispinosa*	1	0	0
Widow Rockfish	*Sebastes entomelas*	162	24	0
Yelloweye Rockfish	*Sebastes ruberrimus*	8	8	8
Yellowmouth Rockfish	*Sebastes reedi*	345	222	0

Hard Bottom Longline Hook Surveys

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

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

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

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

The Hard Bottom Longline Hook surveys follow a random depth-stratified design using standardized “snap and swivel” longline hook gear with prescribed fishing

protocols including bait, soak time and set locations within the selected blocks. Hard bottom regions within each survey were identified through bathymetry analyses, inshore rockfish fishing records and fishermen consultations. Each survey area is divided into 2 km by 2 km blocks and each block is assigned a depth stratum based on the average bottom depth within the block. The three depth strata for the outside area are 20 to 70 meters, 71 to 150 meters, and 151 to 260 meters. Suitable hard bottom regions in the Strait of Georgia and Johnstone Strait are more limited so the depth strata for the inside area are 20 to 70 meters and 71 to 100 meters.

In 2018 the southern region of the outside area and the southern region of the inside area were surveyed.

Outside (Pacific Halibut Management Association) Survey

The 2018 Outside Hard Bottom Longline Hook Survey was conducted in the southern region but at the time of writing, the data are not yet finalized and so have not been included in this report.

Inside (DFO) Survey

The Inside Hard Bottom Longline Hook Survey was conducted in the southern portion of the inside area on board the Canadian Coast Guard vessel Neocaligus from August 21 to September 7, 2018. The survey was later than the standard August period and shortened due to crewing limitations and vessel mechanical issues. As such, we were not able to visit all of the 70 blocks originally selected. We chose to leave the most northern blocks unassessed and those blocks will be added to the 2019 survey of the northern area. A total of 55 sets were completed (Figure 5). The total catch of the survey was 11,860 kg (). The average catch per set was 215 kg, averaging four different species of fish and invertebrates in each. The most abundant fish species encountered were North Pacific Spiny Dogfish (Squalus suckleyi), Quillback Rockfish (Sebastes maliger), Lingcod (Ophiodon elongatus), Yelloweye Rockfish (Sebastes ruberrimus), Longnose Skate (Raja rhina), and Copper Rockfish (Sebastes caurinus). The number of sets where the species was captured as well as the total catch count and proportion of the total catch of all fish species are shown in Table 8. An annual summary of catch by species in the southern area is shown in Table 9. Biological data, including individual length, weight, sex, maturity, and age structure were collected from a total of 5647 individual fish of 15 different species (Table 10). An annual summary of the number of fish sampled for biological data in the southern area is shown in Table 11.

One vertical CTD (conductivity, temperature, and depth recorder) cast was made at each selected block during the 2018 Inside Hard Bottom Longline Hook Survey. The CTD also included a dissolved oxygen sensor. In addition, a temperature depth recorder was deployed at the start, middle, and end of every fishing set.

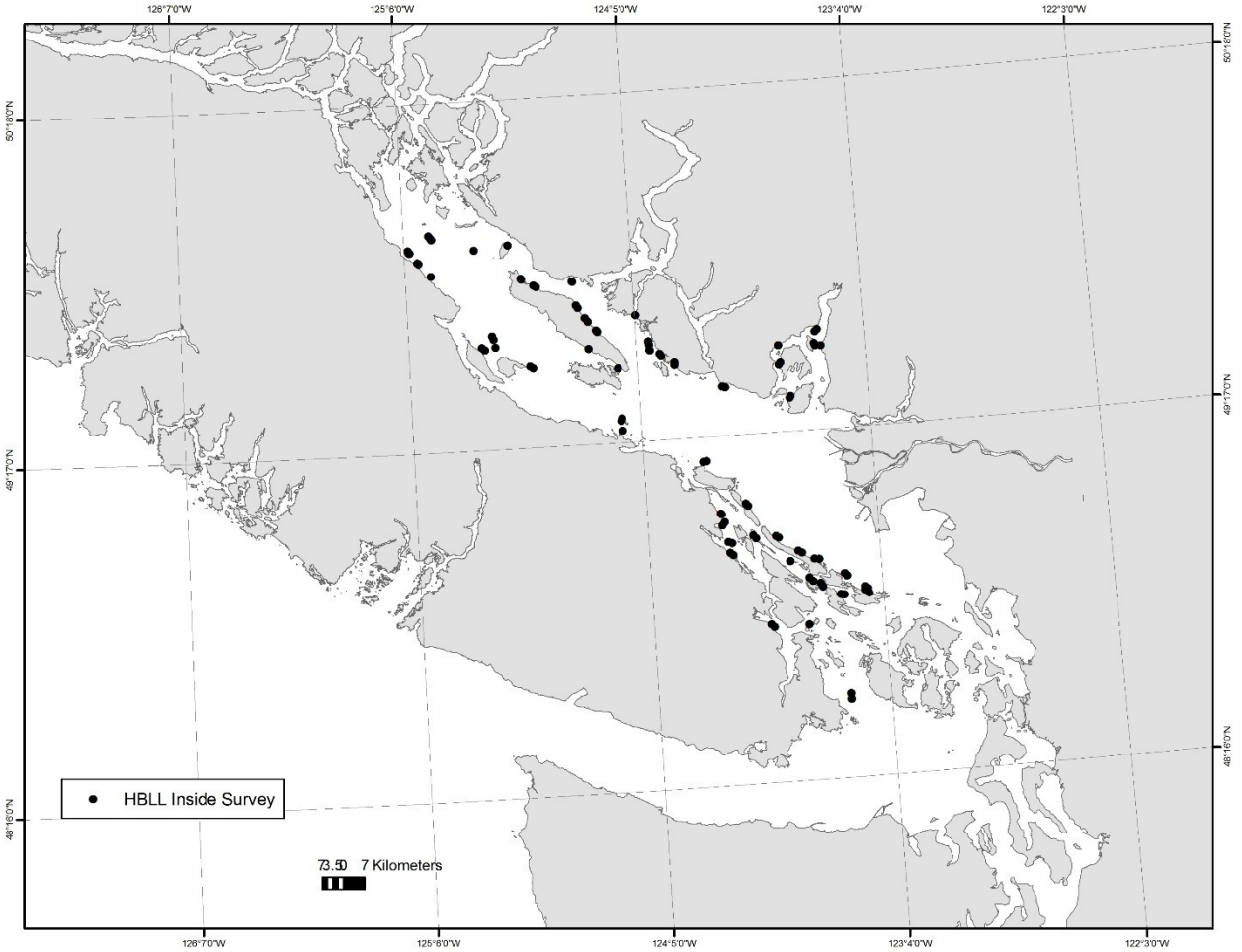


Figure 5. Longline set locations of the 2018 Inside Hard Bottom Longline Hook Survey.

Table 7. Total catch, showing both piece count and weight by species for the 2018 Inside Hard Bottom Longline Hook Survey.

Species	Scientific Name	Total Catch (count)	Total Catch (kg)
North Pacific Spiny Dogfish	*Squalus suckleyi*	5302	10816
Quillback Rockfish	*Sebastes maliger*	88	73
Lingcod	*Ophiodon elongatus*	60	306
Yelloweye Rockfish	*Sebastes ruberrimus*	55	106
Longnose Skate	*Raja rhina*	53	138
Copper Rockfish	*Sebastes caurinus*	37	53
Canary Rockfish	*Sebastes pinniger*	26	53
Big Skate	*Beringraja binoculata*	23	264
Spotted Ratfish	*Hydrolagus colliei*	11	6
Red Rock Crab	*Cancer productus*	11	3
	Metridium	7	1
Pacific Cod	*Gadus macrocephalus*	6	5
Bluntnose Sixgill Shark	*Hexanchus griseus*	5	
Southern Rock Sole	*Lepidopsetta bilineata*	5	2
Sponges	*Porifera*	4	0
Cabezon	*Scorpaenichthys marmoratus*	3	13
Sunflower Starfish	*Pycnopodia helianthoides*	3	2
Fish-eating Star	*Stylasterias forreri*	3	0
Pink Short-spined Star	*Pisaster brevispinus*	2	2
Sea Lilies And Feather Stars	*Crinoidea*	2	
Pacific Sanddab	*Citharichthys sordidus*	2	0
Greenstriped Rockfish	*Sebastes elongatus*	2	0
Vermilion Rockfish	*Sebastes miniatus*	1	2
Kelp Greenling	*Hexagrammos decagrammus*	1	1
Glass Sponges	*Hexactinellida*	1	

Arrowtooth Flounder	*Atheresthes stomias*	1	
Flathead Sole	*Hippoglossoides elassodon*	1	0
Dungeness Crab	*Metacarcinus magister*	1	0
	Antedonidae	1	
	Henricia	1	
	Solaster	1	0
Pacific Staghorn Sculpin	*Leptocottus armatus*	1	0
Mottled Star	*Evasterias troschelii*	1	0
	Mytilus		2
Sea Whip	*Balticina septentrionalis*		

Table 8. Number of sets, catch (piece count), and proportion of the total fish catch for fish species caught during the 2018 DFO Hard Bottom Longline Hook Survey.

Species	Number of Sets	Catch (count)	Proportion of Total Catch (%)
North Pacific Spiny Dogfish	54	5302	93.30
Quillback Rockfish	26	88	1.55
Lingcod	21	60	1.06
Yelloweye Rockfish	15	55	0.97
Longnose Skate	24	53	0.93
Copper Rockfish	13	37	0.65
Canary Rockfish	5	26	0.46
Big Skate	11	23	0.40
Spotted Ratfish	5	11	0.19
Pacific Cod	3	6	0.11
Bluntnose Sixgill Shark	3	5	0.09
Southern Rock Sole	2	5	0.09
Cabezon	3	3	0.05
Greenstriped Rockfish	2	2	0.04
Pacific Sanddab	2	2	0.04
Vermilion Rockfish	1	1	0.02
Pacific Staghorn Sculpin	1	1	0.02
Kelp Greenling	1	1	0.02
Flathead Sole	1	1	0.02
Arrowtooth Flounder	1	1	0.02

Table 9. Annual summary of the total catch (piece count) for the top 25 species (by total piece count over all years) for the Inside Hard Bottom Longline Survey southern region.

Species	2005	2009	2011	2013	2015	2018	Total
North Pacific Spiny Dogfish	10847	3258	5744	5615	5283	5302	36049
Yelloweye Rockfish	215	10	266	223	209	55	978
Quillback Rockfish	196	40	297	199	154	88	974
Spotted Ratfish	186	91	4	5	11	11	308
Copper Rockfish	44	13	21	21	64	37	200
Lingcod	50	2	17	22	28	60	179
Longnose Skate	25	4	17	13	48	53	160
Pacific Cod	48	18	33	17	33	6	155
Canary Rockfish	52	0	14	14	25	26	131
Big Skate	24	5	1	13	29	23	95
Pacific Sanddab	22	25	3	8	11	2	71
Greenstriped Rockfish	8	3	16	11	3	2	43
Cabezon	23	5	2	2	7	3	42
Pacific Halibut	6	13	2	3	3	0	27
Southern Rock Sole	4	1	8	2	6	5	26
Red Irish Lord	3	1	1	7	6	0	18
Arrowtooth Flounder	15	1	0	0	0	1	17
Pacific Staghorn Sculpin	0	10	1	2	2	1	16
Tiger Rockfish	9	0	1	0	0	0	10
Brown Irish Lord	0	1	9	0	0	0	10
Bluntnose Sixgill Shark	2	1	0	0	2	5	10
Kelp Greenling	3	0	0	1	2	1	7
Vermilion Rockfish	4	0	0	0	0	1	5
Yellowtail Rockfish	1	2	0	0	1	0	4
Deacon Rockfish	4	0	0	0	0	0	4

Table 10. Number of fish sampled for biological data during the 2018 Inside Hard Bottom Longline Hook survey showing the number of lengths, age structures, and DNA tissue samples that were collected by species.

Species	Scientific Name	Lengths Collected	Age Structures Collected	DNA Collected
Big Skate	*Beringraja binoculata*	22	0	0
Cabezon	*Scorpaenichthys marmoratus*	3	0	0
Canary Rockfish	*Sebastes pinniger*	22	17	20
Copper Rockfish	*Sebastes caurinus*	30	27	30
Kelp Greenling	*Hexagrammos decagrammus*	1	0	0
Lingcod	*Ophiodon elongatus*	60	60	0
Longnose Skate	*Raja rhina*	52	0	0
North Pacific Spiny Dogfish	*Squalus suckleyi*	5300	0	0
Pacific Cod	*Gadus macrocephalus*	1	0	0
Pacific Sanddab	*Citharichthys sordidus*	2	0	0
Quillback Rockfish	*Sebastes maliger*	83	81	0
Southern Rock Sole	*Lepidopsetta bilineata*	4	0	0
Spotted Ratfish	*Hydrolagus colliei*	11	0	0
Vermilion Rockfish	*Sebastes miniatus*	1	0	0
Yelloweye Rockfish	*Sebastes ruberrimus*	55	54	54

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

Species	2005	2009	2011	2013	2015	2018	Total
North Pacific Spiny Dogfish	5671	1176	5720	5770	5274	5300	28911
Yelloweye Rockfish	206	10	264	222	205	55	962
Quillback Rockfish	187	40	290	195	147	83	942
Spotted Ratfish	152	63	4	4	6	11	240
Copper Rockfish	44	12	19	20	64	30	189
Lingcod	44	2	17	20	28	60	171
Longnose Skate	22	3	16	13	47	52	153
Canary Rockfish	51	0	12	14	25	22	124
Pacific Cod	39	11	15	17	24	1	107
Big Skate	22	5	1	13	27	22	90
Cabezon	23	0	1	2	7	3	36
Greenstriped Rockfish	7	3	4	10	2	0	26
Southern Rock Sole	4	0	6	2	5	4	21
Pacific Sanddab	12	0	1	2	3	2	20
Pacific Halibut	6	8	0	3	2	0	19
Red Irish Lord	3	0	0	5	6	0	14
Tiger Rockfish	9	0	1	0	0	0	10
Kelp Greenling	3	0	0	1	2	1	7
Vermilion Rockfish	4	0	0	0	0	1	5
Sandpaper Skate	4	0	0	0	0	0	4
Walleye Pollock	0	0	1	0	2	0	3
Silvergray Rockfish	1	0	0	2	0	0	3
Deacon Rockfish	3	0	0	0	0	0	3
Yellowtail Rockfish	1	0	0	0	1	0	2
Arrowtooth Flounder	1	0	0	0	0	0	1
Wolf Eel	0	0	0	1	0	0	1
Sculpins	1	0	0	0	0	0	1

Petrale Sole	0	1	0	0	0	0	1
China Rockfish	1	0	0	0	0	0	1
Redstripe Rockfish	1	0	0	0	0	0	1
Sablefish	0	0	0	0	1	0	1

Sablefish Research and Assessment Survey

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

A pilot stratified random design was introduced for the 2003 survey with the dual purposes of random release of tagged fish and development of a second stock abundance index. The offshore survey area was divided into five spatial strata (Figure 5). Each spatial stratum was further divided into 2 km by 2 km blocks and each block was assigned to one three depth strata. Each year, blocks are randomly selected within each combination of spatial and depth strata. From 2003 through 2010, the selected blocks were allocated equally among the strata. An analysis was conducted for the 2011 survey to estimate the optimal allocation of blocks and that allocation was used in both 2011 and 2012. In 2013 the number of blocks in the survey was reduced in an effort to reduce the overall cost of the survey. The allocation from 2013 has been used for all subsequent surveys.

The 2018 Sablefish research and assessment survey was comprised of two main components:

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

3. An **Inlets Program** that releases tagged Sablefish from fixed-stations at four mainland inlet localities (Figure 6). These sets also provide a time series of

catch rate and biological data that can be used for assessing changes in stock abundance.

In addition to the main survey programs, the Sablefish Research and Assessment Survey included a Bottom Contact Research Project to investigate gear interaction with the substrate. Trap-mounted accelerometers recorded motion and orientation of the traps while oceanographic data from trap-mounted recorders collected temperature, depth, and salinity. The autonomous, trap-mounted cameras used in recent years were not deployed in 2018.

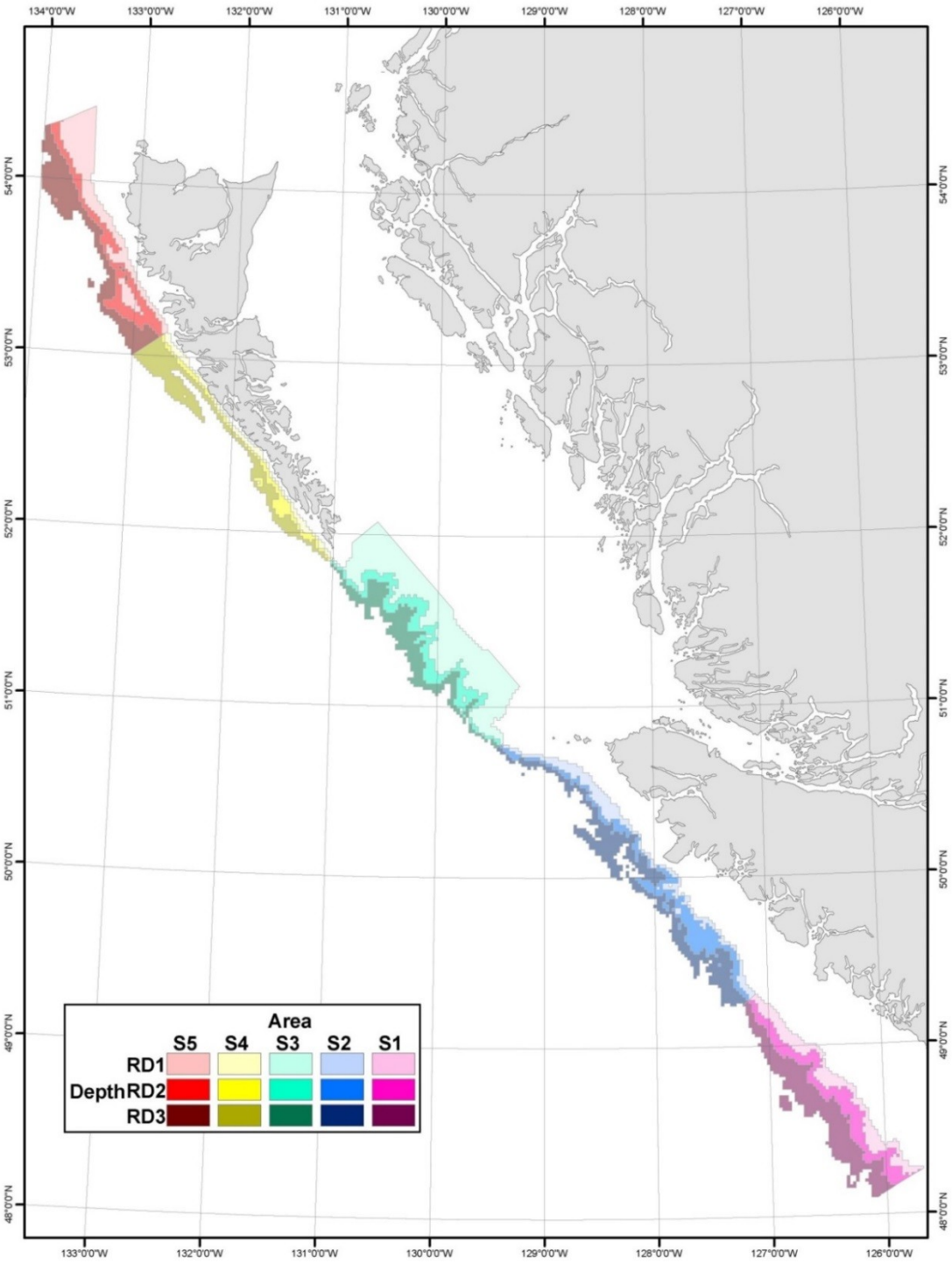


Figure 6. Sablefish Research and Assessment Survey randomized tagging program design showing the boundaries of each of the spatial and depth strata.

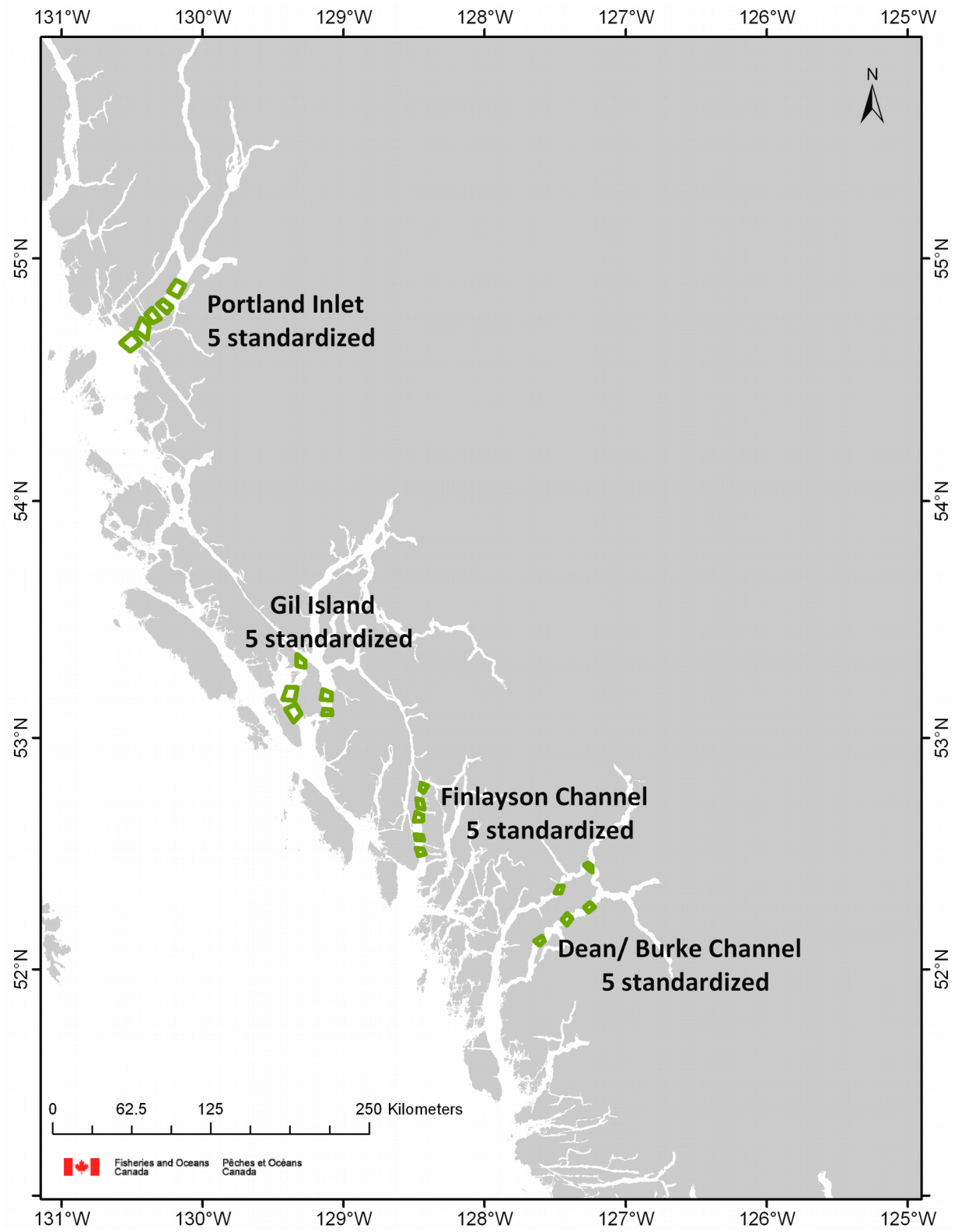


Figure 7. Sablefish Research and Assessment Survey Inlets program locations.

The 2018 Sablefish Research and Assessment Survey was conducted on the Ocean Pearl from October 9 to November 19, 2018. A total of 111 sets were completed (Figure 8) including 91 Randomized Tagging Program sets (Table 12) and 20 Inlets Program sets (Table 13).

The total catch of the survey was 130,719 kg (Table 14) and the average catch per set was 1178 kg. The most abundant fish species encountered by weight were Sablefish (Anoplopoma fimbria), followed by Pacific Halibut (Hippoglossus stenolepis), North Pacific Spiny Dogfish (Squalus suckleyi), Lingcod (Ophiodon elongatus), and Yelloweye Rockfish (Sebastes ruberrimus). The number of sets where the species was captured as well as the total catch count, proportion of the total catch, and a breakdown by area for the 25 most abundant species captured during the Randomized Tagging Program are shown in Table 15. Annual summaries of catch for common species are shown for the Randomized Tagging Program in Table 16 and in Table 17 for the Inlet Program. Biological data, including individual length, weight, sex, maturity, and age structure were collected from a total of 17,322 individual fish of 5 different species (Table 18). An annual summary of the number of fish sampled for biological data during the Randomized Tagging Program is shown in Table 19 and in Table 20 for the Inlets Program.

Table 12. Summary of sets made during the 2018 Sablefish Randomized Tagging Program showing the number of sets in each combination of spatial and depth strata.

Spatial Strata	Depth Strata			Total
	RD1 (100-250 fm)	RD2 (250-450 fm)	RD3 (450-750)	
S1 (South West Coast Vancouver Island or SWCVI)	6	8	5	19
S2 (North West Coast Vancouver Island or NWCVI)	6	7	5	18
S3 (Queen Charlotte Sound or QCS)	8	6	5	19
S4 (South West Coast Haida Gwaii or SWCHG)	6	6	5	17
S5 (North West Coast Haida Gwaii or NWCHG)	6	7	5	18
Total	**32**	**34**	**25**	**91**

Table 13. Summary of sets made during the 2108 Sablefish Inlets Program.

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

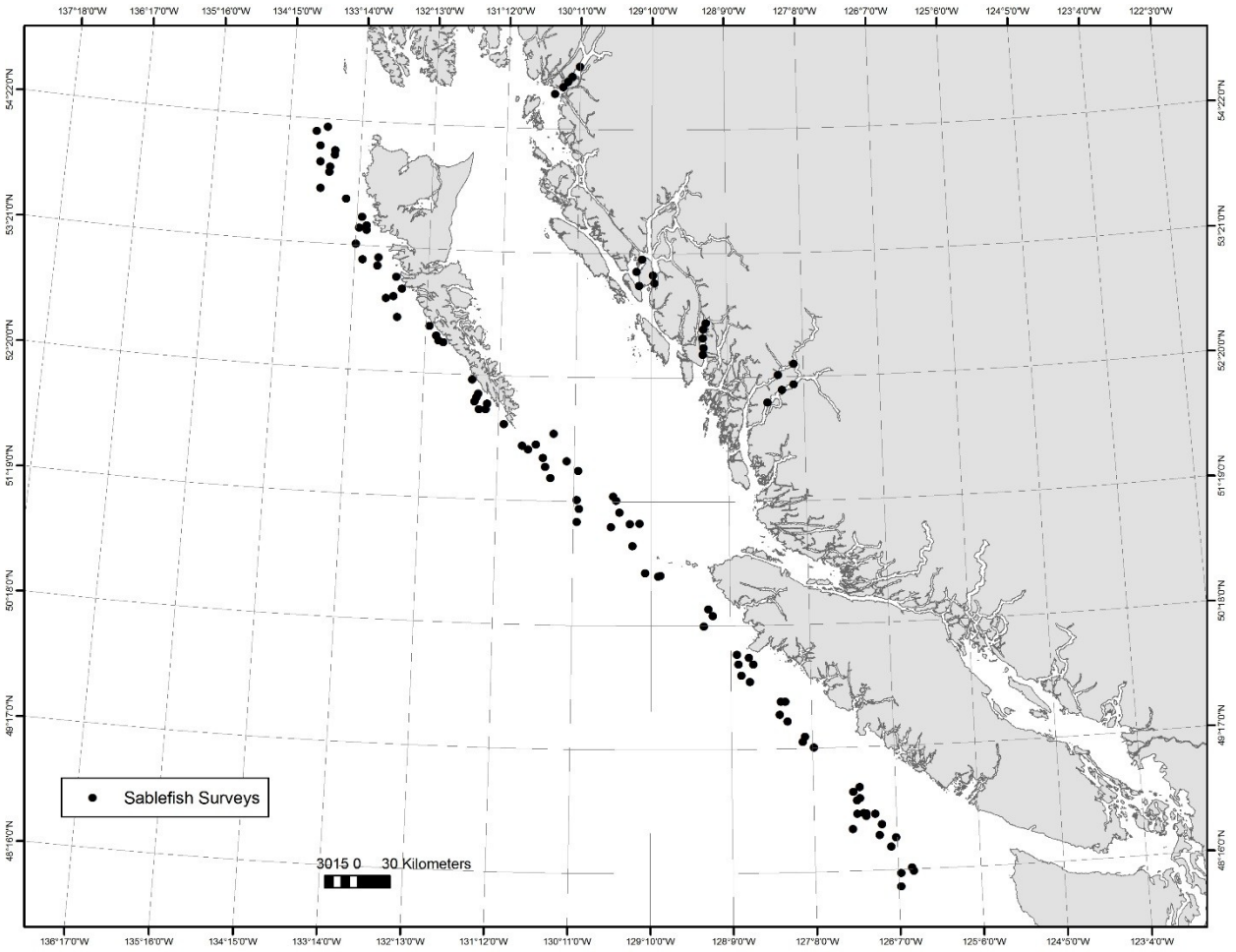


Figure 8. Set locations of the 2018 Sablefish Research and Assessment Survey.

Table 14. Total catch for the top 35 species (by weight) captured during the 2018 Sablefish Research and Assessment Survey.

Species	Scientific Name	Total Catch (count)	Total Catch (kg)
Sablefish	*Anoplopoma fimbria*	58415	119154
Pacific Halibut	*Hippoglossus stenolepis*	387	2986
North Pacific Spiny Dogfish	*Squalus suckleyi*	964	2973
Lingcod	*Ophiodon elongatus*	192	1912
Yelloweye Rockfish	*Sebastes ruberrimus*	311	1157
Arrowtooth Flounder	*Atheresthes stomias*	354	711
Redbanded Rockfish	*Sebastes babcocki*	219	389
Giant Grenadier	*Albatrossia pectoralis*	106	376
Rougheye/Blackspotted Rockfish complex	*Sebastes aleutianus/melanostictus* complex	180	346
Pacific Grenadier	*Coryphaenoides acrolepis*	346	331
Grooved Tanner Crab	*Chionoecetes tanneri*	342	118
Shortraker Rockfish	*Sebastes borealis*	25	86
Shortspine Thornyhead	*Sebastolobus alascanus*	51	62
Canary Rockfish	*Sebastes pinniger*	7	17
	Lithodes couesi	27	13
Pacific Cod	*Gadus macrocephalus*	3	11
Pink Snailfish	*Paraliparis rosaceus*	26	10
	Paralomis multispina	25	9
Pacific Flatnose	*Antimora microlepis*	7	8
Dover Sole	*Microstomus pacificus*	8	8
Fragile Urchin	*Allocentrotus fragilis*	58	8
Brown Box Crab	*Lopholithodes foraminatus*	5	4
Oregontriton	*Fusitriton oregonensis*	109	3
	Neptuneidae	58	2
Rosethorn Rockfish	*Sebastes helvomaculatus*	5	1
Silvergray Rockfish	*Sebastes brevispinis*	1	1

Aurora Rockfish	*Sebastes aurora*	2	1
Fish-eating Star	*Stylasterias forreri*	7	1
Black Hagfish	*Eptatretus deani*	3	1
Golden King Crab	*Lithodes aequispinus*	1	1
Spotted Ratfish	*Hydrolagus colliei*	1	0
	Neptunea	40	0
Pacific Ocean Perch	*Sebastes alutus*	1	0
Sharpchin Rockfish	*Sebastes zacentrus*	2	0
Rockfishes	*Sebastes*	1	0

Table 15. Number of sets where the species was captured, total catch count, proportion of the total catch, and a breakdown by area for the 25 most abundant species (by weight) captured during the 2018 Sablefish Research and Assessment Survey Randomized Tagging Program sets.

Species	Scientific Name	Number of Sets	Catch (count)	Proportion of Total Catch (%)	4B	3C	3D	5A	5B	5C	5D	5E
Sablefish	*Anoplopoma fimbria*	110	58415	94.80	0	11591	7680	3946	7764	6407	3616	17411
North Pacific Spiny Dogfish	*Squalus suckleyi*	33	964	1.56	0	44	156	171	140	0	0	453
Pacific Halibut	*Hippoglossus stenolepis*	49	387	0.63	0	21	120	46	31	15	44	110
Arrowtooth Flounder	*Atheresthes stomias*	46	354	0.57	0	130	15	32	44	9	1	123
Pacific Grenadier	*Coryphaenoides acrolepis*	17	346	0.56	0	19	48	0	163	0	0	116
Yelloweye Rockfish	*Sebastes ruberrimus*	12	311	0.50	0	3	3	27	126	0	0	152
Redbanded Rockfish	*Sebastes babcocki*	29	219	0.36	0	16	23	53	52	0	0	75
Lingcod	*Ophiodon elongatus*	25	192	0.31	0	1	80	22	27	0	0	62
Rougheye/Blackspotted Rockfish complex	*Sebastes aleutianus/ melanostictus* complex	19	180	0.29	0	16	1	30	4	0	3	126
Giant Grenadier	*Albatrossia pectoralis*	27	106	0.17	0	20	23	3	16	0	0	44
Shortspine Thornyhead	*Sebastolobus alascanus*	34	51	0.08	0	8	17	5	5	0	1	15
Pink Snailfish	*Paraliparis rosaceus*	7	26	0.04	0	7	13	1	5	0	0	0
Shortraker Rockfish	*Sebastes borealis*	12	25	0.04	0	1	7	8	5	1	0	3
Dover Sole	*Microstomus pacificus*	8	8	0.01	0	4	0	2	0	0	0	2
Canary Rockfish	*Sebastes pinniger*	2	7	0.01	0	1	6	0	0	0	0	0
Pacific Flatnose	*Antimora microlepis*	4	7	0.01	0	2	0	0	1	0	0	4

Rosethorn Rockfish	*Sebastes helvomaculatus*	4	5	0.01	0	0	0	2	2	0	0	1
Pacific Cod	*Gadus macrocephalus*	3	3	0.00	0	1	1	0	0	0	0	1
Black Hagfish	*Eptatretus deani*	2	3	0.00	0	0	0	0	3	0	0	0
Longspine Thornyhead	*Sebastolobus altivelis*	2	2	0.00	0	0	1	0	0	0	0	1
Aurora Rockfish	*Sebastes aurora*	2	2	0.00	0	0	1	0	0	0	1	0
Sharpchin Rockfish	*Sebastes zacentrus*	1	2	0.00	0	0	0	0	2	0	0	0
Spotted Ratfish	*Hydrolagus colliei*	1	1	0.00	0	0	1	0	0	0	0	0
Silvergray Rockfish	*Sebastes brevispinis*	1	1	0.00	0	0	0	0	1	0	0	0
Pacific Ocean Perch	*Sebastes alutus*	1	1	0.00	0	0	0	0	1	0	0	0

Table 16. Annual summary of the total catch (piece count) for the top 10 species (by total piece count over all years) for the Sablefish Research and Assessment Survey Randomized Tagging Program sets. Data from 2003 and 2004 have been omitted from this table.

Species	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Total
Sablefish	17730	24105	18833	20326	15529	17375	22568	16845	18095	14266	25428	18073	36604	46808	350988
Arrowtooth Flounder	598	763	1655	1163	1787	553	1037	921	414	864	610	427	686	336	12831
Pacific Grenadier	399	313	880	608	829	676	742	715	254	534	686	627	276	346	8867
North Pacific Spiny Dogfish	465	317	437	162	565	414	868	966	386	287	365	699	158	964	8385
Rougheye/ Blackspotted Rockfish complex	166	355	558	513	418	406	266	941	223	488	320	386	257	177	6059
Pacific Halibut	114	163	185	125	224	172	256	342	99	447	444	283	165	323	3489
Redbanded Rockfish	113	93	154	257	150	131	244	208	127	241	295	217	287	219	2948
Lingcod	128	108	201	109	93	97	165	71	88	92	121	154	106	192	1890
Giant Grenadier	97	67	162	146	179	118	105	195	80	87	206	72	67	106	1848
Yelloweye Rockfish	33	22	71	58	60	21	106	34	13	17	81	97	22	311	1005

Table 17. Annual summary of the total catch (piece count) for the top 10 species (by total piece count over all years) for the Sablefish Research and Assessment Survey Inlet Program sets. Data from 2003 and 2004 have been omitted from this table.

Species	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Total
Sablefish	7066	5062	3453	2498	4339	7507	11034	6213	3271	3341	2708	5050	8110	11607	101156
Pacific Halibut	72	104	111	99	78	109	108	113	88	265	333	243	90	64	1979
Arrowtooth Flounder	23	46	101	108	49	25	11	20	11	49	30	24	14	18	553
North Pacific Spiny Dogfish	6	6	8	1	2	15	18	12	4	5	44	14	1	0	142
Dover Sole	4	4	4	23	1	0	0	1	2	5	1	1	2	0	49
Walleye Pollock	7	1	6	3	3	3	3	4	1	4	2	2	1	0	42
Pacific Sleeper Shark	1	5	5	4	2	0	1	0	0	2	0	2	0	0	29
Shortraker Rockfish	0	4	4	5	4	1	3	2	0	0	3	0	0	1	27
Pacific Cod	0	0	0	8	1	5	0	1	1	2	1	0	1	0	20
Rougheye/Blackspotted Rockfish complex	0	1	2	1	1	1	0	2	0	2	0	1	1	3	17

Table 18. Number of fish sampled for biological data during the 2018 Sablefish Research and Assessment Survey showing the number of tag releases, lengths, age structures, and DNA tissue samples that were collected by species.

Species	Scientific Name	Tags	Lengths Collected	Age Structures Collected	DNA Tissue Collected
Pacific Halibut	*Hippoglossus stenolepis*	0	325	0	0
Rougheye/Blackspotted Rockfish complex	*Sebastes aleutianus/melanostictus* complex	0	147	147	147

Sablefish	*Anoplopoma fimbria*	10965	16706	5492	0
Shortraker Rockfish	*Sebastes borealis*	0	25	25	0
Yelloweye Rockfish	*Sebastes ruberrimus*	0	150	144	102

Table 19. Annual summary of the number of common fish species sampled for biological data during the Sablefish Research and Assessment Survey Randomized Tagging Program sets. Data from 2003 and 2004 have been omitted from this table.

Species	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Total
Sablefish	8999	12210	10385	11059	9331	10270	12463	10486	10118	8204	12094	9910	15841	13094	184318
Rougheye/ Blackspotted Rockfish complex	0	56	0	282	289	266	240	393	179	373	270	270	183	144	2945
Pacific Grenadier	0	0	0	461	562	378	471	380	188	0	0	0	0	0	2440
Arrowtooth Flounder	0	0	0	441	379	245	400	656	140	0	0	0	0	0	2261
North Pacific Spiny Dogfish	0	0	0	0	219	326	440	674	207	0	0	0	0	0	1866
Redbanded Rockfish	0	0	0	224	145	131	243	204	113	0	0	0	29	0	1089
Giant Grenadier	0	0	0	129	141	111	99	195	79	0	0	0	0	0	754
Yelloweye Rockfish	0	0	0	55	60	21	106	32	12	0	75	58	21	150	590
Pacific Halibut	0	0	0	0	2	60	5	15	0	0	0	0	158	261	501
Shortraker Rockfish	0	0	0	53	65	73	18	59	18	13	10	59	26	24	426
Pacific Flatnose	0	0	0	18	39	27	17	24	11	0	0	10	0	0	146
Shortspine Thornyhead	0	0	0	1	9	26	22	53	34	0	0	0	0	0	145
Lingcod	0	0	0	0	27	36	1	3	1	0	0	0	0	0	68
Rosethorn Rockfish	0	0	0	8	6	2	23	7	3	0	0	0	0	0	49
Dover Sole	0	0	0	3	1	3	13	18	3	0	0	0	0	0	41

Pink Snailfish	0	0	0	30	0	0	1	0	0	0	0	0	0	0	31

Table 20. Annual summary of the number of common fish species sampled for biological data during the Sablefish Research and Assessment Survey Randomized Inlet Program sets. Data from 2003 and 2004 have been omitted from this table.

Species	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Total
Sablefish	4394	3506	2554	1993	3070	5064	5984	3900	2503	2379	2234	3272	4693	3582	60647
Pacific Halibut	0	0	0	0	0	0	0	4	0	0	0	0	90	63	157
North Pacific Spiny Dogfish	6	0	0	0	0	0	8	11	0	0	0	0	0	0	25
Arrowtooth Flounder	0	0	0	0	0	0	3	18	0	0	0	0	0	0	21
Shortraker Rockfish	0	0	0	0	3	1	2	2	0	0	3	0	0	1	12
Rougheye/Blackspotted Rockfish complex	0	0	0	0	0	1	0	2	0	2	0	1	1	3	10
Walleye Pollock	7	0	0	0	0	0	1	1	0	0	0	0	0	0	9

Multi-species Small-mesh Bottom Trawl Survey

An annual fixed-station survey of commercially important shrimp grounds off the West Coast of Vancouver Island was initiated in 1973. In 1998, areas in Eastern Queen Charlotte Sound were added to the survey. Given that the survey is conducted using a shrimp bottom trawl without an excluder device, groundfish can make up a significant portion of the catch in many of the tows. Catch rate indices generated by the survey have been used to track the abundances of several groundfish stocks. Although catch rates are useful indicators of stock status, additional information such as the size and age composition of the catch improves the usefulness of the indices. Consequently, a program was initiated in 2003 to collect biological samples from all groundfish species caught during the survey. Groundfish staff provide assistance in catch sorting and species identification and also collect biological samples from selected fish species. From 2010 through 2013, the goal was to collect biological information from as many different species in each tow as possible - as opposed to detailed information from only a few species. As such, two groundfish program staff members were deployed and the biological sampling effort was focused on length by sex data in favour of collecting ageing structures. Starting in 2014, only one groundfish staff member participated in the survey and the biological sampling program was reduced so that a single person could accomplish all the work. In addition, the sampling program was rationalized to only include species where the survey is expected to provide a useful index of abundance.

Starting in 2013, the West Coast Vancouver Island portion of the survey also included locations in Barkley Sound that were surveyed by the Canadian Coast Guard Ship Neocaligus in previous years. In 2014, the Queen Charlotte Sound portion of the survey was not conducted due to the limited number of vessel days available for the program. The Queen Charlotte Sound area was also not visited in 2015, 2017, and 2018 due to staffing limitations.

The 2018 survey was conducted onboard the F/V Nordic Pearl and ran from May 2 to May 17. A total of 126 tows were completed, of which 122 were usable (Figure 9). Tows were determined to be unusable if there was insufficient bottom contact time or if the gear was damaged. The total catch weight of all species was 50,850 kg. The mean catch per tow was 416 kg, averaging 39 different species of fish and invertebrates in each. Over all tows over the entire survey, the most abundant fish species encountered were Rex Sole (Glyptocephalus zachirus), Dover Sole (Microstomus pacificus), Flathead Sole (Hippoglossoides elassodon), Slender Sole (Lyopsetta exilis), Spotted Ratfish (Hydrolagus colliei), and Pacific Hake (Merluccius

productus). The number of tows where the species was captured, total catch weight from successful tows, estimated biomass, and relative survey error for the top 25 fish species by weight are shown in Table 21 for the West Coast Vancouver Island tow locations. Biomass indices have not been calculated for the Barkley Sound tow locations as these locations have not yet been used for any groundfish assessments.

Biological data were collected from a total of 10,377 individual fish from 17 different species (Table 22). Most biological samples included fish length and sex but age structures were also collected for Bocaccio (Sebastes paucispsinis) and Lingcod (Ophiodon elongatus) and both age structures and tissue samples for DNA analysis were collected from Rougheye/ Blackspotted Rockfish (Sebastes aleutianus/ melanostictus) and Yelloweye Rockfish (Sebastes ruberrimus). Almost half of all the individual fish measured during the survey were Eulachon (Thaleichthys pacificus). Although we include this species in these summaries, the groundfish program staff typically does not directly collect the biological data from this species or American Shad (Alosa sapidissima).

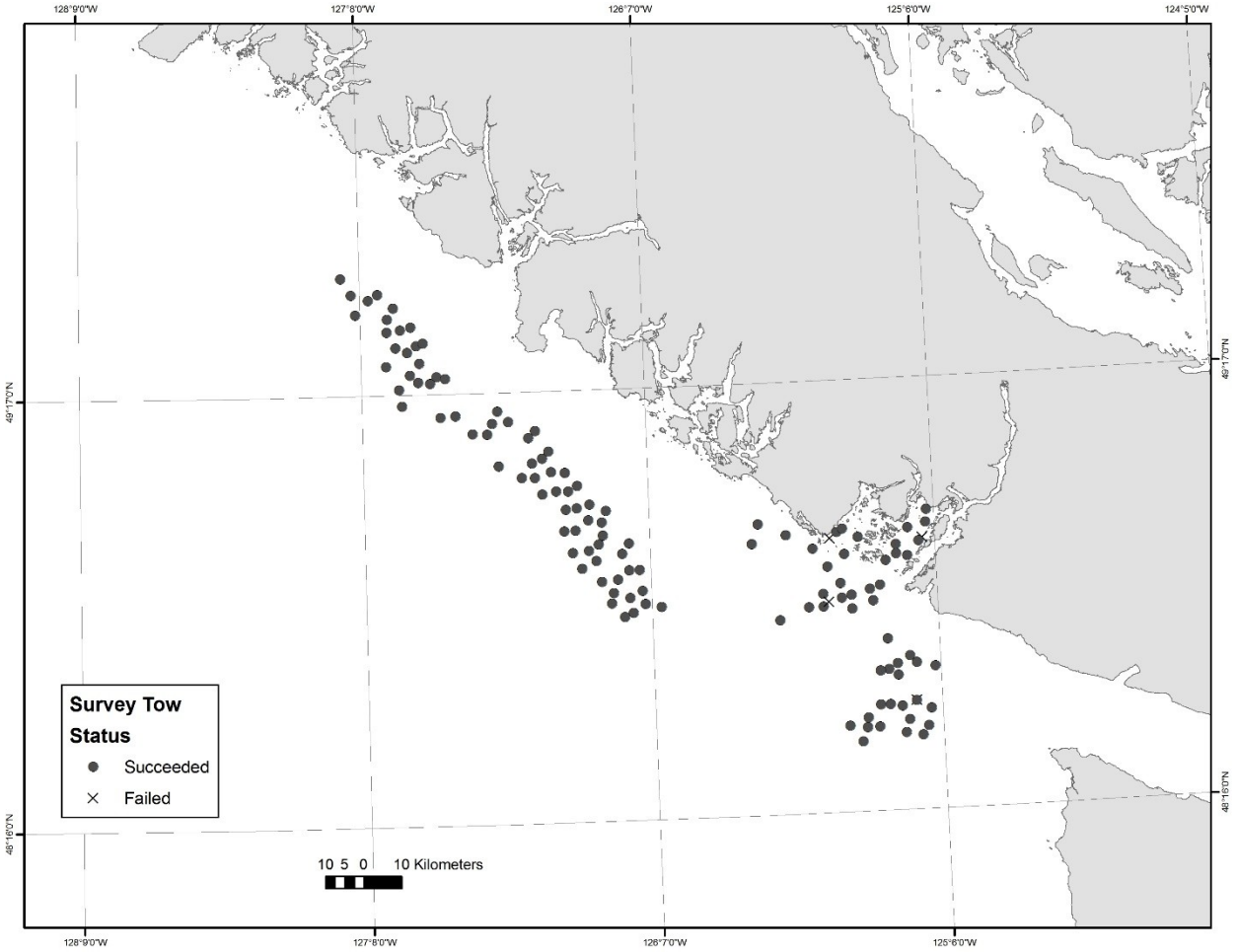


Figure 9. Tow locations of the 2018 Multi-species Small-mesh Bottom Trawl Survey.

Table 21. Number of tows, catch weight from successful tows, estimated biomass, and relative survey error for the top 25 species (by weight) captured in the West Coast Vancouver Island tow locations of the 2018 Multi-species Small-mesh Bottom Trawl Survey.

Species	Scientific Name	Number of Tows	Catch (kg)	Biomass (t)	Relative Error
Rex Sole	*Glyptocephalus zachirus*	72	4635	3864	0.05
Dover Sole	*Microstomus pacificus*	71	4427	3759	0.09
Flathead Sole	*Hippoglossoides elassodon*	71	2733	2500	0.16
Pacific Hake	*Merluccius productus*	61	2158	1676	0.24
Slender Sole	*Lyopsetta exilis*	71	1946	1694	0.1
Pacific Sanddab	*Citharichthys sordidus*	46	980	788	0.19
Arrowtooth Flounder	*Atheresthes stomias*	69	908	819	0.15
Spotted Ratfish	*Hydrolagus colliei*	69	749	604	0.12
English Sole	*Parophrys vetulus*	65	632	518	0.17
Sablefish	*Anoplopoma fimbria*	69	561	468	0.39
North Pacific Spiny Dogfish	*Squalus suckleyi*	39	497	370	0.2
Pacific Cod	*Gadus macrocephalus*	39	452	391	0.24
Longnose Skate	*Raja rhina*	69	440	354	0.08
Petrale Sole	*Eopsetta jordani*	60	439	380	0.14
Greenstriped Rockfish	*Sebastes elongatus*	62	281	221	0.19
Lingcod	*Ophiodon elongatus*	49	262	220	0.15
Yellowtail Rockfish	*Sebastes flavidus*	35	241	212	0.25
Walleye Pollock	*Gadus chalcogrammus*	61	220	179	0.17
Eulachon	*Thaleichthys pacificus*	61	146	123	0.16
Pacific Halibut	*Hippoglossus stenolepis*	27	143	124	0.19
Darkblotched Rockfish	*Sebastes crameri*	56	124	100	0.19
Blackbelly Eelpout	*Lycodes pacificus*	62	117	96	0.13
Pacific Ocean Perch	*Sebastes alutus*	15	102	70	0.9
Big Skate	*Beringraja binoculata*	11	78	61	0.37

Pacific Herring	*Clupea pallasii*	38	68	69	0.77

Table 22. Number of fish sampled for biological data during the 2018 Multi-species Small-mesh Bottom Trawl Survey showing the number of lengths and age structures that were collected by species.

Species	Scientific Name	Lengths Collected	Age Structures Collected	DNA Tissue Collected
American Shad	*Alosa sapidissima*	78	0	0
Arrowtooth Flounder	*Atheresthes stomias*	195	0	0
Big Skate	*Beringraja binoculata*	55	0	0
Bocaccio	*Sebastes paucispinis*	35	35	0
Dover Sole	*Microstomus pacificus*	1167	0	0
English Sole	*Parophrys vetulus*	377	0	0
Eulachon	*Thaleichthys pacificus*	4680	0	424
Lingcod	*Ophiodon elongatus*	170	127	0
Longnose Skate	*Raja rhina*	870	0	0
Pacific Cod	*Gadus macrocephalus*	80	0	0
Pacific Halibut	*Hippoglossus stenolepis*	40	0	0
Petrale Sole	*Eopsetta jordani*	359	0	0
Rex Sole	*Glyptocephalus zachirus*	1467	0	0
Rougheye/Blackspotted Rockfish complex	*Sebastes aleutianus/melanostictus complex*	42	42	42
Sablefish	*Anoplopoma fimbria*	134	0	0
Sandpaper Skate	*Bathyraja interrupta*	99	0	0
Walleye Pollock	*Gadus chalcogrammus*	529	0	0

International Pacific Halibut Commission Fishery-independent Setline Survey

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

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

At the time of writing, the 2018 IPHC survey data are not yet finalized and so have not been included in this report.