

CANADA

British Columbia Groundfish Fisheries and Their Investigations in 2014

April 2015

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REVIEW OF AGENCY GROUND FISH RESEARCH, STOCK ASSESSMENT, AND MANAGEMENT

A. 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 new 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. Miriam O (Acting)
Salmon & Freshwater Ecosystems	Mr. Mark Saunders
Marine Ecosystems & Aquaculture	Dr. Laura Brown

Section Heads within the Marine Ecosystems & Aquaculture Division (MEAD) are:

Groundfish	Mr. Greg Workman
Invertebrates	Mr. Dennis Rutherford (Acting)
Pelagic Fish Research & Conservation Biology	Dr. Nathan Taylor (Acting)
Applied Technologies	Mr. Henrik Kriebert
Aquaculture and Environmental Research	Dr. Steven MacDonald

Groundfish research and stock assessments are conducted in the Groundfish Section. Groundfish specimen ageing and hydroacoustic work are conducted in the Applied Technologies Section. The Canadian Coast Guard operates DFO research vessels. These research vessels include the *W.E. Ricker*, *J.P. Tully*, *Vector*, and *Neocaligus*. A replacement vessel for the *W.E. Ricker* has been delayed until 2016 or beyond.

The Pacific Region Headquarters (RHQ) of Fisheries and Oceans Canada is located at 401 Burrard Street, in Vancouver, BC, V6C 3S4. Management of groundfish resources is the responsibility of the Pacific Region Groundfish Regional Manager (Mr. Neil Davis, Acting) within the Fisheries and Aquaculture Management Branch (FAM). Fishery Managers receive assessment advice from MEAD through the Canadian Centre for Scientific Advice Pacific (CSAP) review committee which is headed by Mrs. Marilyn Hargreaves. The Groundfish Section has at least two review meetings per year, in which stock assessments or other documents undergo 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 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 2015 Groundfish Integrated Fisheries Management Plan can be viewed at <http://www.pac.dfo-mpo.gc.ca/fm-gp/ifmp-eng.htm#Groundfish>.

A shift in the funding of industry collaborations, particularly in conducting cooperative surveys, was required after the *Larocque* court decision of June 23, 2006. Prior to the *Larocque* decision, compensation provided to fishers for their data collection services took the form of the proceeds of the unavoidable fish kills in the research surveys, less any samples retained for detailed scientific analysis. In instances where these proceeds did not cover the cost of the research survey, the department allowed fishers to catch additional fish for payment purposes. Post-*Larocque* these “top up” payments for fishing activities were no longer possible. Larocque Relief Funding, to replace fish allocations, was provided in 2007 and continued to fund surveys through March 2013. Recent legislative changes grant the Minister of Fisheries and Oceans the authority to allocate fish or fishing gear for the purpose of financing scientific and fisheries management activities that are described in a joint project agreement entered into with any person or body, or any federal or provincial minister, department, or agency. Some of the Larocque Relief funded projects transitioned to the new Fisheries Act provisions for the 2013-14 fiscal year, where stakeholders were willing.

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 2014-15 between Fisheries and Oceans Canada and several partner organisations to support groundfish science activities through the allocation of fish to finance the activities. These JPAs will be updated for 2015-16.

B. Multispecies or ecosystem models and research

1. Development of a tiered approach to the provision of harvest advice for B.C.’s groundfish.

Many species of groundfish in B.C. are data deficient where 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. A tiering framework would define guidelines for assessing the adequacy of data for stock assessment and recommend assessment approaches for species with limited information. Similar frameworks have been developed for Alaskan, Australian, and European fisheries.

2. Implementing Ecosystem Approaches to Management in the Pacific Groundfish Stock Assessment Process Post-Doctoral Research Fellow Dr. Jean-Baptiste Lecomte

In 2011, the DFO Sustainable Aquatic Ecosystems Strategic Outcome Committee identified the need for a DFO National policy regarding Ecosystem Approach to Management (EAM). This

project first investigates mechanistic ecosystem processes (ecosystem considerations) and their use in the provision of science advice for Pacific groundfish. Secondly, it will provide recommendations to groundfish science on how its operational advice can be best structured within a regional EAM framework.

During the past year, a Bayesian approach aimed at identifying relationships between climatic and environmental variables and the productivity of Pacific groundfish species has been developed. This approach accounts for all uncertainties in productivity estimates provided by age-structured or surplus production Bayesian models already used for science advice. This method allows drawing mechanistic ecosystem processes that affect groundfish species. In particular, this approach was applied to the Pacific Ocean Perch (*Sebastes alutus*, POP) stock in the Queen Charlotte Sound (BC, Canada). POP recruitment estimates, number of age 1 fish, are provided by a Bayesian catch at age model used for the stock assessment of this species for the period 1940 to 2010, and are used to identify relationships between environment and POP productivity. Key climatic and environmental variables (i.e. PDO, NPGO, Sea level at Prince Rupert) impacting POP recruitment were identified and illustrated a conceptual mechanism of the ecosystem processes that affect POP productivity.

The next step of this project is to build a decision-based framework with a priori rules and harvest strategies incorporating the mechanistic ecosystem processes previously identified. The objective is to have a suite of harvest strategies that can accommodate multiple states of productivity and uncertainty inherent in ecosystems, monitoring and assessment modelling.

3. Summary of research surveys in 2014

A number of multi-species trawl surveys are conducted by the Groundfish Section and Groundfish staff participate in trawl surveys conducted by other groups. For a summary of research trawl survey activity in 2014, please see Appendix 2. Other research surveys conducted in 2014 include longline and trap surveys. These surveys are described under their respective species programs below.

C. By species

1. Pacific Cod

i. Research program in 2014

Statistical analyses were developed in 2014 to investigate alternative drivers of productivity and abundance of Pacific Cod (*Gadus macrocephalus*) in British Columbia. Simulation models and linear regression analyses were used to evaluate fishing, climate drivers and density-dependent mortality as possible contributors to large apparent cycles in recruitment and abundance of Pacific Cod since the 1950s. Unfortunately, the work was mostly inconclusive. Estimates of recruitment from the 2013 stock assessment were highly uncertain and confounded with large changes in fishery practices. Length data proved inadequate for estimation of recruitment, due to uncertainty in selectivity and inconsistencies in the sampling program throughout the time series. Previously-identified correlates with recruitment (e.g., Prince Rupert sea level) were no longer

significantly related to recruitment. Feedback simulation modelling was used to search for management procedures that are robust to uncertainty in underlying drivers of abundance and productivity, including performance of alternative fishery reference points. Results of this work were presented at several meetings, including the 2014 PICES Annual Meeting in Yeosu, South Korea, and the Western Groundfish Conference in Victoria, BC. Results of the feedback modelling component are currently being developed into a primary paper.

Genetic tissue was collected during 2014 Synoptic Surveys in the Strait of Georgia and the West Coast of Vancouver Island. Genetic samples were also collected by a commercial vessel during the 2015 spring spawning season. These samples are intended to be used in studies on stock structure in British Columbia. In addition, otoliths were collected, along with dorsal fins during the 2014 synoptic surveys. Pacific Cod are notoriously difficult to age, especially in British Columbia, and are currently aged using dorsal fin rays. The otoliths will be used in a new age-validation project due to begin in 2015, in collaboration with the PBS Sclerochronology Laboratory.

ii. Stock Assessments

A stock assessment for Areas 5CD (Hecate Strait) and 5AB (Queen Charlotte Sound) was reviewed in January 2014. The stock assessment applied a Bayesian delay-difference model to catch, survey and biological data from 1956-2013. Following the discovery of some problems in the data used to calculate mean weight in the commercial fishery in Area 5AB, this portion of the stock assessment was re-done and reviewed in December 2014. For both areas, there was large uncertainty in the estimates of natural mortality, and consequently in estimates of fishery reference points and stock status, especially for Area 5AB. Alternative reference points based on estimated historical biomass and fishing mortality were used as an alternative to MSY-based reference points. Performance of alternative reference points was evaluated using feedback simulation modelling.

2. Rockfish – inshore

i. Research programs in 2014 and planned for 2015

1. Surveys on the Inside (PMFC Area 4B)

A research longline survey was designed and initiated in 2003 to survey hard bottom (non-trawlable) areas over the Inside waters east of Vancouver Island. Hard bottom areas were identified through bathymetric analyses, inshore rockfish fishing records, and fishermen consultations. The hard bottom areas were then overlain with a 2 km by 2 km grid and survey blocks were stratified by area and depth (41 – 70 m and 71 – 100 m) and selected for sampling at random. The Inside waters are divided into two regions; Northern and Southern and one region is surveyed in each year. Twenty-one days of DFO ship time are allocated in August for this longline survey. In 2014, the Northern region was surveyed, hence, in 2015 the Southern region is planned for a survey.

2. Surveys on the Outside (PMFC Areas 3CD, 5ABCDE)

Since 2003, the International Pacific Halibut Commission (IPHC) has allowed a third technician onboard charter vessels during the Area 2B setline survey to collect hook-by-hook catch data and conduct biological sampling of non-Halibut catch (Yamanaka et al. 2011; Flemming et al. 2011). The third technician was supported by DFO and the Halibut and Sablefish commercial industry between 2003 and 2006 and Larocque funds between 2007 and 2012. A transition to other funding mechanisms was not completed in time for a survey program in 2013, however, a survey program was conducted under a “Use-of-Fish” policy and Joint Project Agreement (JPA) with the Pacific Halibut Management Association (PHMA) in 2014. This JPA is scheduled for renewal for 2015.

In collaboration with the PHMA, a research longline survey was designed and conducted in the outside BC coastal waters in 2006. Hard bottom areas were identified through bathymetric analyses, inshore rockfish fishing records, and fishermen consultations. The hard bottom survey areas were then overlain with a 2 km by 2 km grid (matched with the adjacent trawl survey grid) and survey blocks were stratified by area and depth and chosen at random. Approximately 200 survey sets are targeted annually. The survey covers the coastwide Outside waters over two years, alternating annually between the north and the south. Three chartered fishing vessels conduct this survey between August 15 and September 15. Similar to the IPHC survey, alternative funding was not secured for this program in 2013 but a survey program was conducted for the southern portion of BC in 2014 under a “Use-of-Fish” policy and JPA with the PHMA. This JPA is scheduled for renewal for 2015.

3. Assessment of Rockfish Conservation Areas (RCAs) using visual surveys.

Late in 2014, competitive funding was granted to continue the analysis of the visual data to assess inshore rockfishes within and adjacent to RCAs. Documentation of survey and video review methods is underway, as well as, the analysis of reef-fish species within and adjacent to RCAs.

ii. Stock assessment

There were no stock assessments prepared in 2014. An outside population stock assessment for Yelloweye Rockfish is underway with a proposed data review with industry in May and assessment review in September 2015.

iii. Management

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 2014. If listed as *threatened*, DFO must create recovery strategies and action plans within a year of listing.

Yelloweye Rockfish was listed as *Special Concern* under the SARA in 2011. DFO is developing a SARA management plan in 2015.

3. Rockfish – shelf

Research Programs in 2014

There was no directed biological research work on shelf rockfish in 2014 with the exceptions that (a) biological samples are routinely collected from the commercial trawl fishery and from the four multi-species synoptic bottom trawl surveys off the west coast of Vancouver Island, the west coast of Haida Gwaii, Queen Charlotte Sound, and Hecate Strait, and (b) genetic material is collected on all major groundfish surveys for species identification of the Rougheye Rockfish/Blackspotted Rockfish sibling species complex.

Stock assessments in 2014

In 2014, the first stock assessment of Yellowtail Rockfish (YT, *Sebastes flavidus*) in BC waters since 1998 was conducted (DFO 2015). This work was completed in collaboration with an analyst from the Canadian Groundfish Research and Conservation Society. The primary challenge to the assessment of YT in both Canadian and US waters is the lack of reliable indices of stock abundance. This species usually resides near the bottom but is often found in the water column and, therefore, may not be reliably represented in the various bottom trawl surveys conducted coastwide. Survey sampling error for relative biomass estimates is typically large, with coefficients of variation often exceeding 50% and reaching as high as 90%. Alternative survey gears (e.g., longline hook and trap) are inefficient for catching YT, and there is no available midwater trawl survey or time-series derived from acoustic measurements suitable for indexing the abundance of this species.

An annual, two-sex statistical catch-at-age (SCA) model was applied to (i) reconstructed catches starting in 1940, (ii) fishery-independent indices of relative biomass derived from six bottom trawl surveys spanning 48 years from 1967 to 2014, and (iii) proportion-at-age data from commercial and survey sources spanning 34 years from 1980 to 2013. A Bayesian approach was used to allow the modelled uncertainty to be characterized by a Markov Chain Monte Carlo (MCMC) approximation to the posterior probability distribution of leading and derived model parameters. The leading parameters estimated by the model include stock-recruitment parameters, natural mortality (independently for females and males), catchability coefficients for the six survey series, and sex-specific selectivity parameters for the commercial fishery data and for the three survey series for which age data are available. Fixed inputs to the model include growth and maturity information and the selectivity parameters for the remaining three survey series.

Estimates of the leading model parameters were used to reconstruct derived quantities annually from 1940 to 2014, including the vulnerable biomass (the biomass that is vulnerable to capture by the fishery), the spawning stock biomass (mature females only), the mid-year exploitation rate, and the population age structure. Reference points related to the unfished equilibrium biomass, current stock biomass, minimum stock biomass and the biomass at maximum sustainable yield (MSY) were used to evaluate current and future stock status. Forecasts from 2016 to 2025 (10 years) were performed for a fixed range of constant annual catches to estimate the probabilities that the spawning biomass will exceed the reference points in each future year. The uncertainty associated with parameter estimates and forecast performance was calculated using 1000 draws from five million MCMC samples from the Bayes posterior probability distribution, and presented as the median and a 90% credible interval (i.e., the 5th, 50th and 95th percentiles).

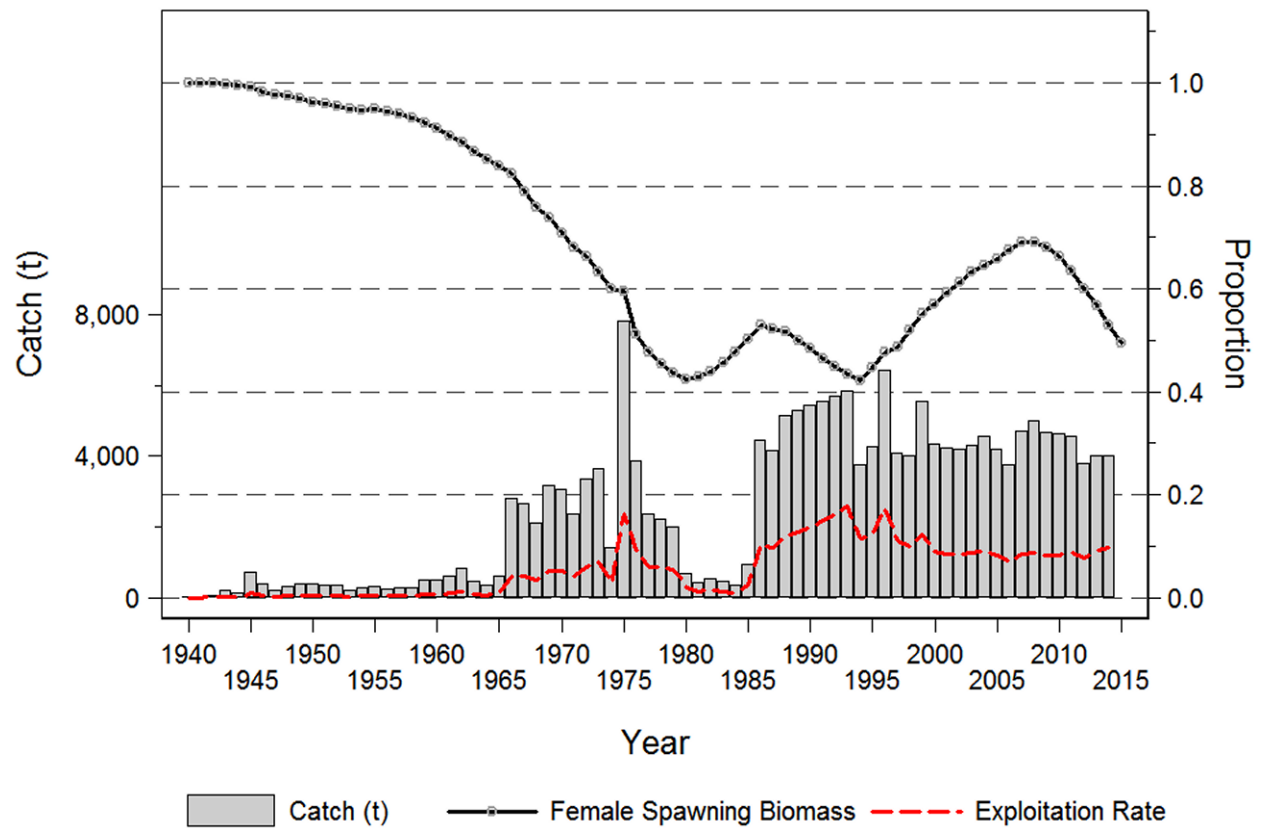


Figure 1. Annual commercial catch (tonnes, vertical bars scaled to left-hand axis) and median estimates for B_t/B_0 (female spawning biomass in year t relative to that in 1940) and exploitation rate u_t (ratio of total annual catch to the vulnerable biomass in the middle of the year) scaled to the right-hand axis. These results are based on the reference case. Source: DFO 2015.

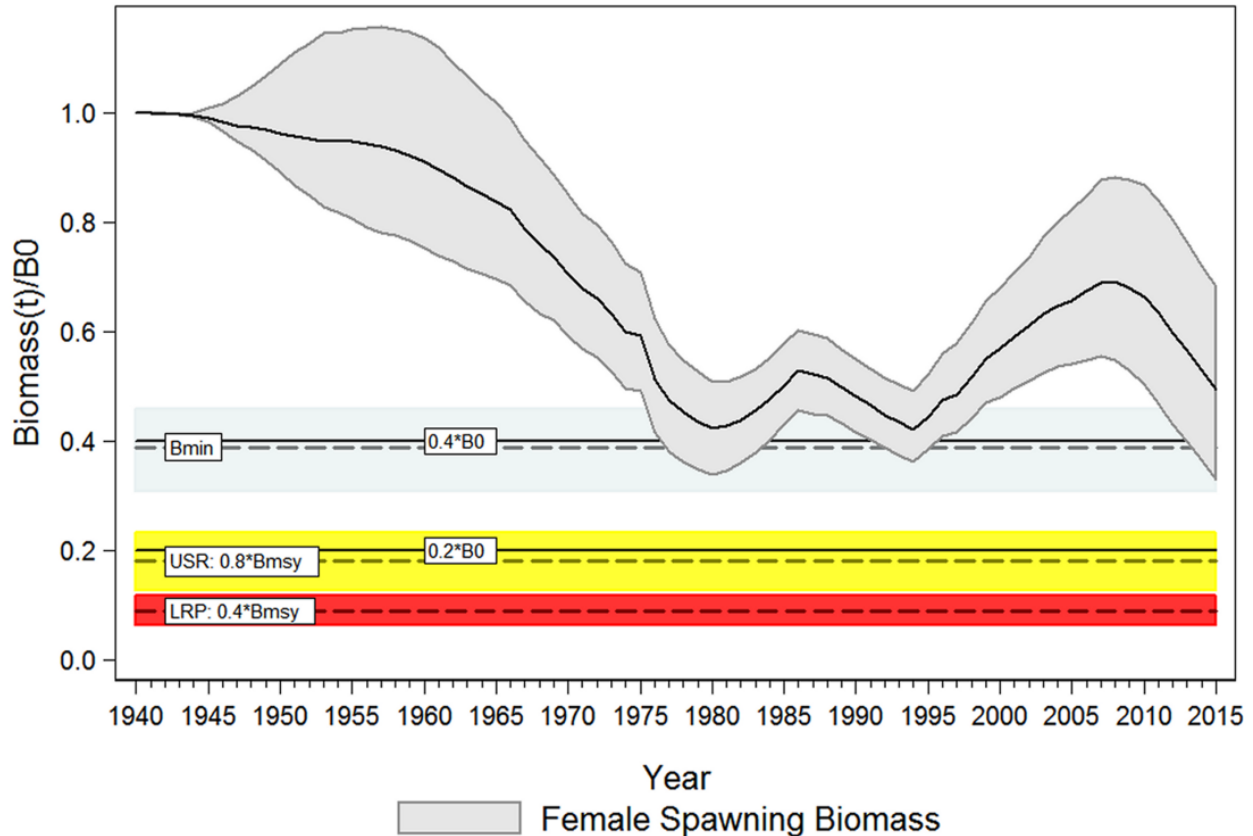


Figure 2. Posterior median estimates and 80% credibility intervals for female spawning biomass (B_t) by year relative to B_0 for Yellowtail Rockfish (grey envelope with black line median). Also shown relative to B_0 are posterior median estimates (dashed lines) and 80% credibility intervals for the MSY-based reference points (LRP: Limit Reference Point = $0.4B_{MSY}$ in red; USR: Upper Reference Point = $0.8B_{MSY}$ in yellow) and the minimum biomass reference point (B_{min}) from the MCMC posterior of B_t . The reference levels of $0.2B_0$ and $0.4B_0$ appear as solid black lines in B_0 space. Source: DFO (2015).

The interpretation of YT stock status that can be derived from the reference case (single gear, six groundfish bottom trawl survey indices) is of a population that has declined from a median spawning stock depletion of about 0.7 to about 0.49 of the unfished state over the last eight years, as a relatively strong 2001 year class is removed by fishing and natural mortality (emigration is not explicitly accounted for in the model and will appear as a higher natural mortality). Estimated spawning stock biomass remains above historical lows that occurred in 1980 and 1994, when the median depletion was below $0.4B_0$. Median exploitation rates have been near 0.1 since 1990, ending with $u_{2014}=0.10$ by the terminal year in the reconstruction. The population is forecast to decline modestly over the next 10 years at current harvest levels to a median depletion of about $0.4B_0$.

Research activities planned for 2015

DFO staff continues to collect genetic material from the Blackspotted and Rougheye Rockfish species complex. Tissue samples from these species are collected from all major surveys and analysed for species identification. Joint work is underway with colleagues from Simon Fraser

University to map the spatial distribution of the two species and identify scenarios for partitioning the historical catch, which was recorded simply as “Rougheye Rockfish”.

Stock assessments planned for 2015

No shelf rockfishes are scheduled for assessment in 2015.

References

DFO. 2015. Yellowtail Rockfish (*Sebastes flavidus*) Stock Assessment for the Coast of British Columbia, Canada. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2015/010.

4. Rockfish – slope

i. Research programs

The Slope Rockfish Program remains responsible for the assessment of rockfish species living on the marine continental slope of British Columbia (BC). The program 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, and scientific research in marine ecological modelling.

The Groundfish Section at the Pacific Biological Station (PBS, Nanaimo BC) conducts a suite of synoptic surveys that covers most of BC’s ocean bottom ecosystems, including those on the continental shelf and slope. The survey team gathers information on abundance and biology (lengths, weights, maturity, otoliths, etc.). The Slope Rockfish Program, headed by Andrew M. Edwards (PBS research scientist) and including Rowan Haigh (PBS research biologist), focuses on the development of models and software tools for the analysis of data pertaining to groundfish and other species. The program retains the interest of two scientists – Jon T. Schnute (PBS scientist emeritus) who contributes time and expertise; and Paul J. Starr who works for the Canadian Groundfish Research and Conservation Society and plays an integral role in the stock assessments assigned to our program.

Work was completed on the first phase of an International Governance Strategy (IGS) project entitled *Ocean Acidification and Impacts on Marine Ecosystems* headed by Debby Ianson at the Institute of Ocean Sciences (IOS, Sidney BC). The project explored the potential effects of ocean acidification on BC fisheries and temperate marine ecosystems. A manuscript was submitted to PLOS ONE on Jul 29, 2014. It was accepted on Dec 23, 2014 and the paper was published on Feb 11, 2015 ([Haigh et al. 2015](#)).

All PBS packages on CRAN were updated to comply with the ever-changing R environment – [PBSmapping](#) 2.68.68 published Jan 14, 2015; [PBSmodelling](#) 2.67.266 published Jan 23, 2015; [PBSddesolve](#) 1.11.29 published Jun 16, 2014; [PBSadmb](#) 0.68.104 published Apr 9, 2014. The DFO packages not on CRAN were also maintained and rebuilt (see [PBS Software](#)). Additionally, collaboration started on a new package *PBSsatellite* initiated by Lyse Godbout from DFO’s

Salmon Assessment and Freshwater Ecosystems (SAFE) division and implemented by Nicholas Boers (MacEwan University, Edmonton AB).

Work started in collaboration with Jackie King (PBS) on a project called “Implementing Ecosystem-based Fisheries Management in the Groundfish Stock Assessment Process” funded by the Strategic Program for Ecosystem-Based Research and Advice (SPERA). The objectives are (i) to identify mechanisms linking climate-ocean variability to groundfish recruitment, and (ii) to construct and test the decision-based framework for commercially important groundfish species. A postdoctoral fellow, Jean-Baptiste Lecomte, was recruited from France to work on this (see above B. Multispecies or ecosystem models and research).

ii. Stock assessment

In 2014, our group presented an updated stock assessment (since 2006) for the Redbanded Rockfish (RBR, *Sebastes babcocki*) stock along the BC coast. There was an attempt to fit a statistical catch-age model (specifically Awatea, a version of Coleraine); however, the ageing data were sparse and inconsistent, and the model fits proved to be unstable. It became clear after some discussion with the Sclerochronology Laboratory that ageing RBR is difficult and that estimated ages are likely inaccurate and imprecise.

The RBR assessment team tried running Awatea without the age data, fitting only to the survey indices. Such a model run should behave similarly to a surplus production model, with the main difference being the formulation of the productivity assumptions. Unlike a surplus production model where productivity is embodied in a single estimable parameter, this model formulation fixed natural mortality, steepness of the stock-recruitment function and all the selectivity parameters using the means of the informed priors for these parameters. This model run was characterized by enormous uncertainty, particularly at the upper end of possible biomass levels, and would require considerable more work before being suitable for providing advice to management.

In the end, the RBR team fitted unweighted linear regressions to each survey series (each survey series independently). All of the fitted trends for all the surveys had $p > 0.05$. The smallest p-value was 0.06 for the IPHC survey (*Figure 1*). The 95% confidence intervals for the slopes all overlapped 0, except for the IPHC longline survey where the upper bound equaled 0. Thus, none of the fitted trends appeared to be significantly different to 0 (at the 0.05 level). By definition, this analysis ignored any structure in the series; for example, the IPHC survey (*Figure 1*) showed an increase in the late 1990s followed by a drop to a lower level.

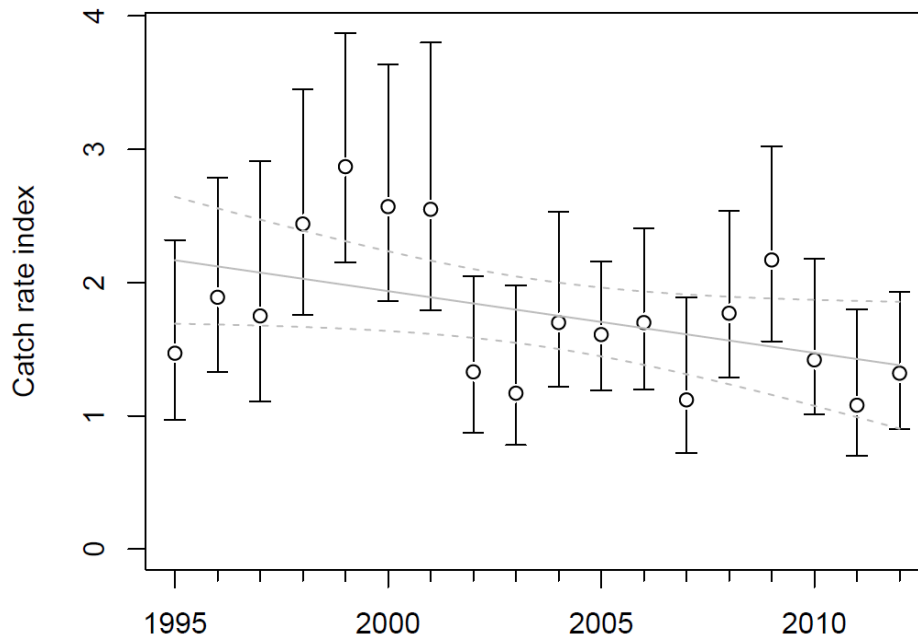


Figure 1. Relative catch rate index (numbers per effective skate) for the IPHC Longline series, shown as mean values (circles) and bootstrapped 95% confidence intervals (bars). Unweighted linear regression fit shown as solid lines (with 95% confidence intervals as dashed lines), but in light grey to indicate that the trend is not significantly different from 0 ($p=0.06$).

iii Research activities for 2015

Rowan will be chairing regional peer review meetings in May for stock assessments on Arrowtooth Flounder (*Atheresthes stomias*). The quality control work conducted on the IPHC longline survey data will be written up in more detail, and methods will be explored to properly consider the zero observations in such data.

Collaboration continues with Jackie King (PBS) and Jean-Baptiste Lecomte (postdoctoral fellow, PBS) on the aforementioned project “Implementing Ecosystem-based Fisheries Management in the Groundfish Stock Assessment Process” (see above B. Multispecies or ecosystem models and research).

Collaboration continues on a new R package, tentatively called *PBSsatellite*, which will provide support for reading and manipulating satellite data from NetCDF files. This project is lead by Lyse Godbout (DFO, SAFE) and incorporates the technical expertise of Dr. Nicholas Boers (MacEwan University) and student(s). In 2015, this project hopes to build on the capabilities of *PBSsatellite* to develop applications that will use satellite data (e.g., chlorophyll, temperature) to facilitate or complement fisheries stock assessments.

Work continues with international colleagues on developing methods for calculation biomass size spectra, with a view to applying them in future to data on the groundfish community.

5. Sablefish

i. Research activities in 2014 and planned for 2015

The Sablefish Research and Assessment Survey Program includes the following program components:

a) A **Traditional Standardized Program** (1990-2010)

This program was not conducted in 2011-2014 and is unlikely to be resumed. This program included standardized sets at nine (9) offshore fishing localities and biological sampling. Starting in 1990, one set was made in each of five (5) depth intervals in each locality. Since 1999, additional shallower and deeper depth intervals have been added, removed and changed. However, the 5 core intervals have remained the same over time. Catch rates from these core sets extend a stock abundance index series and Sablefish are sampled for data on size and growth.

b) A **Traditional Tagging Program** (1991-2007, discontinued)

This program captures Sablefish for tagging and release at historical tagging locations. Sets are made in the 9 traditional standardized program localities as well as five (5) tagging-only localities. The protocol for this program is to release a specified number of tagged fish in each locality. Low catch rates in some areas in previous years have resulted in survey vessels being required to re-set additional strings in an area. Tag-recoveries from these sets can be used for studying movement, obtaining estimates of gear selectivity, and deriving an index of tagging-based abundance.

c) A **Randomized Tagging Program** (2003-2014)

This program captures Sablefish for tagging and release following a depth and area stratified random survey design. The catch rate data can be used to derive an index of stock abundance. Tag-recoveries can be used for deriving estimates of gear selectivity, studying movement, and deriving an index of tagging-based abundance. The survey also provides biological samples.

d) An **Inlets Program** (1995-2014)

This program includes standardized sets at four (4) mainland inlet localities. Sablefish are tagged and released from inlet sets and are sampled for biological data.

The annual Research and Stock Assessment Survey Program will be conducted in the fall of 2014 contingent on adequate resources from DFO and the Sablefish industry, but will include only the randomized program (c) and the inlets program (d).

A new introduction to the surveys in 2013 was the deployment of “trap camera” system consisting of (1) tri-axial accelerometers that produce measurements of quasi-continuous 3-axis motion and orientation of fishing traps, (2) deep-water autonomous cameras affixed to traps that produces motion-activated and fixed-interval high definition video of benthic substrate type, gear interaction with the substrate, and biological communities; and (3) standard oceanographic

probes that measure in-situ depth and temperature data needed for gear mobility (depth) and habitat suitability modeling (both). Developmental work on the camera system in 2014/15 includes provision of a graphical user interface for camera configuration, and replacement of the existing “stand-alone” accelerometers with new units capable of higher temporal resolution. The “trap-camera” system is deployed on most Sablefish survey sets and has been deployed on three commercial fishing trips to northern seamounts (including Bowie Seamount) when fishery-independent at-sea observers were on-board.

ii. Stock assessment activities in 2014 and planned for 2015

In 2013, fishing industry stakeholders proposed a TAC floor of 1,992 t, because lower quotas may increase economic risks. The existing management procedure was 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. The revised procedure provides conservation performance that is comparable to the existing procedure. Applying the revised procedure to updated landings and biomass index data resulted in a harvest recommendation of 2,129 t for the 2013/14 fishing year, which was above the proposed TAC floor. A lower survey index in 2014 resulted in the catch floor being invoked, i.e., a catch recommendation of 1,992t for the 2015/16 fishing year.

Development of the Sablefish operating model used for feedback simulations was delayed from 2014 to 2015. Consequently, an updated management strategy evaluation will not be conducted until 2015/16. Recent publications related to BC Sablefish reviewed evidence for stock structure, documented the revised management procedure, and described the use of biological reference points and operational control points for the BC Sablefish fishery.

6. Flatfish

i. Research program in 2014

Ongoing data collection in support of the flatfish research program continued in 2014 through the Groundfish Synoptic Surveys, port sampling, and at-sea observer sampling.

ii. Research activities planned for 2015

A review and summary of biological and abundance information collected from multiple flatfish species during Groundfish Synoptic Surveys between 2003 and 2014 is planned for 2015 – 2016.

An evaluation of management procedures for Rock Sole stocks that differ in the approach used to estimate reference points is also planned for 2015; this evaluation will be contrasted with a similar analysis for Pacific Cod stocks.

iii. Stock assessments planned for 2015

A coastwide assessment of Arrowtooth Flounder in BC will be delivered in May 2015 and an assessment of Petrale Sole stocks in BC is anticipated in November 2015.

7. Lingcod

i. Research programs in 2014

Ongoing data collection in support of the lingcod research program continued in 2014 through the Groundfish Synoptic Surveys, port sampling, at-sea observer sampling, and recreational creel surveys.

ii. Stock assessments in 2014

A stock assessment for the Inside Strait of Georgia Lingcod stock was completed in 2014 that updated stock status for Minor Statistical Areas 13-19, 28 and 29 within Major Statistical Area 4B. The assessment focussed on characterizing how stock status had changed since the current management regime for recreational fisheries was introduced in 2006, as well as how current spawning biomass compared to biomass-based reference points. Nine stock assessment scenarios were used to characterize a range of stock status estimates in 2014. All scenarios were weighted equally when characterizing stock status and a model-averaging approach, in which estimated Bayesian posterior distributions from all nine scenarios were combined with equal weights, was used to represent structural uncertainty across scenarios. All scenarios estimated a continued recovery in Strait of Georgia spawning biomass to 2014 from historically low levels in the late 1980's. Spawning biomass in 2014 was estimated with 100% certainty to be greater than spawning biomass at the start of the current management regime in 2006. Results from the model-averaging approach estimated that spawning biomass in 2014 was most likely in the cautious zone based on the provisional reference points identified in the DFO Fishery Decision-Making Framework Incorporating the Precautionary Approach (i.e., cautious zone = spawning biomass between $0.4B_{MSY}$ and $0.8B_{MSY}$). The median estimate of the model-averaged posterior distribution for the ratio of B_{2014} / B_0 was 0.23 (5th and 95th percentiles = 0.17, 0.30).

8. Pacific Hake

i. Research program

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 was run in 2013, to continue the biennial time series. The estimated biomass from the 2013 survey was 2.423 million metric tonnes with a CV of 0.0433. This estimate is approximately 1.75 times the 2012 survey estimate and 4.66 times the 2011 survey estimate. The survey catch was dominated by three-year olds at 76.2% of the total number. Nearly all the three-year olds were found in United States (US) waters, only 4.6% of the overall biomass was in Canadian waters at the time of the survey.

Being an off-survey year, 2014 ship time for Canada was used for research of Pacific Hake. The research included haul representativeness, which was done by performing a series of tows across single hake aggregations at different depths and spatial locations. This was done to determine the efficacy of performing a single tow on an aggregation of Hake during the survey and attributing

the length frequency from the single tow to the entire aggregation for biomass estimate purposes. Age-1 hake aggregations were also insonified and measured for target strength, which will be used to improve the target strength/length relationship which is applied to the acoustics in the biomass estimation procedure.

ii. Stock Assessment in 2015

The majority of the Canadian Pacific Hake catch for the 2014 season was taken from the Southwest coast of Vancouver Island in the third quarter (July-Sept). The recent (2008-2013) shift in temporal and spatial distribution of Pacific Hake Northward was not apparent in 2014.

The Joint Venture (JV) fishery did not receive any quota in 2014. The total Canadian TAC including carryover for 2014 was 111,357 metric tonnes (mt). The domestic sector was allocated all of this and caught 34,784 mt (31% of total allocation).

Management of Pacific Hake has been under a treaty (The Agreement) between Canada and the United States since 2011. As in previous years, and as required by The Agreement, The 2015 harvest advice was prepared jointly by Canadian and US scientists working together, collectively called the Joint Technical Committee (JTC) as stated in the treaty. A single assessment model was used; Stock Synthesis 3 (SS3). The SS3 model was selected as the base model by the JTC, and endorsed by the SRG. The 2015 model was the same model used in 2014, with time series updates (catch and age compositions) but without a new acoustic biomass index, because it was a non-survey year.

The final decision on catch advice for the 2015 fishing season was made at the meeting of the International Pacific Hake Joint Management Committee in Lynnwood, Washington on March 18-19, 2015. A coastwide TAC of 440,000 mt for 2015 was established, which includes any carryover from 2014. As laid out in the treaty, Canada will receive 26.12% of this, or 114,928 mt.

The final assessment document and other treaty-related documents are posted at:
http://www.nwr.noaa.gov/fisheries/management/whiting/pacific_whiting_treaty.html

9. Elasmobranchs

i. Research programs in 2014

Active programs for Basking shark (*Cetorhinus maximus*), big skate (*Bathyraja binoculata*), longnose skate (*Raja rhina*), blue shark (*Prionace glauca*), salmon shark (*Lamna ditropis*) and spotted ratfish (*Hydrolagus collieri*).

ii. Stock assessment in 2014

The stock assessment for Pacific spiny dogfish (*Squalus suckleyi*) was cancelled upon request from fisheries management for Nov 2014. The IUCN Red List Reassessment for big skate was completed through the Shark Specialist Sub-group of IUCN.

iii. Management

Code of Conduct for sharks captured in commercial and recreational fisheries were released in 2014. The Code of Conduct provides instruction for identification, reporting and sampling (by onboard observers). The shark sightings network was fully launched in 2014 with online or phone in reports (www.pac.dfo-mpo.gc.ca/SharkSightings; 1-877-507-4275). Reward badges and postcards are provided for reported shark sightings.

iv. Research activities for 2014.

1. Habitat modelling of critical habitat on basking shark based on satellite chlorophyll and SST, coupled to field samples of zooplankton density.
2. NPRB funded collaborative research with NMFS and MLML for bomb radiocarbon age validation of big skate and longnose skate.
3. Development of microsatellite markers for salmon shark.

D. Other related studies

1. Statistics and Sampling

i. Biological sampling and database work in 2014

Principal Statistics and Sampling activities in 2014 included the ongoing population of the groundfish biological database (GFBio). This database now includes over 10,045,000 specimens. Data entry activities continued to concentrate on the input of current port sampling and observer biological data and recent research cruises. There was also further targeted effort towards the entry of historic research cruises and the scanning of original documents to electronic format.

The groundfish trawl fishery continues to be covered by 100% dockside and virtually 100% observer coverage. These observers also provided 252 length/sex/age samples and 80 length samples in 2014. Port samplers provided an additional 33 samples, all except one sample with ageing structures (length/sex/age/weight). The focus of their sampling efforts continued to be from those fisheries not covered by at-sea observers with the bulk of the samples (21) coming from sablefish tag recoveries and frozen samples from seamount trips. In addition, there were 26 samples collected in Ucluelet from the domestic hake fishery; 22 of the samples had ageing structures.

The GFBio database tag release module underwent a major revision in 2014. This was necessary to enable individual tagged fish that were captured and subsequently re-released with a new tag to be properly connected to all of its related information (e.g., length, weight, previous tag number). It was also necessary to modify GFBioField to facilitate the changes in the tagging module.

Development of “GFCatchAll” as a comprehensive database that will include all known sources of groundfish catch (1900-present) is still on hold but work was initiated in 2014 to enter known sources of catch information from historic catch reports published in the 1960s and 1970s.

The statistics group continued to field a large number of internal and external data requests in 2014 and worked on methods to streamline the responses. This included the development of standardized tables for release to the public that respected confidentiality issues of commercial fisheries data.

ii. Catch monitoring in 2014

Staff continued to be being actively involved in the Recreational Catch Monitoring Working Group.

iii. Field work in 2014

Staff participated on various bottom trawl surveys (see Summary of Groundfish Surveys below) including the west coast Vancouver Island and west coast Haida Gwaii groundfish trawl surveys, the west coast Vancouver Island, and Queen Charlotte Sound shrimp trawl surveys, as well as the Pacific Hake hydroacoustic survey. This group also included the port sampling activity (1 person-years) in the Vancouver area. Staff continued to enhance GFBioField, the integrated (paper-less) data capture system for surveys.

iv. Proposed field and database work for 2015

Port sampling in the Vancouver area will continue in 2015.

Staff will participate in groundfish bottom trawl surveys to the Strait of Georgia, Hecate Strait and Queen Charlotte Sound, the shrimp trawl survey off the west coast of Vancouver Island, and the Pacific Hake hydroacoustic survey.

Development of “GFCatchAll” as a comprehensive database that will include all known sources of groundfish catch (1900-present) will continue in 2015 to identify all possible sources of catch information and to work on the documentation of various fishery sectors through time.

APPENDIX 1. REVIEW OF CANADIAN GROUND FISH FISHERIES

1. Commercial fisheries

All catch figures for the 2013 calendar year are preliminary. Canadian domestic trawl landings of groundfish (excluding halibut) in 2013 were 89,761 t, a decrease of 12% from the 2012 catch. The major species in the trawl landings were Pacific Hake (60%), Arrowtooth Flounder (9%), Pacific Ocean Perch (5%), Yellowtail Rockfish (4%), and Walleye Pollock (4%). Trawl production was distributed amongst areas 3C (35%), 3D (26%), 5A (16%), 5B (6%), 4B (6%), 5D (4%), 5E (4%), and 5C (1%).

Canadian landings of groundfish caught by gear other than trawl in 2012 totalled 5,746 t. Landings of Sablefish by trap and longline gear accounted for 2,212 t, approximately 58% by trap gear, 40% by longline gear and 2% by unspecified. Landings of species other than Sablefish by trap, longline, handline and troll gear accounted for 3,266 t (49% rockfish, 27% Lingcod, 12% North Pacific Spiny Dogfish, and 11% skates).

2. Recreational fisheries

Each year, Fisheries Management Branch of DFO conducts creel surveys and collects fishing lodge logbooks for the recreational angling fishery in the four south coast regions.

For the Strait of Georgia, in 2013, the estimates were generated from a combination of creel surveys and fishing lodge reports and covered the months of March to October. Provisional estimates of 2013 catches, landings and releases, for this 8-month period were 17,312 fish for Lingcod, 18,856 fish for all rockfish species, 581 fish for Pacific Halibut, 3,814 fish for Rock Sole, 1,511 fish for Starry Flounder, 2,057 fish for other flatfish species, 25,404 fish for North Pacific Spiny Dogfish, 2,231 fish for greenlings, 1,364 fish for Pacific Cod and 1,710 fish for other groundfish species.

For the Strait of Juan de Fuca catch estimates have been generated from creel surveys and fishing lodge reports for the months of March to October. Provisional estimates for this 8-month period are 7,750 fish for Lingcod, 14,689 for all rockfish species, 8,108 fish for Pacific Halibut, 3,039 fish for all flatfish species, 17,248 fish for North Pacific Spiny Dogfish, 4,481 fish for greenlings, and 3,324 fish for other groundfish species.

Along the west coast of Vancouver Island catch estimates have been generated from creel surveys and fishing lodge reports. Data are available for June to September. Provisional estimates of 2013 catches were 14,826 fish for Lingcod, 19,307 fish for all rockfish species, 27,583 fish for Pacific Halibut, 1,313 fish for North Pacific Spiny Dogfish, 172 fish for greenlings, 1,136 for all flatfish species, and 495 fish for other groundfish species.

Fisheries and Oceans Canada (DFO) has also implemented an internet survey (iRec) of people who hold a [Tidal Waters Sport Fishing Licence](#) to collect data on recreational fishing activity and catch in the tidal waters of British Columbia. The information collected will be used, in combination with data from other sources, to provide estimates of catch and effort in recreational fisheries. Random samples of people with Tidal Waters Sport Fishing Licences will be selected

monthly. Selected licence holders will be asked to summarize all of their fishing activity and catch during that month.

The estimates from the iREC surveys won't be used for management purposes until two specific actions have been completed:

- 1.) Independent science review of the survey design, analysis methods and results to date.
- 2.) A review of iREC results against local knowledge in the recreational sector.

3. Joint-venture fisheries

There were no joint-venture fisheries conducted off British Columbia in 2013.

4. Foreign fisheries

There were no national or supplemental fisheries for Pacific Hake off British Columbia in 2013.

APPENDIX 2. SUMMARY OF BOTTOM TRAWL SURVEYS IN 2014

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1. Multi-Species Small mesh (SHRIMP) bottom trawl Survey

An annual fixed-station survey of commercially important shrimp grounds off the West Coast of Vancouver Island was initiated in 1973. In 1998, areas in Eastern Queen Charlotte Sound were added to the survey. The survey is conducted using a shrimp bottom trawl without an excluder device. As a result, 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. Catch rates are useful indicators of stock status but additional information such as the size and age composition of the catch improves the usefulness of the index. Consequently, a program was initiated in 2003 to collect biological samples from all groundfish species caught during the survey. Groundfish staff provides assistance in catch sorting and species identification and also collect biological samples from selected 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, most of the biological sampling effort was focused on length by sex data as opposed to collecting ageing structures. In 2014 the sampling program was rationalized to only include species where the survey is expected to provide a useful index of abundance. Up until 2013, the groundfish section routinely placed two staff on board for the duration of the survey. Recent staffing reductions resulted in only one person being available to participate in the 2014 survey. In addition, the sampling program was further reduced so that the single person from the groundfish section could accomplish all the work.

Starting in 2013, the survey 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 2014 survey was conducted onboard the W.E. Ricker and ran from May 2 to 25. A total of 133 tows were completed. The total catch weight of all species was 69,977 kg. The mean catch per tow was 530 kg, averaging 26 different species of fish and invertebrates in each. Over the entire survey, the most abundant fish species encountered were Eulachon (*Thaleichthys pacificus*) followed by Spotted Ratfish (*Hydrolagus colliei*), Walleye Pollock (*Theragra chalcogramma*) and Arrowtooth Flounder (*Reinhardtius stomias*). The number of tows where the species was captured, total catch weight, estimated biomass, and relative survey error for the top 25 fish species by weight are shown in Table 1 for the West Coast Vancouver Island set locations. Abundance indices have not been calculated for the Barkley Sound set locations as these locations have not yet been used for any groundfish assessments.

Biological data were collected from a total of 10,445 individual fish from 20 different groundfish species (Table 2). Most biological samples included fish length and sex but age structures were also collected for Lingcod (*Ophiodon elongatus*) and both age structures and tissue samples for DNA analysis were collected from Rougheye Rockfish (*Sebastes aleutianus*). More than half of all the individual fish measured during the survey were Eulachon (*Thaleichthys pacificus*). Although we include this species in these summaries, the groundfish section staff typically does not collect the biological data from this species.

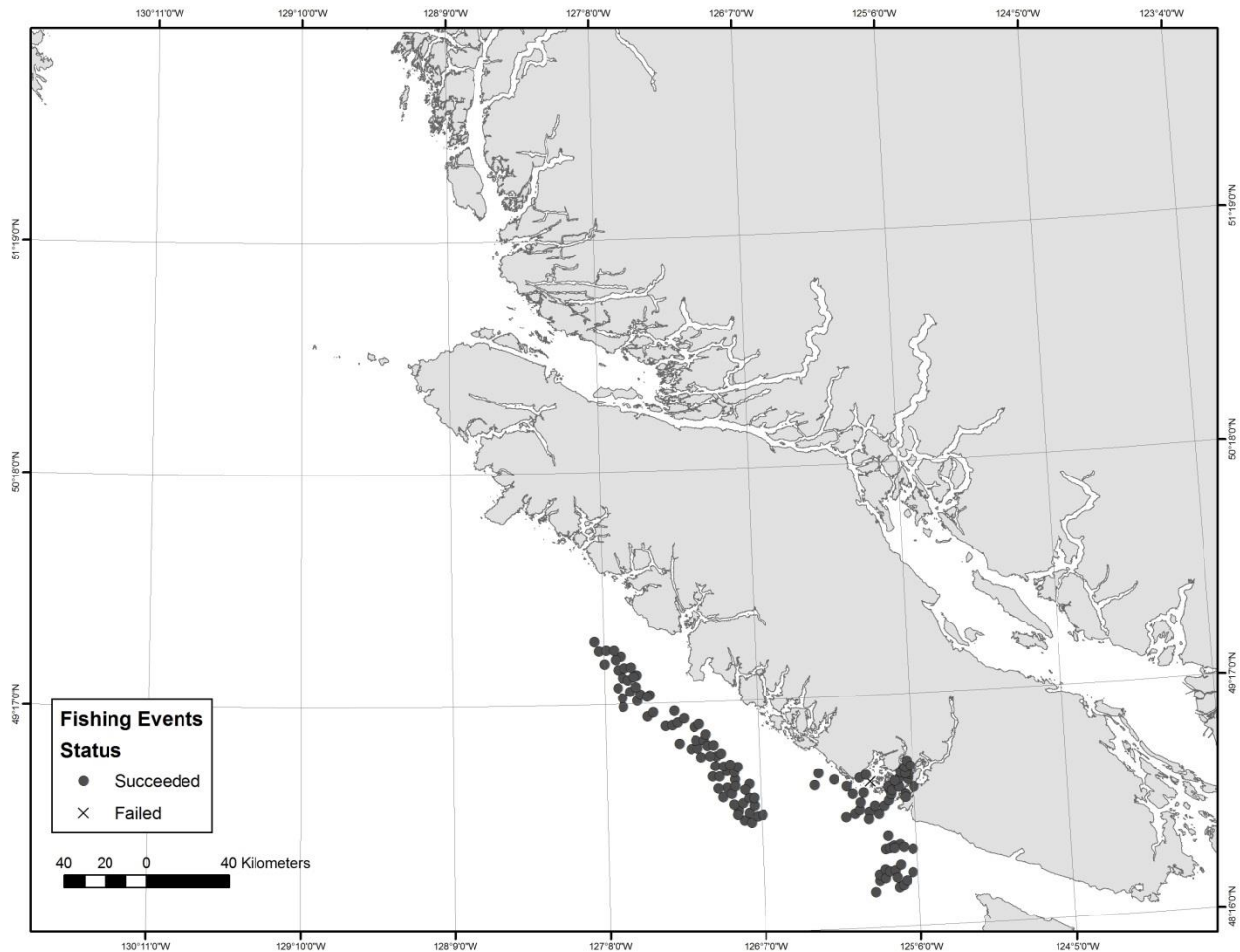


Figure 2. Barkley Sound and West Coast Vancouver Island set locations of the 2014 Multi-species Small Mesh Bottom Trawl Survey

Table 1. Number of tows, catch weight, estimated biomass, and relative survey error for the top 25 species (by weight) captured in the West Coast Vancouver Island set locations of the 2014 Multi-species Small Mesh Bottom Trawl Survey.

Species	Scientific Name	Num. Tows	Catch (kg)	Biomass (t)	Rel. Error
Arrowtooth Flounder	<i>Reinhardtius stomias</i>	68	4193	3871	0.10
Eulachon	<i>Thaleichthys pacificus</i>	69	4034	3897	0.12
Walleye Pollock	<i>Theragra chalcogramma</i>	40	3195	2721	0.36
Pacific Herring	<i>Clupea pallasii</i>	58	2221	1961	0.38
Pacific Cod	<i>Gadus macrocephalus</i>	60	1428	1295	0.32
Rex Sole	<i>Glyptocephalus zachirus</i>	67	1136	1068	0.09
Flathead Sole	<i>Hippoglossoides elassodon</i>	59	868	759	0.14
Dover Sole	<i>Microstomus pacificus</i>	68	742	662	0.10
Slender Sole	<i>Lyopsetta exilis</i>	69	588	525	0.11
Spotted Ratfish	<i>Hydrolagus colliei</i>	61	564	502	0.12
Lingcod	<i>Ophiodon elongatus</i>	47	478	469	0.13
North Pacific Spiny Dogfish	<i>Squalus suckleyi</i>	29	466	402	0.31
English Sole	<i>Parophrys vetulus</i>	49	390	337	0.21
Pacific Halibut	<i>Hippoglossus stenolepis</i>	34	351	354	0.18
Blackbelly Eelpout	<i>Lycodes pacificus</i>	56	207	191	0.23
Sablefish	<i>Anoplopoma fimbria</i>	42	190	156	0.22
Longnose Skate	<i>Raja rhina</i>	48	182	164	0.16
Pacific Sanddab	<i>Citharichthys sordidus</i>	10	159	128	0.78
Whitebait Smelt	<i>Allosmerus elongatus</i>	3	134	117	1.01
Petrale Sole	<i>Eopsetta jordani</i>	29	101	94	0.26
Yellowtail Rockfish	<i>Sebastes flavidus</i>	18	44	45	0.29
Big Skate	<i>Raja binoculata</i>	2	20	14	0.93
Darkblotched Rockfish	<i>Sebastes crameri</i>	25	18	20	0.46
Sandpaper Skate	<i>Bathyraja interrupta</i>	15	17	15	0.24
Pacific Ocean Perch	<i>Sebastes alutus</i>	22	12	10	0.52

Table 2. Number of fish sampled for biological data during the 2013 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
North Pacific Spiny Dogfish	<i>Squalus suckleyi</i>	242	0
Big Skate	<i>Raja binoculata</i>	3	0
Sandpaper Skate	<i>Bathyraja interrupta</i>	3	0
Longnose Skate	<i>Raja rhina</i>	98	0
American Shad	<i>Alosa sapidissima</i>	127	0
Eulachon	<i>Thaleichthys pacificus</i>	5548	0
Pacific Cod	<i>Gadus macrocephalus</i>	255	0
Pacific Hake	<i>Merluccius productus</i>	30	0
Walleye Pollock	<i>Theragra chalcogramma</i>	1123	0
Rougheye Rockfish	<i>Sebastes aleutianus</i>	31	31
Pygmy Rockfish	<i>Sebastes wilsoni</i>	99	0
Sablefish	<i>Anoplopoma fimbria</i>	166	0
Lingcod	<i>Ophiodon elongatus</i>	149	121
Arrowtooth Flounder	<i>Reinhardtius stomias</i>	885	0
Petrale Sole	<i>Eopsetta jordani</i>	95	0
Rex Sole	<i>Glyptocephalus zachirus</i>	918	0
Flathead Sole	<i>Hippoglossoides elassodon</i>	19	0
Pacific Halibut	<i>Hippoglossus stenolepis</i>	95	0
Dover Sole	<i>Microstomus pacificus</i>	243	0
English Sole	<i>Parophrys vetulus</i>	316	0

2. Multi-species Synoptic bottom trawl surveys

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

The surveys follow a random depth stratified design. Fishing sites are predetermined by randomly selecting survey blocks (2 km x 2 km) within each depth strata. 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 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 on even-numbered years. Surveys are conducted on both chartered commercial vessels and government research vessels. The Hecate Strait survey and the West Coast Vancouver Island survey are 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.

In 2014 the West Coast Vancouver Island and West Coast Haida Gwaii surveys were conducted.

2.1. West Coast Vancouver Island Synoptic Bottom Trawl Survey

The West Coast Vancouver Island Multi-Species Synoptic Bottom Trawl Survey was conducted on the Canadian Coast Guard Ship W. E. Ricker between May 28 and June 21. We assessed a total of 193 blocks (Table 3). We conducted a total of 153 tows; 147 were successful survey sets and 6 were failures due to hang ups or insufficient bottom time. Note that some blocks are only successfully fished following more than one attempt.

A total of 15 different DFO staff and one volunteer student participated in the survey.

The total catch weight of all species was 138,217 kg. The mean catch per tow was 903 kg, averaging 27 different species of fish and invertebrates in each. The most abundant fish species encountered were Arrowtooth Flounder (*Reinhardtius stomias*), Pacific Ocean Perch (*Sebastes alutus*), Splitnose Rockfish (*Sebastes diploproa*), and North Pacific Spiny Dogfish (*Squalus suckleyi*). The number of tows where the species was captured and total catch weight from usable tows as well as the estimated biomass and relative survey error for the 25 most abundant species are shown in Table 4. Biological data, including individual length, weight, sex, maturity, and age structure were collected from a total of 30,198 individual fish of 49 different species (Table 5). Oceanographic data, including water temperature, depth, salinity, and dissolve oxygen were also recorded for most tows.

Table 3. 2014 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) per survey stratum.

Depth Stratum (m)	Rejected Prior	Rejected Inspected	Failed	Success	Not Fished	Total
50 to 125	3	16	2	55	2	78
125 to 200	3	5	1	49	1	59
200 to 330	2	0	0	29	0	31
330 to 500	2	9	0	14	0	25
Total	10	30	3	147	3	193

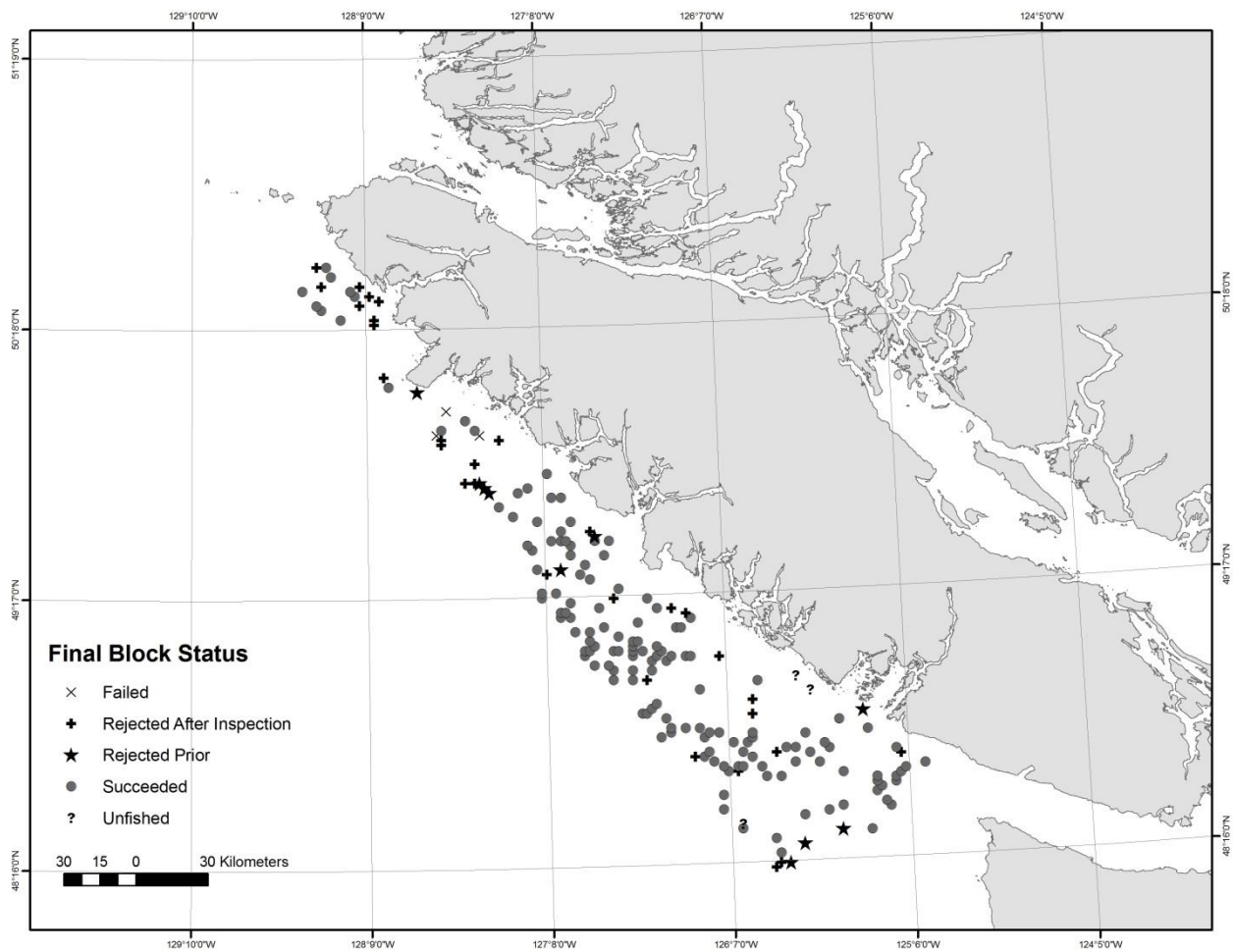


Figure 3. Final status of the allocated blocks for the 2014 West Coast Vancouver Island Multi-Species Synoptic Bottom Trawl Survey.

Table 4. 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 2014 West Coast Vancouver Island Multi-Species Synoptic Bottom Trawl Survey.

Species	Scientific Name	Num. Tows	Catch (kg)	Biomass (t)	Rel. Error
Arrowtooth Flounder	<i>Reinhardtius stomias</i>	142	24850	14124	0.11
Pacific Ocean Perch	<i>Sebastes alutus</i>	57	19684	5334	0.36
Splitnose Rockfish	<i>Sebastes diploproa</i>	36	12931	3007	0.52
North Pacific Spiny Dogfish	<i>Squalus suckleyi</i>	98	10922	4762	0.26
Sharpchin Rockfish	<i>Sebastes zacentrus</i>	58	9233	2856	0.42
Yellowtail Rockfish	<i>Sebastes flavidus</i>	72	8317	5281	0.35
Redstripe Rockfish	<i>Sebastes proriger</i>	43	5952	2209	0.35
Rex Sole	<i>Glyptocephalus zachirus</i>	136	5396	3211	0.07
Dover Sole	<i>Microstomus pacificus</i>	135	4293	2144	0.08
Sablefish	<i>Anoplopoma fimbria</i>	97	3285	1109	0.19
Silvergray Rockfish	<i>Sebastes brevispinis</i>	41	3210	793	0.36
Pacific Cod	<i>Gadus macrocephalus</i>	110	2889	2197	0.21
English Sole	<i>Parophrys vetulus</i>	104	2418	2187	0.14
Spotted Ratfish	<i>Hydrolagus coliei</i>	132	2117	1712	0.18
Flathead Sole	<i>Hippoglossoides elassodon</i>	66	1581	1360	0.21
Canary Rockfish	<i>Sebastes pinniger</i>	58	1548	992	0.72
Lingcod	<i>Ophiodon elongatus</i>	88	1496	1045	0.2
Greenstriped Rockfish	<i>Sebastes elongatus</i>	76	1493	736	0.18
Petrale Sole	<i>Eopsetta jordani</i>	99	1465	1260	0.16
Walleye Pollock	<i>Theragra chalcogramma</i>	61	1418	1132	0.48
Eulachon	<i>Thaleichthys pacificus</i>	70	1359	1090	0.21
Pacific Hake	<i>Merluccius productus</i>	39	1302	370	0.3
Redbanded Rockfish	<i>Sebastes babcocki</i>	43	1160	265	0.3
Pacific Halibut	<i>Hippoglossus stenolepis</i>	89	1067	848	0.14
Yellowmouth Rockfish	<i>Sebastes reedi</i>	7	901	191	0.64

Table 5. Number of fish sampled for biological data during the 2014 West Coast Vancouver Island 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
Brown Cat Shark	<i>Apristurus brunneus</i>	4	0
North Pacific Spiny Dogfish	<i>Squalus suckleyi</i>	898	177
Skates	<i>Rajidae</i>	3	0
Big Skate	<i>Raja binoculata</i>	14	0
Sandpaper Skate	<i>Bathyraja interrupta</i>	18	0
Longnose Skate	<i>Raja rhina</i>	142	0
Spotted Ratfish	<i>Hydrolagus colliei</i>	775	0
Green Sturgeon	<i>Acipenser medirostris</i>	4	0
Eulachon	<i>Thaleichthys pacificus</i>	1403	0
Pacific Cod	<i>Gadus macrocephalus</i>	1196	1008
Pacific Hake	<i>Merluccius productus</i>	366	77
Pacific Tomcod	<i>Microgadus proximus</i>	81	0
Walleye Pollock	<i>Theragra chalcogramma</i>	549	76
Rougheye Rockfish	<i>Sebastes aleutianus</i>	268	268
Pacific Ocean Perch	<i>Sebastes alutus</i>	959	534
Redbanded Rockfish	<i>Sebastes babcocki</i>	439	427
Shortraker Rockfish	<i>Sebastes borealis</i>	4	4
Silvergray Rockfish	<i>Sebastes brevispinis</i>	234	185
Darkblotched Rockfish	<i>Sebastes crameri</i>	145	30
Splitnose Rockfish	<i>Sebastes diploproa</i>	502	122
Greenstriped Rockfish	<i>Sebastes elongatus</i>	1226	22
Puget Sound Rockfish	<i>Sebastes emphaeus</i>	24	0
Widow Rockfish	<i>Sebastes entomelas</i>	78	25
Yellowtail Rockfish	<i>Sebastes flavidus</i>	766	379
Rosethorn Rockfish	<i>Sebastes helvomaculatus</i>	325	68
Quillback Rockfish	<i>Sebastes maliger</i>	19	0
Bocaccio	<i>Sebastes paucispinis</i>	22	22
Canary Rockfish	<i>Sebastes pinniger</i>	232	192
Redstripe Rockfish	<i>Sebastes proriger</i>	867	362
Yellowmouth Rockfish	<i>Sebastes reedi</i>	67	35
Yelloweye Rockfish	<i>Sebastes ruberrimus</i>	30	30
Stripetail Rockfish	<i>Sebastes saxicola</i>	59	0
Pygmy Rockfish	<i>Sebastes wilsoni</i>	35	0
Sharpchin Rockfish	<i>Sebastes zacentrus</i>	833	256
Shortspine Thornyhead	<i>Sebastolobus alascanus</i>	1073	211
Sablefish	<i>Anoplopoma fimbria</i>	1063	412
Kelp Greenling	<i>Hexagrammos decagrammus</i>	15	0
Lingcod	<i>Ophiodon elongatus</i>	385	273
Pacific Sanddab	<i>Citharichthys sordidus</i>	610	0
Arrowtooth Flounder	<i>Reinhardtius stomias</i>	2711	848
Petrale Sole	<i>Eopsetta jordani</i>	1046	905
Rex Sole	<i>Glyptocephalus zachirus</i>	3227	486
Flathead Sole	<i>Hippoglossoides elassodon</i>	923	125
Pacific Halibut	<i>Hippoglossus stenolepis</i>	259	0
Southern Rock Sole	<i>Lepidopsetta bilineata</i>	344	322

Species	Scientific Name	Lengths Collected	Age Structures Collected
Slender Sole	<i>Lyopsetta exilis</i>	1788	0
Dover Sole	<i>Microstomus pacificus</i>	2671	821
English Sole	<i>Parophrys vetulus</i>	1463	623
Curlfin Sole	<i>Pleuronichthys decurrens</i>	33	22

2.2. 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 E.J. Safarik between Aug 25 and Oct 2. Of those days, fishing operations were conducted on only 12. The other days were lost either to inclement weather conditions or mechanical breakdowns and repairs. We conducted a total of 64 tows; 54 were successful and 10 were failures due to hang ups or insufficient bottom time. Note that some blocks are only successfully fished following more than one attempt. The survey design called for 125 blocks to be assessed but we were only able to assess a total of 55 blocks (Table 6). Further, all the completed blocks are clustered in two parts of the survey grounds (Figure 4). Unfortunately, it is unlikely that the catch rate indices that could be generated from this survey will be meaningful due to the low number and pattern of the assessed blocks.

A total of four different DFO staff and two contract science staff from Archipelago Marine Research participated in the survey.

The total catch weight of all species was 98,232 kg. The mean catch per tow was 1534 kg, averaging 20 different species of fish and invertebrates in each. The most abundant fish species encountered were Pacific Ocean Perch (*Sebastes alutus*), Sharpchin Rockfish (*Sebastes zacentrus*), Arrowtooth Flounder (*Reinhardtius stomias*), Silvergray Rockfish (*Sebastes brevispinis*), and Redstripe Rockfish (*Sebastes proriger*). The number of tows where the species was captured and total catch weight from usable tows as well as the estimated biomass and relative survey error for the 25 most abundant species are shown in Table 7. Biological data, including individual length, weight, sex, maturity, and age structure were collected from a total of 7,307 individual fish of 71 different species (Table 8). Oceanographic data, including water temperature, depth, salinity, and dissolve oxygen were also recorded for most tows.

Table 6. 2014 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-assessed blocks per survey stratum.

Depth Stratum (m)	Rejected Prior	Rejected Inspected	Failed	Success	Total Assessed	Not Assessed
180-330	0	0	1	39	40	33
330-500	0	0	0	7	7	23
500-800	0	0	0	5	5	6
800-1300	0	0	0	3	3	8
Total	0	0	1	54	55	70

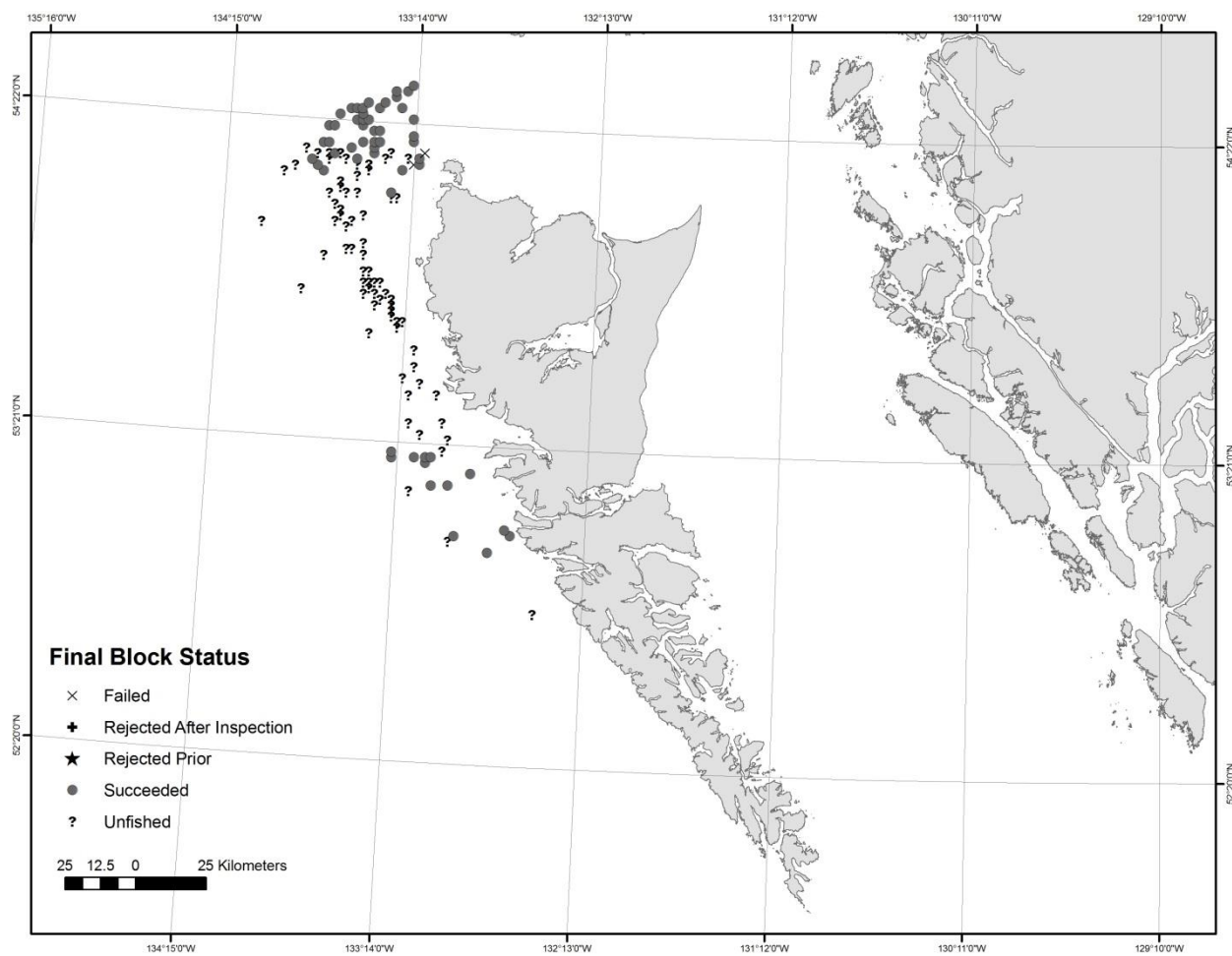


Figure 4. Final status of the allocated blocks for the 2014 West Coast Haida Gwaii Multi-Species Synoptic Bottom Trawl Survey.

Table 7. 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 2014 West Coast Haida Gwaii Multi-Species Synoptic Bottom Trawl Survey.

Species	Scientific Name	Num. Tows	Catch (kg)	Biomass (t)	Rel. Error
Pacific Ocean Perch	<i>Sebastes alutus</i>	38	46848	8838	0.29
Sharpchin Rockfish	<i>Sebastes zacentrus</i>	31	8903	2058	0.47
Silvergray Rockfish	<i>Sebastes brevispinis</i>	34	5323	988	0.35
Arrowtooth Flounder	<i>Reinhardtius stomias</i>	43	5275	4318	0.71
Redstripe Rockfish	<i>Sebastes proriger</i>	22	3601	706	0.44
Yellowmouth Rockfish	<i>Sebastes reedi</i>	15	3018	542	0.7
Rougheye Rockfish	<i>Sebastes aleutianus</i>	22	2695	514	0.33
Shortspine Thornyhead	<i>Sebastolobus alascanus</i>	48	2649	919	0.28
Dover Sole	<i>Microstomus pacificus</i>	44	1662	1225	0.58
Widow Rockfish	<i>Sebastes entomelas</i>	11	884	65	0.54
Sablefish	<i>Anoplopoma fimbria</i>	27	831	410	0.28
Redbanded Rockfish	<i>Sebastes babcocki</i>	33	694	177	0.51
Harlequin Rockfish	<i>Sebastes variegatus</i>	16	682	180	0.92
Rex Sole	<i>Glyptocephalus zachirus</i>	42	649	227	0.19
Spotted Ratfish	<i>Hydrolagus colliei</i>	38	550	155	0.21
Pacific Halibut	<i>Hippoglossus stenolepis</i>	28	537	136	0.3
Pacific Cod	<i>Gadus macrocephalus</i>	32	439	113	0.28
Rosethorn Rockfish	<i>Sebastes helvomaculatus</i>	32	305	60	0.2
Longnose Skate	<i>Raja rhina</i>	17	282	213	0.22
Shortraker Rockfish	<i>Sebastes borealis</i>	9	247	30	0.44
Pacific Hake	<i>Merluccius productus</i>	7	214	245	0.51
Lingcod	<i>Ophiodon elongatus</i>	12	206	112	0.68
Walleye Pollock	<i>Theragra chalcogramma</i>	26	193	19	0.29
Yelloweye Rockfish	<i>Sebastes ruberrimus</i>	2	153	41	0.91
Dusky Rockfish	<i>Sebastes variabilis</i>	3	49	12	0.77

Table 8. Number of fish sampled for biological data during the 2014 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
Brown Cat Shark	<i>Apristurus brunneus</i>	8	0
Aleutian Skate	<i>Bathyraja aleutica</i>	7	0
Roughtail Skate	<i>Bathyraja trachura</i>	3	0
Sandpaper Skate	<i>Bathyraja interrupta</i>	17	0
Longnose Skate	<i>Raja rhina</i>	33	0
Pacific Flatnose	<i>Antimora microlepis</i>	15	0
Pacific Cod	<i>Gadus macrocephalus</i>	63	0
Pacific Hake	<i>Merluccius productus</i>	56	0
Walleye Pollock	<i>Theragra chalcogramma</i>	98	0
Popeye	<i>Coryphaenoides cinereus</i>	31	0
Pacific Grenadier	<i>Coryphaenoides acrolepis</i>	54	0
Giant Grenadier	<i>Albatrossia pectoralis</i>	36	0
Rougheye Rockfish	<i>Sebastes aleutianus</i>	269	268
Pacific Ocean Perch	<i>Sebastes alutus</i>	1063	869
Redbanded Rockfish	<i>Sebastes babcocki</i>	168	161
Shortraker Rockfish	<i>Sebastes borealis</i>	46	46
Silvergray Rockfish	<i>Sebastes brevispinis</i>	461	199
Dusky Rockfish	<i>Sebastes variabilis</i>	27	0
Splitnose Rockfish	<i>Sebastes diploproa</i>	12	0
Greenstriped Rockfish	<i>Sebastes elongatus</i>	12	0
Widow Rockfish	<i>Sebastes entomelas</i>	34	0
Rosethorn Rockfish	<i>Sebastes helvomaculatus</i>	367	0
Bocaccio	<i>Sebastes paucispinis</i>	6	6
Canary Rockfish	<i>Sebastes pinniger</i>	8	0
Redstripe Rockfish	<i>Sebastes proriger</i>	265	131
Yellowmouth Rockfish	<i>Sebastes reedi</i>	94	81
Yelloweye Rockfish	<i>Sebastes ruberrimus</i>	29	29
Harlequin Rockfish	<i>Sebastes variegatus</i>	80	0
Sharpchin Rockfish	<i>Sebastes zacentrus</i>	570	47
Shortspine Thornyhead	<i>Sebastolobus alascanus</i>	1077	182
Longspine Thornyhead	<i>Sebastolobus altivelis</i>	224	152
Sablefish	<i>Anoplopoma fimbria</i>	202	57
Lingcod	<i>Ophiodon elongatus</i>	26	19
Arrowtooth Flounder	<i>Reinhardtius stomias</i>	661	67
Petrale Sole	<i>Eopsetta jordani</i>	5	0
Rex Sole	<i>Glyptocephalus zachirus</i>	505	31
Pacific Halibut	<i>Hippoglossus stenolepis</i>	70	0
Slender Sole	<i>Lyopsetta exilis</i>	15	0
Dover Sole	<i>Microstomus pacificus</i>	590	191

APPENDIX 3. PARTIAL LIST OF GROUND FISH RELATED REPORTS WITH 2014 PUBLICATION DATES.

PRIMARY

King, J.R. and R.P. McPhie. 2014. Preliminary age, growth and maturity estimates of spotted ratfish (*Hydrolagus coliei*) in British Columbia. *Deep Sea Research II* (doi:10.1016/j.dsr2.2013.11.002).

McFarlane, G.A., and J.R. King. 2014. History of the Fisheries. In: R.J. Beamish and G.A. McFarlane (eds.), *The Sea Among Us: the Amazing Strait of Georgia*, Harbour Publishing.

Okamura, H., McAllister, M. K. Ichinokawa, M., Yamanaka, K. L., and Holt, K.. 2014. Evaluation of the sensitivity of biological reference points to the spatio-temporal distribution of fishing effort when seasonal migrations are sex-specific. *Fisheries Research* 158 (2014) 116-123. doi:10.1016/j.fishres.2013.10.022

OTHER PUBLICATIONS

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

Taylor, I.G., C. Grandin, A.C. Hicks, N. Taylor, and S. Cox. 2015. *Status of the Pacific Hake (whiting) stock in U.S. and Canadian waters in 2015*. Prepared by the Joint Technical Committee of the U.S. and Canada Pacific Hake/ Whiting Agreement; National Marine Fishery Service; Canada Department of Fisheries and Oceans. 159 p.

Edwards, A.M., Haigh, R. and Starr, P.J. (2014). Pacific Ocean Perch (*Sebastes alutus*) stock assessment for the north and west coasts of Haida Gwaii, British Columbia. DFO Canadian Science Advisory Secretariat Research Document 2013/092. vi + 126p.

Edwards, A.M., Haigh, R. and Starr, P.J. (2014). Pacific Ocean Perch (*Sebastes alutus*) stock assessment for the west coast of Vancouver Island, British Columbia. DFO Canadian Science Advisory Secretariat Research Document 2013/093. vi + 135p.

APPENDIX 3. GROUND FISH STAFF IN 2014

Greg Workman	Section Head
Schon Acheson	Technician, Pacific Hake, port sampling and surveys
Kristina Anderson	Technician, Sablefish and surveys (maternity leave until Jan 2015)
Karina Cooke	Technician, Database support and surveys, Inshore Rockfish
Andrew Edwards	Program Head, Statistical & mathematical modelling, stock assessment
Robyn Forrest	Program Head, Pacific Cod, Pacific Halibut, stock assessment
Chris Grandin	Program Head, Pacific Hake stock assessment and Port sampling
Lorri Granum	Technician, Database support
Rowan Haigh	Statistical & exploratory data analysis, stock assessment, R packages
Kendra Holt	Program Head, Lingcod, Flatfish stock assessment
Jackie King	Program Head, Elasmobranchs, Climate studies
Brian Krishna	Biologist, Database support and analysis, Flatfish
Rob Kronlund	Program Head, Sablefish, Analytical programs
Lisa Lacko	Biologist, GIS and database, Sablefish
Jean-Baptiste Lecomte	Post-doctoral Fellow (France)
Sandy McFarlane	Emeritus scientist
Wendy Mitton	Technician, Sablefish (retired April 2014)
Melissa Nottingham	Technician, Groundfish surveys
Norm Olsen	Program Head, Groundfish Surveys, Programmer/GIS and Statistics
Kate Rutherford	Biologist, Database manager, Groundfish Statistics
Jon Schnute	Emeritus scientist
Maria Surry	Technician, Elasmobranchs
Kathryn Temple	Technician, Groundfish surveys
Daniel Williams	Technician, Groundfish surveys
Malcolm Wyeth	Biologist, Groundfish surveys
Lynne Yamanaka	Program Head, Inshore rockfish research and stock assessment