CANADA

British Columbia Groundfish Fisheries and Their Investigations in 2015

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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
Salmon & Freshwater Ecosystems	Mr. Mark Saunders
Marine Ecosystems & Aquaculture	Dr. Nathan Taylor (Acting)

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

Groundfish	Mr. Greg Workman
Invertebrates	Mr. Dennis Rutherford
Pelagic Fish Research & Conservation Biology	Mr. Sean MacConnachie (Acting)
Applied Technologies	Mr. Henrik Krieberg
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 2016 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 2015-16 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 2016-17.

II. Surveys

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 2015, please see Appendix 1. Other research surveys conducted in 2015 include longline and trap surveys. These surveys are described under their respective species programs below.

III. Reserves

IV. Review of Agency Groundfish Research, Assessment and Management

A. Hagfish

1. Research

An experimental fishery has been conducted since 2013. The experimental program consist of three elements: 1) a systematic depth stratified survey in each of the 3 area pairs (PFMAs 23/123, 25/125, and 8-9/108-109); 2) experimental fishing to fixed effort caps in each of the area pairs; and 3) monitoring the previously selected index site within PFMA 23 (Kirby Point).

The sequence of activities intended during the initial development of the science program was to undertake a survey in each of the area pairs and conduct an initial sampling at the Kirby Point site prior to commencing the depletion experiment; once these two activities were completed experimental fishing could then start with subsequent surveys occurring every 6 months. The reason for doing the surveys and sampling first is to establish a baseline snap-shot of the species distribution, relative abundance and biological condition prior to removals. It was anticipated that once experimental fishing began, changes (reductions) in survey and fishery CPUE would be detectable after some period of fishing. The levels of effort authorized for the experimental fishery should be sufficient to impose a detectable signal in the CPUE data that should make it possible to generate a depletion estimate of abundance, at least for the locations where fishing is taking place.

2. Assessment

A summary of the experimental fishery will be undertaken for completion in 2017.

3. Management

B. Dogfish and other sharks

1. Research

Ongoing data collection in support of the Dogfish and Shark research program continued in 2015 through the Groundfish Synoptic Surveys, port sampling, at-sea observer sampling, and recreational creel surveys.

C. Skates

1. Research

Ongoing data collection in support of the Dogfish and Shark research program continued in 2015 through the Groundfish Synoptic Surveys, port sampling, at-sea observer sampling, and recreational creel surveys.

D. Pacific cod

1. Research

Ongoing data collection in support of the Pacific cod research program continued in 2015 through the Groundfish Synoptic Surveys, port sampling, at-sea observer sampling, and recreational creel surveys. Collection of DNA was initiated in the spawning areas of Hecate Strait (PSMFC Area 5D) and will continue in 2016.

E. Walleye pollock

1. Research

There is no directed work being conducted on Walleye Pollock but ongoing data collection continued in 2015 through the Groundfish Synoptic Surveys, port sampling, at-sea observer sampling, and recreational creel surveys.

F. Pacific whiting (hake)

1. Research

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 2015, to continue the biennial time series. The estimated biomass from the 2015 survey was 2.156 million metric tonnes with a CV of 0.092. The survey catch was dominated by five year-olds, which represent

the very large 2010 year class. This cohort was distributed in both the U.S. and Canadian waters.

4. Assessment

As in previous years, and as required by The Agreement, The 2016 harvest advice was prepared jointly by Canadian and U.S. scientists working together, collectively called the Joint Technical Committee (JTC) as stated in the treaty. The assessment model used was Stock Synthesis 3 (SS3). The 2016 model had the same model structure used in 2015, with time series updates (catch and age compositions) and a new acoustic biomass index.

5. 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 2015 was 114,928 t including a carryover of 14,793 t. The shoreside/freezer trawler sector was allocated 84,928 t of this and caught 36,507 t (31.8% of total TAC). The Joint Venture (JV) fishery received a quota of 30,000 t in 2015, but did not choose to participate in the fishery. For the second year in a row, the four freezer trawlers caught more than the shoreside vessels. The majority of the Canadian Pacific Hake catch for the 2015 season was taken from the west coast of Vancouver Island in the third quarter (July-Sept).

The final decision on catch advice for the 2016 fishing season was made at the meeting of the International Pacific Hake JMC in Vancouver, B.C. on March 15-18, 2016. A coastwide TAC of 497,000 t for 2016 was agreed upon. As laid out in the treaty, Canada will receive 26.12% of this, or 129,816 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.nwr.noaa.gov/fisheries/management/whiting/pacific_whiting_treaty.html

G. Grenadiers

1. Research

There is no directed work being conducted on Grenadiers but ongoing data collection continued in 2015 through the Groundfish Synoptic Surveys, port sampling, at-sea observer sampling, and recreational creel surveys.

H. Rockfish

1. Research

a) Surveys on the inside (PMFC Area 4B)

A Fisheries and Oceans Canada (DFO) 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 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 (Lochead and Yamanaka 2004; 2006; 2007). 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, in August 2015, were allocated for the longline survey in the Southern region. The Northern region is due to be surveyed over 24 days in August 2016.

b) 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). Funding for this survey has evolved from industry sources to DFO National budgets throughout the survey series, with the exception of 2013 where no funding mechanism was available to fund the surveys. Since 2014, the survey program has been conducted under a “Use-of-Fish” DFO policy in conjunction with a Collaborative Agreement which outlines this project and includes responsibilities for the IPHC, the Pacific Halibut Management Association (PHMA) and DFO.

In collaboration with industry (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 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. 198 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, annually, with the exception of 2013. Similar to the IPHC survey, a survey program was conducted for the southern portion of BC in 2014 under a “Use-of-Fish” policy and Collaborative Agreement with the PHMA. These Collaborative Agreements are scheduled for renewal in 2016.

c) 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.

d) Slope Rockfish Program

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.

All PBS packages on CRAN are kept current as needed to comply with the CRAN Repository Policy – PBSmapping 2.69.76 published Jan 14, 2015; PBSmodelling 2.67.266 published Jan 23, 2015; PBSddesolve 1.11.29 published May 16, 2014; PBSadmb 0.68.104 published Apr 9, 2014. The full suite of PBS R packages was migrated successfully from Google Code to GitHub. Rowan maintains these packages on his local machine which are then pushed to the GitHub repositories (see PBS Software). Additionally, Rowan collaborates on a package called *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 continued in collaboration with Jackie King (PBS) and postdoctoral fellow Jean-Baptiste Lecomte on a project called "Implementing Ecosystem-based Fisheries Management in the Groundfish Stock Assessment Process" funded by DFO's 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.

6. Assessment

a) Yelloweye Rockfish

A stock assessment for the Outside population of Yelloweye Rockfish in 2014 was reviewed by the Canadian Science Advisory Secretariat in September 2015. The Science Advisory Report from this process is available at: http://www.dfo-mpo.gc.ca/csas-sccs/publications/sar-as/2015/2015_060-eng.pdf

A non-equilibrium, age-aggregated Bayesian surplus production (BSP) model was used to assess the Outside population of Yelloweye Rockfish in BC, employing catch data derived from historic commercial, recreational and Aboriginal catch records reconstructed back to 1918, life history data to estimate the intrinsic rate of increase (r), and abundance trends derived from research surveys and commercial hook and line catch records. Sensitivity analyses considered six different sources of uncertainty: assumptions about the historic catch, priors for the intrinsic rate of increase and carrying

capacity, process error standard deviation, various abundance indices, form of the surplus production function, and the form of the stock assessment model.

The biomass in 2014 (B2014) is estimated at 3,821 t (90% credibility interval of 2,428 – 7,138 t), which is 18% (90% credibility interval 10 – 33 %) of the estimated initial biomass (B1918) of 21,955 t (90% credibility interval 13,747 – 37,694 t) in 1918. Fisheries reference points consistent with DFO's Precautionary Reference Points are presented for this assessment. There is a 63% probability that stock biomass in 2014 is below the Limit Reference Point (LRP) of 0.4BMSY and a 99% probability that it is below the Upper Stock Reference (USR) of 0.8BMSY.

Advice to management is presented in the form of decision tables, using 5, 10, and 15 year projections, for constant catch policies between 0 and 300 t/year. Replacement yield or surplus production in 2014 is estimated at 162 t (90% credibility interval 80 – 258 t). The current catch of 287 t in 2014 is estimated at 178% (90% credibility interval 114 – 360%) of replacement yield.

The assessment suggests that the stock has continued to decline, despite more than a decade of rockfish conservation measures. Increases in Yelloweye Rockfish density have not yet been seen in Rockfish Conservation Areas, but given the low productivity of this species, benefits are not expected to be detected until at least 10 years after their closure.

7. Management

a) Inshore Rockfish

Management, in consultation with the commercial industry, will step down the current Outside Yelloweye Rockfish Total Allowable Catch (TAC) over the next three years to bring harvests 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. Similarly, recreational bag limits have been reduced from 3 to 2 Yelloweye Rockfish in the north and from 2 to 1 in the south.

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 2018.

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 2015. Quillback Rockfish is up for reassessment by the COSEWIC by November 2019.

I. Thornyheads

1. Research

Responsibility for assessing thornyheads lies with the Slope Rockfish group. In 2015, the Sclerochronology Lab made progress developing a thin-sectioning technique for thornyheads, which helps to resolve the fine micro-structure of older specimens. Some of the findings from the thin-sectioning technique include: (i) the sulcal groove appears to be the most promising reading plane, (ii) there is difficulty in determining the first year, (iii) there are many fine checks, and (iv) there is an uneven growth pattern in the mature stages of life (>20y).

8. Assessment

Historically, Shortspine Thornyhead (*Sebastolobus alascanus*) was caught in amounts less than 100 t by the commercial trawl fishery up to the late 1980s, followed by increasing catches into the 1990s, when catches reached 958 t. Although there is some directed fishing on this species, it is most often caught along with other groundfish species in the commercial trawl fishery. Species separation with its congener *S. altivelis* (Longspine Thornyhead) did not occur in catch records until 1996 with the introduction of 100% observer coverage.

The coastwide stock was assessed using a delay-difference model fit to five fishery-independent surveys, a catch per unit of effort (CPUE) time series derived from commercial catch and effort data, and an annual time series of mean weights derived from unsorted commercial catch samples.

Uncertainty due to growth, natural mortality, and the age of knife-edged selectivity was evaluated by selecting 12 model scenarios for inclusion in the final averaged model. These included growth (options DFO vs. NMFS), natural mortality with three options (M = 0.03, 0.06, 0.08) for both growth functions, and size at knife-edge selectivity – one option for DFO growth (k = 29 cm) and three options for NMFS growth (k = 29, 24, 21 cm).

A model-averaged decision table was presented using the provisional reference points from the Fisheries and Oceans Canada Fishery Decision-making Framework incorporating the Precautionary Approach policy: a limit reference point (LRP) of $0.4B_{MSY}$, an upper stock reference (USR) of $0.8B_{MSY}$, and a reference harvest rate of u_{MSY}.

The estimated stock biomass trajectory remained above the estimates of the stock status reference points throughout the history of the fishery. Estimated current stock status (beginning year biomass in 2016) has a 0.97 probability of being above the USR and a 1.0 probability of being above the LRP (Figure 0). The probability that u_{2015} exceeded u_{MSY} is 0.72.

The stock is expected to decline if annual harvests of 600 t/year (the 2010-2014 average catch) are removed in each of the next three years. The probability that the decline will stay above the USR at the end of the next three years is 0.76. The probability that the stock will remain above the LRP after three years is 0.88.

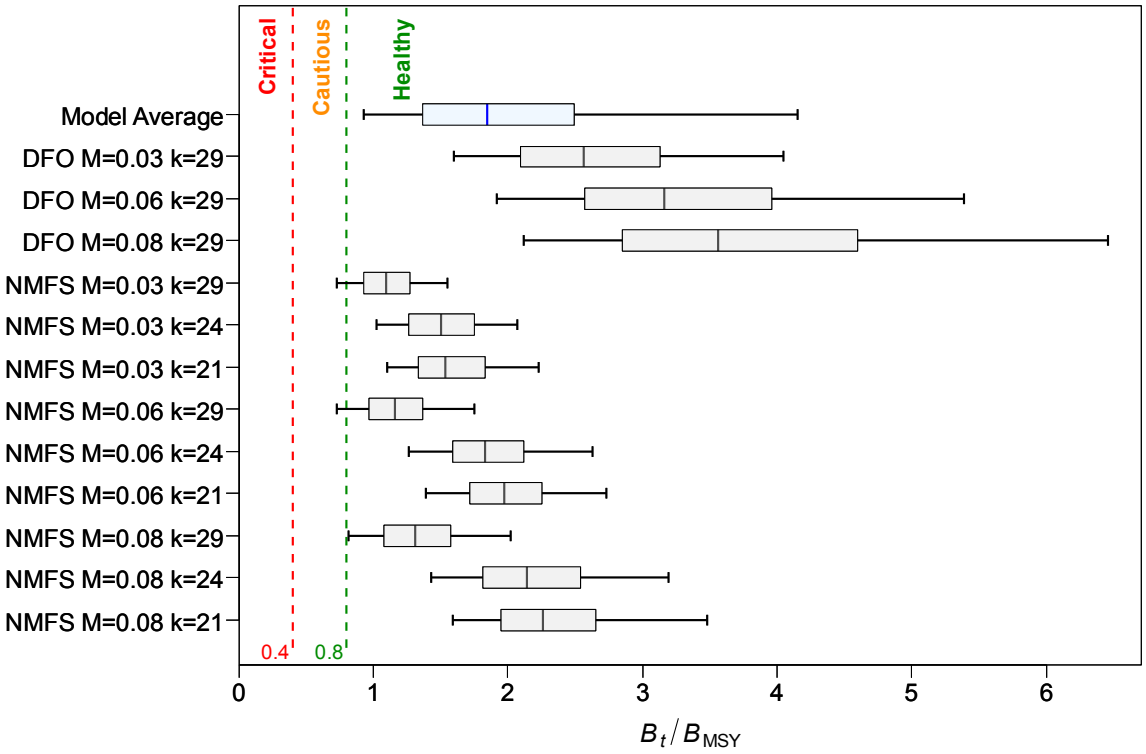

Figure 0. Current status of the coastwide BC Shortspine Thornyhead stock relative to the DFO Precautionary Approach provisional reference points of 0.4BMSY and 0.8BMSY. The value of Bt /BMSY uses t=2016. Boxplots show the 5, 25, 50, 75 and 95 percentiles from the MCMC results. The model average (top boxplot in blue) summarizes the 12 scenarios represented in the grey boxplots below the model average. DFO = Canadian Fisheries and Oceans; NMFS = US National Marine Fisheries Service; M = natural mortality (y-1); k = length (cm) at knife-edge selectivity.

J. Sablefish

1. Research

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) processes. 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. Fishery independent research surveys include the following activities:

a) A Stratified Random Survey using Longline Trap Gear (2003-2015)

This activity captures Sablefish for tagging and release following a depth and area stratified random survey design. Tag-recoveries are used for deriving estimates of gear selectivity and studying Sablefish movement. The catch rate data are used to derive an index of stock abundance. The survey also provides biological samples for determination of life history characteristics for Sablefish and non-target species (e.g., Blackspotted and Rougheye Rockfish.

e) An Inlets Survey using Longline Trap Gear (1995-2015)

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

Sablefish research surveys are planned for the fall of 2016 contingent on the availability of resources.

A new introduction to both surveys (a, b) in 2013-2015 was the deployment 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). This novel equipment will be deployed for the 2016 survey, and has been deployed on commercial trap gear fishing trips to SGaan Kinghlas-Bowie Seamount over the 2013-2015 period.

9. Assessment

As part of the ongoing development of the Sablefish MSE process, the Sablefish operating model was revised in 2015/16 to account for potential structural model mis-specification and lack-of-fit to key observations recognized in previous models. Specific modifications include: (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. 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. Estimates of Sablefish stock status, productivity, and trends over the past several years are consistent with previous harvest strategy simulations.

10. Management

In 2013, fishing industry stakeholders proposed a TAC floor of 1,992 t, because lower quotas may increase economic risks. The management procedure first applied in 2010 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 2010 procedure. Applying the revised procedure to updated landings and biomass index data resulted in a harvest recommendation of 1,992 t for the 2016/17 fishing season. The Sablefish operating model revised in 2015/16 will be used for feedback simulations to evaluate the expected performance of the existing management procedure against alternatives in 2016/17.

K. Lingcod

1. Research

Ongoing data collection in support of the lingcod research program continued in 2015 through the Groundfish Synoptic Surveys, port sampling, at-sea observer sampling, and recreational creel surveys.

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 continued in 2015 through the Groundfish Synoptic Surveys, port sampling, and at-sea observer sampling.

11. Assessment

In 2015, the first assessment of Arrowtooth Flounder since 2001 was done in B.C. The assessment model used was the Integrated Statistical Catch-at-Age model (iSCAM). A formal, statistical catch-at-age model has never previously been done in B.C. The model was female-only, since the catch data was found to be composed of 80-90% females. The model was fit to four indices of abundance and catch data. Reference

points estimated were the annual harvest rate producing MSY (U_{MSY}), and parameters relating to the initial biomass (B_0).

The probability of reducing the biomass to less than the level in 2015 was found to be less than 13% for all catch projections ranging from 0 to 30,000 t. The probability of reducing the biomass to less than the level in 1996 was found to be less than 11% for all catch projections ranging from 0 to 50,000 t.

The final assessment document is currently being completed for submission to CSAS.

12. Management

Arrowtooth Flounder are managed on a status-quo basis. An annual allocation of 15,000 t has been applied by managers since 2006. Before that time, there were no limits on catches or discards.

From 2005 – 2013, four freezer trawlers were added to the fishery. Their ability to process Arrowtooth Flounder while at sea mitigated some of the issues with proteolysis of the flesh and made the product more marketable. These new vessels have increased the fishing pressure on this stock, although they have stayed well below the 15,000 t TAC. The highest catch was in 2014 with 13,571 t and the last 5-year's average catch was 8,487 t.

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 this length data is supplied annually to IPHC. In addition, summaries of live and dead releases (based on condition) are provided.

O. Other groundfish species

V. Ecosystem Studies

A. 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.

Work was initiated on this project in 2015. A workplan has been developed and one of the first steps was a literature search and annotated bibliography on work that has been carried out on tiered approaches in other international jurisdictions. A workshop will be

held in May 2016 to present this work and to make decisions on an approach for BC groundfish fisheries.

VI. Publications

A. Primary

Breed, G.A, Severns, P.M, Edwards, A.M. 2015. Apparent power-law distributions in animal movements can arise from intraspecific interactions. *Journal of the Royal Society Interface,* 12 (103): 20140927.

Forrest, R.E., Savina, M., Fulton, E.A., Pitcher, T.J. 2015. Do marine ecosystem models give consistent policy evaluations? A comparison of Atlantis and Ecosim. Fisheries Research 167: 293-312.

Haigh, R., Ianson, D., Holt, C.A., Neate, H.E., Edwards, A.M. 2015. Effects of ocean acidification on temperate coastal marine ecosystems and fisheries in the northeast Pacific. *PLOS ONE* 10(2): e0117533. doi:10.1371/journal.pone.0117533

P. Other publications

Appendix 1

SUMMARY OF FISHERIES AND OCEANS CANADA PACIFIC REGION GROUNDFISH BOTTOM TRAWL SURVEYS IN 2015

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A. Multi-Species Small-mesh Bottom Trawl Survey

An annual fixed-station survey of commercially important shrimp grounds off the West Coast of Vancouver Island was initiated in 1973. In 1998, areas in Eastern Queen Charlotte Sound were added to the survey. The survey 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. Starting in 2014, only one groundfish staff participated in the survey. At that time, the sampling program was reduced so that a single person could accomplish all the work. In addition, the sampling program was also rationalized to only include species where the survey is expected to provide a useful index of abundance.

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 Queen Charlotte Sound area was also not visited in 2015 due to staffing limitations.

The 2015 survey was conducted onboard the W.E. Ricker and ran from April 30 to May 16. A total of 122 tows were completed (Figure 1). The total catch weight of all species was 48,185 kg. The mean catch per tow was 395 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 Pacific Herring (*Clupea pallasii*), Arrowtooth Flounder (*Reinhardtius stomias*), Flathead Sole (*Hippoglossoides elassodon*), and Spotted Ratfish (*Hydrolagus colliei*). 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 9,454 individual fish from 18 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 directly collect the biological data from this species.

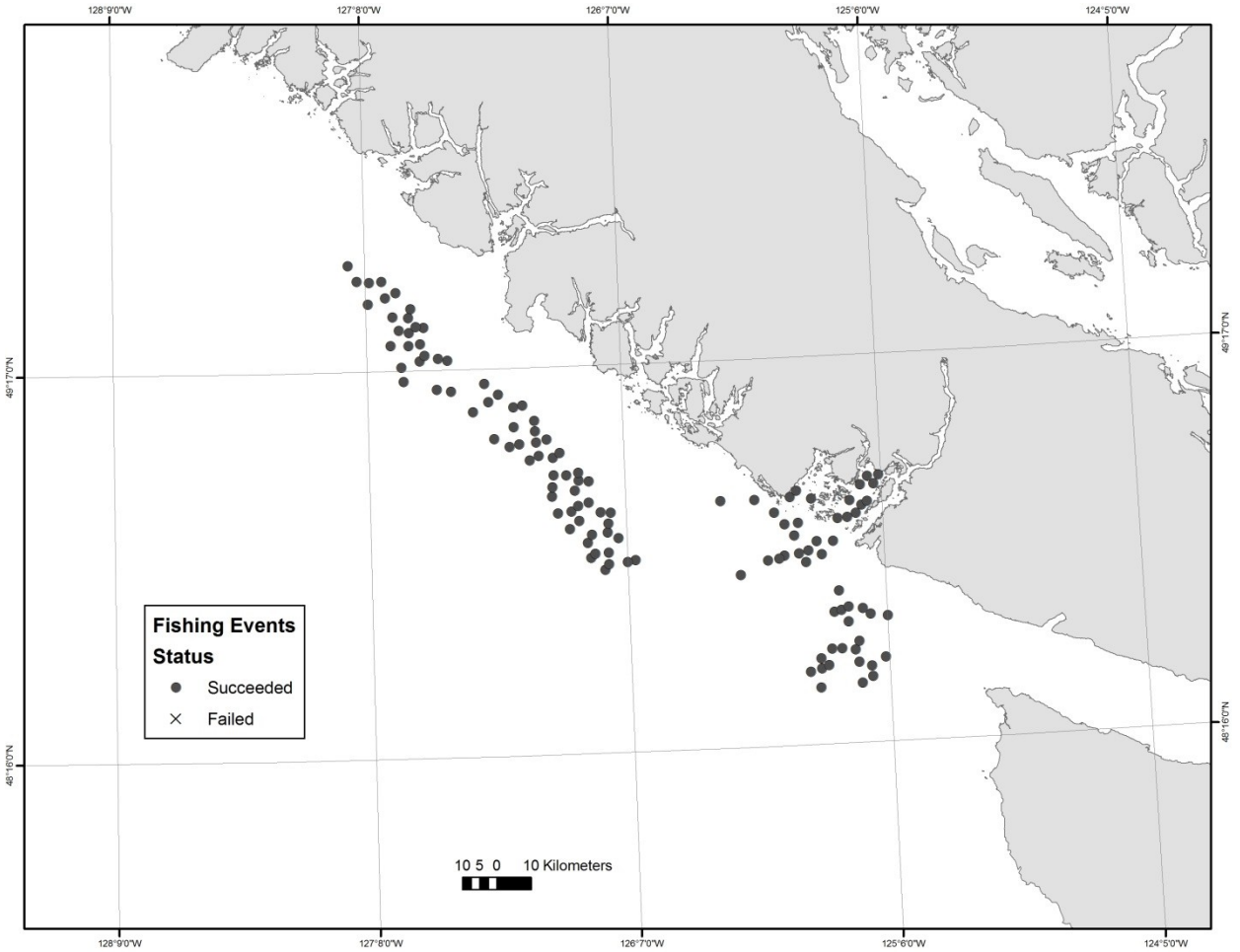

Figure 1. Barkley Sound and West Coast Vancouver Island set locations of the 2015 Multi-species Small Mesh Bottom Trawl Survey

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 2015 Multi-species Small Mesh Bottom Trawl Survey.

Species	Scientific Name	Num. Tows	Catch (kg)	Biomass (t)	Rel. Error
Eulachon	*Thaleichthys pacificus*	66	5777	1262	0.38
Pacific Herring	*Clupea pallasii*	70	3086	266	0.28
Arrowtooth Flounder	*Reinhardtius stomias*	71	2755	614	0.39
Flathead Sole	*Hippoglossoides elassodon*	69	1347	279	0.38
Pacific Cod	*Gadus macrocephalus*	58	1105	238	0.51
Rex Sole	*Glyptocephalus zachirus*	70	945	154	0.25
Yellowtail Rockfish	*Sebastes flavidus*	28	841	107	0.81
Walleye Pollock	*Theragra chalcogramma*	61	775	170	0.59
Pacific Sanddab	*Citharichthys sordidus*	40	627	105	0.45
Slender Sole	*Lyopsetta exilis*	71	623	84	0.29
Dover Sole	*Microstomus pacificus*	67	549	64	0.31
Sablefish	*Anoplopoma fimbria*	50	328	29	0.51
Spotted Ratfish	*Hydrolagus colliei*	61	289	47	0.28
Lingcod	*Ophiodon elongatus*	44	264	54	0.28
Pacific Halibut	*Hippoglossus stenolepis*	31	214	38	0.4
Pacific Hake	*Merluccius productus*	32	208	23	0.51
English Sole	*Parophrys vetulus*	53	142	31	0.32
Blackbelly Eelpout	*Lycodes pacificus*	59	139	22	0.58
North Pacific Spiny Dogfish	*Squalus suckleyi*	17	104	11	0.73
Petrale Sole	*Eopsetta jordani*	27	78	14	0.58
Longnose Skate	*Raja rhina*	31	70	5	0.58
Darkblotched Rockfish	*Sebastes crameri*	42	31	2	0.32
Chinook Salmon	*Oncorhynchus tshawytscha*	14	25	3	0.61
American Shad	*Alosa sapidissima*	18	23	1	0.55
Whitebait Smelt	*Allosmerus elongatus*	22	18	2	0.52

Table 2. Number of fish sampled for biological data during the 2015 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
Big Skate	*Raja binoculata*	6	0
Sandpaper Skate	*Bathyraja interrupta*	9	0
Longnose Skate	*Raja rhina*	107	0
American Shad	*Alosa sapidissima*	188	0
Pacific Herring	*Clupea pallasii*	750	0
Eulachon	*Thaleichthys pacificus*	4799	0
Pacific Cod	*Gadus macrocephalus*	322	0
Walleye Pollock	*Theragra chalcogramma*	541	0
Rougheye Rockfish	*Sebastes aleutianus*	61	61
Sablefish	*Anoplopoma fimbria*	255	0
Lingcod	*Ophiodon elongatus*	58	12
Arrowtooth Flounder	*Reinhardtius stomias*	671	0
Petrale Sole	*Eopsetta jordani*	12	0
Rex Sole	*Glyptocephalus zachirus*	1028	0
Flathead Sole	*Hippoglossoides elassodon*	28	0
Pacific Halibut	*Hippoglossus stenolepis*	68	0
Dover Sole	*Microstomus pacificus*	275	0
English Sole	*Parophrys vetulus*	276	0

Q. 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 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 on even-numbered years. 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.

In 2015 the Hecate Strait and Queen Charlotte Sound surveys were conducted.

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. Research vessel time has been secured for March 2017 and the new plan is to move forward conducting the Strait of Georgia survey biennially, in odd numbered years.

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.

1. Strait of Georgia Multi-species Synoptic Bottom Trawl Survey

The Strait of Georgia Multi-Species Synoptic Bottom Trawl Survey was conducted on the Canadian Coast Guard Ship W. E. Ricker between May 17 and 24. We assessed a total of 121 blocks (Table 3, Figure 2). Of the 45 total tows conducted, 42 were successful and 3 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 7 different DFO staff participated in the survey.

The total catch weight of all species was 17,972 kg. The mean catch per tow was 408 kg, averaging 27 different species of fish and invertebrates in each. The most abundant fish species encountered were North Pacific Spiny Dogfish (*Squalus suckleyi*), Spotted Ratfish (*Hydrolagus colliei*), Pacific Hake (*Merluccius productus*), and Slender Sole (*Lyopsetta exilis*). 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 6,976 individual fish of 31 different species (

). Oceanographic data, including water temperature, depth, salinity, and dissolve oxygen were also recorded for most tows.

Table 3. 2015 Strait of Georgia 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, other vessels in the area, or insufficient time at the end of the survey) by stratum.

Depth Stratum (m)	Rejected Prior	Rejected Inspected	Failed	Success	Not Fished	Total
10 - 75	18	13	1	4	8	44
75 - 150	6	6	2	16	1	31
150 - 250	5	4	0	11	8	28
250 - 500	5	3	0	11	4	23
Total	**34**	**26**	**3**	**42**	**21**	**126**

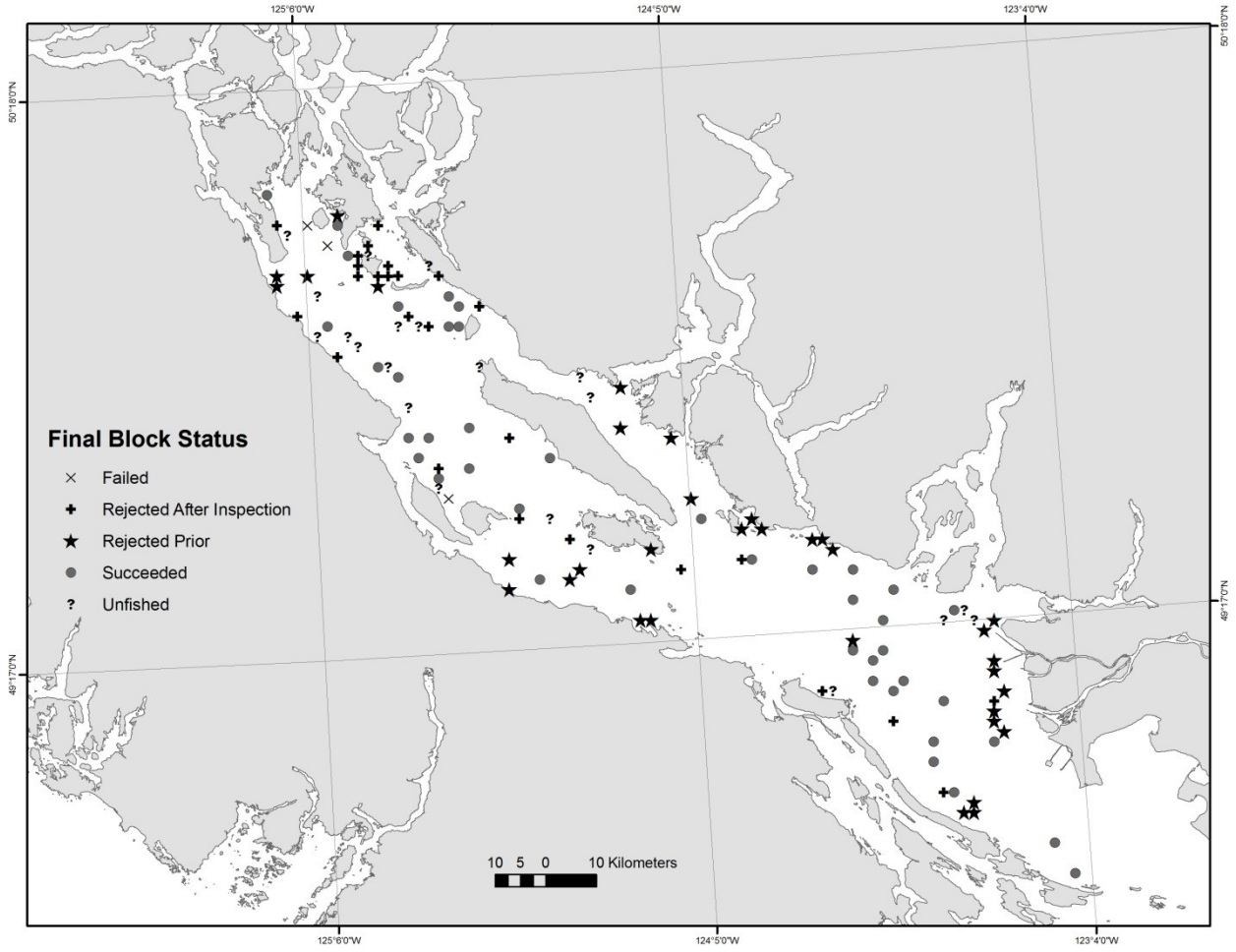

Figure 2. Final status of the allocated blocks for the 2015 Strait of Georgia Multi-Species Synoptic Bottom Trawl Survey.

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 2015 Strait of Georgia Multi-Species Synoptic Bottom Trawl Survey.

Species	Scientific Name	Num. Tows	Catch (kg)	Biomass (t)	Rel. Error
North Pacific Spiny Dogfish	*Squalus suckleyi*	42	4175	3583	0.24
Spotted Ratfish	*Hydrolagus colliei*	42	3958	4354	0.17
Pacific Hake	*Merluccius productus*	38	3635	2902	0.33
Slender Sole	*Lyopsetta exilis*	41	1308	1079	0.31
English Sole	*Parophrys vetulus*	35	1116	1201	0.43
Walleye Pollock	*Theragra chalcogramma*	21	736	694	0.46
Pacific Cod	*Gadus macrocephalus*	20	499	456	0.36
Flathead Sole	*Hippoglossoides elassodon*	14	282	340	0.53
Plainfin Midshipman	*Porichthys notatus*	15	215	156	0.42
Greenstriped Rockfish	*Sebastes elongatus*	18	165	147	0.4
Dover Sole	*Microstomus pacificus*	32	140	136	0.17
Longnose Skate	*Raja rhina*	34	121	105	0.18
Starry Flounder	*Platichthys stellatus*	4	115	200	0.81
Arrowtooth Flounder	*Reinhardtius stomias*	27	111	80	0.35
Blackbelly Eelpout	*Lycodes pacificus*	16	98	127	0.47
Big Skate	*Raja binoculata*	7	93	106	0.42
Quillback Rockfish	*Sebastes maliger*	9	82	60	0.44
Splitnose Rockfish	*Sebastes diploproa*	15	81	54	0.39
Pacific Herring	*Clupea pallasii*	15	58	71	0.54
Rex Sole	*Glyptocephalus zachirus*	19	48	35	0.3
Lingcod	*Ophiodon elongatus*	14	44	38	0.3
Yelloweye Rockfish	*Sebastes ruberrimus*	9	25	23	0.5
Brown Cat Shark	*Apristurus brunneus*	18	23	22	0.19
Southern Rock Sole	*Lepidopsetta bilineata*	11	23	29	0.3
Black Eelpout	*Lycodes diapterus*	19	16	15	0.22

Table 5. Number of fish sampled for biological data during the 2015 Strait of Georgia 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
Bluntnose Sixgill Shark	*Hexanchus griseus*	1	0
Brown Cat Shark	*Apristurus brunneus*	96	0
North Pacific Spiny Dogfish	*Squalus suckleyi*	706	26
Big Skate	*Raja binoculata*	18	0
Longnose Skate	*Raja rhina*	127	0
Spotted Ratfish	*Hydrolagus colliei*	1043	0
American Shad	*Alosa sapidissima*	9	0
Pacific Herring	*Clupea pallasii*	157	0
Pacific Sardine	*Sardinops sagax*	1	0
Pacific Cod	*Gadus macrocephalus*	164	150
Pacific Hake	*Merluccius productus*	1086	253
Walleye Pollock	*Theragra chalcogramma*	370	28
Shiner Perch	*Cymatogaster aggregata*	1	0
Pile Perch	*Rhacochilus vacca*	1	0
Copper Rockfish	*Sebastes caurinus*	1	1
Splitnose Rockfish	*Sebastes diploproa*	207	0
Greenstriped Rockfish	*Sebastes elongatus*	343	0
Quillback Rockfish	*Sebastes maliger*	90	88
Yelloweye Rockfish	*Sebastes ruberrimus*	27	27
Shortspine Thornyhead	*Sebastolobus alascanus*	65	0
Sablefish	*Anoplopoma fimbria*	22	0
Lingcod	*Ophiodon elongatus*	32	20
Arrowtooth Flounder	*Reinhardtius stomias*	118	0
Petrale Sole	*Eopsetta jordani*	11	9
Rex Sole	*Glyptocephalus zachirus*	149	0
Flathead Sole	*Hippoglossoides elassodon*	208	0
Southern Rock Sole	*Lepidopsetta bilineata*	27	0
Slender Sole	*Lyopsetta exilis*	981	0
Dover Sole	*Microstomus pacificus*	333	30
English Sole	*Parophrys vetulus*	550	249
Starry Flounder	*Platichthys stellatus*	32	27

13. Hecate Strait Multi-species Synoptic Bottom Trawl Survey

The Hecate Strait Multi-Species Synoptic Bottom Trawl Survey was conducted on the Canadian Coast Guard Ship W. E. Ricker between May 26 and June 22. We assessed a total of 184 blocks (Table 6, Figure 3). Of the 152 total tows conducted, 148 were successful and 4 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 62,496 kg. The mean catch per tow was 411 kg, averaging 24 different species of fish and invertebrates in each. The most abundant fish species encountered were Arrowtooth Flounder (R*einhardtius stomias*), Spotted Ratfish (*Hydrolagus colliei*), Dover Sole (*Microstomus pacificus*), and Rex Sole (*Glyptocephalus zachirus*). 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 24,421 individual fish of 48 different species (

). Oceanographic data, including water temperature, depth, salinity, and dissolve oxygen were also recorded for most tows.

Table 6. 2015 Hecate Strait Multi-Species Synoptic Bottom Trawl Survey final block summary showing the number of blocks rejected based on fishing master's knowledge or by on-ground inspection, number of failed blocks (due to hang-ups or insufficient bottom time), number of successful tows, and number of un-fished blocks (due to other reasons such as tide, weather, or other vessels in the area) by stratum.

Depth Stratum (m)	Rejected Prior	Rejected Inspected	Failed	Success	Not Fished	Total
10-70	0	21	2	47	6	76
70-130	1	1	1	46	0	49
130-220	0	3	0	40	0	43
220-500	0	1	0	15	0	16
Total	**1**	**26**	**3**	**148**	**6**	**184**

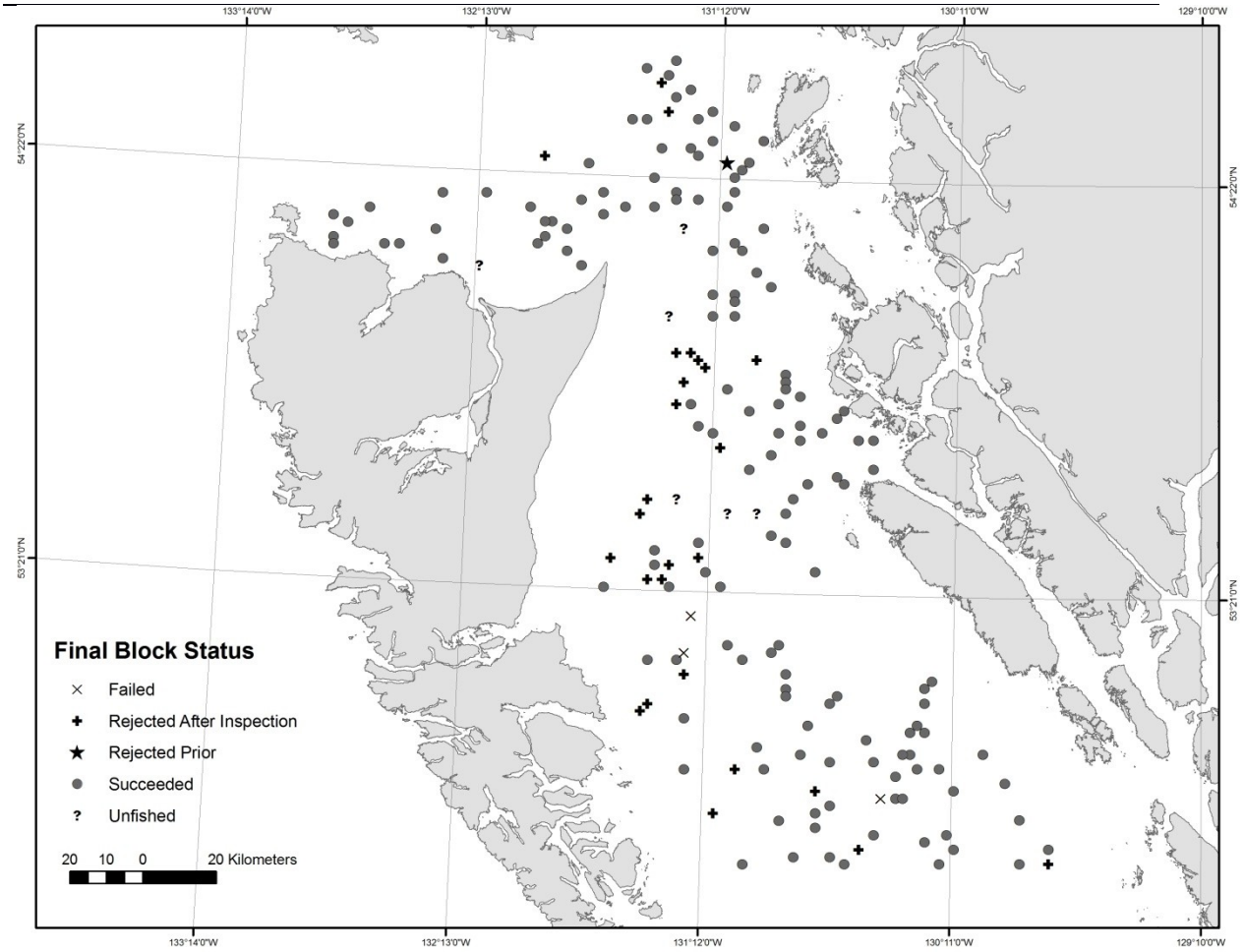

Figure 3. Final status of the allocated blocks for the 2015 Hecate Strait Multi-Species Synoptic Bottom Trawl Survey.

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 2015 Hecate Strait Multi-Species Synoptic Bottom Trawl Survey.

Species	Scientific Name	Num. Tows	Catch (kg)	Biomass (t)	Rel. Error
Arrowtooth Flounder	*Reinhardtius stomias*	123	13322	8563	0.18
Spotted Ratfish	*Hydrolagus colliei*	135	10927	9056	0.19
Dover Sole	*Microstomus pacificus*	117	5707	3258	0.17
Rex Sole	*Glyptocephalus zachirus*	120	4011	2504	0.12
English Sole	*Parophrys vetulus*	94	3973	3748	0.15
Pacific Halibut	*Hippoglossus stenolepis*	111	3636	3434	0.17
Walleye Pollock	*Theragra chalcogramma*	89	2924	1987	0.28
Southern Rock Sole	*Lepidopsetta bilineata*	70	2436	3294	0.28
Sablefish	*Anoplopoma fimbria*	93	1961	1539	0.37
Flathead Sole	*Hippoglossoides elassodon*	74	1802	1287	0.25
Pacific Cod	*Gadus macrocephalus*	107	1343	953	0.21
North Pacific Spiny Dogfish	*Squalus suckleyi*	77	1299	975	0.35
Sand Sole	*Psettichthys melanostictus*	33	651	840	0.27
Eulachon	*Thaleichthys pacificus*	59	649	471	0.35
Yellowtail Rockfish	*Sebastes flavidus*	28	522	422	0.5
Redbanded Rockfish	*Sebastes babcocki*	38	467	281	0.19
Big Skate	*Raja binoculata*	35	465	367	0.21
Pacific Ocean Perch	*Sebastes alutus*	53	461	249	0.28
Silvergray Rockfish	*Sebastes brevispinis*	48	439	265	0.23
Petrale Sole	*Eopsetta jordani*	69	369	281	0.16
Pacific Herring	*Clupea pallasii*	69	358	456	0.29
Shortspine Thornyhead	*Sebastolobus alascanus*	43	358	276	0.3
Quillback Rockfish	*Sebastes maliger*	32	314	280	0.32
Longnose Skate	*Raja rhina*	29	267	157	0.27
Pacific Sanddab	*Citharichthys sordidus*	21	260	298	0.45

Table 8. Number of fish sampled for biological data during the 2015 Hecate Strait 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
Tope Shark	*Galeorhinus galeus*	9	0
North Pacific Spiny Dogfish	*Squalus suckleyi*	292	79
Aleutian Skate	*Bathyraja aleutica*	4	0
Big Skate	*Raja binoculata*	69	0
Sandpaper Skate	*Bathyraja interrupta*	21	0
Longnose Skate	*Raja rhina*	59	0
Spotted Ratfish	*Hydrolagus colliei*	3040	0
Pacific Herring	*Clupea pallasii*	50	0
Eulachon	*Thaleichthys pacificus*	1272	0
Pacific Cod	*Gadus macrocephalus*	903	834
Pacific Tomcod	*Microgadus proximus*	404	0
Walleye Pollock	*Theragra chalcogramma*	1061	240
Rougheye Rockfish	*Sebastes aleutianus*	63	63
Pacific Ocean Perch	*Sebastes alutus*	364	269
Redbanded Rockfish	*Sebastes babcocki*	208	208
Shortraker Rockfish	*Sebastes borealis*	2	2
Silvergray Rockfish	*Sebastes brevispinis*	223	56
Copper Rockfish	*Sebastes caurinus*	123	109
Puget Sound Rockfish	*Sebastes emphaeus*	28	28
Widow Rockfish	*Sebastes entomelas*	34	28
Yellowtail Rockfish	*Sebastes flavidus*	184	82
Quillback Rockfish	*Sebastes maliger*	321	261
Bocaccio	*Sebastes paucispinis*	3	3
Canary Rockfish	*Sebastes pinniger*	62	54
Redstripe Rockfish	*Sebastes proriger*	84	24
Yellowmouth Rockfish	*Sebastes reedi*	5	0
Yelloweye Rockfish	*Sebastes ruberrimus*	4	4
Pygmy Rockfish	*Sebastes wilsoni*	7	0
Sharpchin Rockfish	*Sebastes zacentrus*	43	0
Shortspine Thornyhead	*Sebastolobus alascanus*	509	85
Sablefish	*Anoplopoma fimbria*	695	186
Kelp Greenling	*Hexagrammos decagrammus*	60	0
Lingcod	*Ophiodon elongatus*	36	14
Pacific Sanddab	*Citharichthys sordidus*	236	0
Arrowtooth Flounder	*Reinhardtius stomias*	3019	853
Petrale Sole	*Eopsetta jordani*	364	255
Rex Sole	*Glyptocephalus zachirus*	2715	321
Flathead Sole	*Hippoglossoides elassodon*	1283	233
Pacific Halibut	*Hippoglossus stenolepis*	686	0
Butter Sole	*Isopsetta isolepis*	366	188
Southern Rock Sole	*Lepidopsetta bilineata*	1550	874
Yellowfin Sole	*Limanda aspera*	25	0
Slender Sole	*Lyopsetta exilis*	101	0
Dover Sole	*Microstomus pacificus*	1868	1068
English Sole	*Parophrys vetulus*	2215	1156
Starry Flounder	*Platichthys stellatus*	37	0
Curlfin Sole	*Pleuronichthys decurrens*	93	49
Sand Sole	*Psettichthys melanostictus*	603	0

14. Queen Charlotte Sound Multi-species Synoptic Bottom Trawl Survey

The Queen Charlotte Sound Multi-Species Synoptic Bottom Trawl Survey was conducted on the F/V Frosti between July 6 and August 8. We assessed a total of 293 blocks (Table 9, Figure 4). Of the 251 total tows conducted, 239 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.

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

The total catch weight of all species was 90,986 kg. The mean catch per tow was 368 kg, averaging 23 different species of fish and invertebrates in each. The most abundant fish species encountered were Arrowtooth Flounder (*Reinhardtius stomias*), Pacific Ocean Perch (*Sebastes alutus*), Silvergray Rockfish (*Sebastes brevispinis*), and Rex Sole (G*lyptocephalus zachirus*), 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 10. Biological data, including individual length, weight, sex, maturity, and age structure were collected from a total of 28,686 individual fish of 46 different species (Table 11). Oceanographic data, including water temperature, depth, salinity, and dissolve oxygen were also recorded for most tows.

Table 9. 2015 Queen Charlotte Sound Multi-Species Synoptic Bottom Trawl Survey final block summary showing the number of blocks rejected based on fishing master's knowledge or by on-ground inspection, number of failed blocks (due to hang-ups or insufficient bottom time), number of successful tows, and number of un-fished blocks (due to other reasons such as tide, weather, or other vessels in the area) by stratum.

Depth Stratum (m)	Rejected Prior	Rejected Inspected	Failed	Success	Not Fished	Total
North 50 to 125 m	0	8	1	12	0	21
North 125 to 200 m	2	7	2	50	0	61
North 200 to 330 m	0	3	0	44	0	47
North 330 to 500 m	0	0	0	7	1	8
South 50 to 125 m	2	1	2	30	5	40
South 125 to 200 m	3	5	0	65	0	73
South 200 to 330 m	0	6	2	26	0	34
South 330 to 500 m	0	4	1	4	0	9
Total	**7**	**34**	**8**	**238**	**6**	**293**

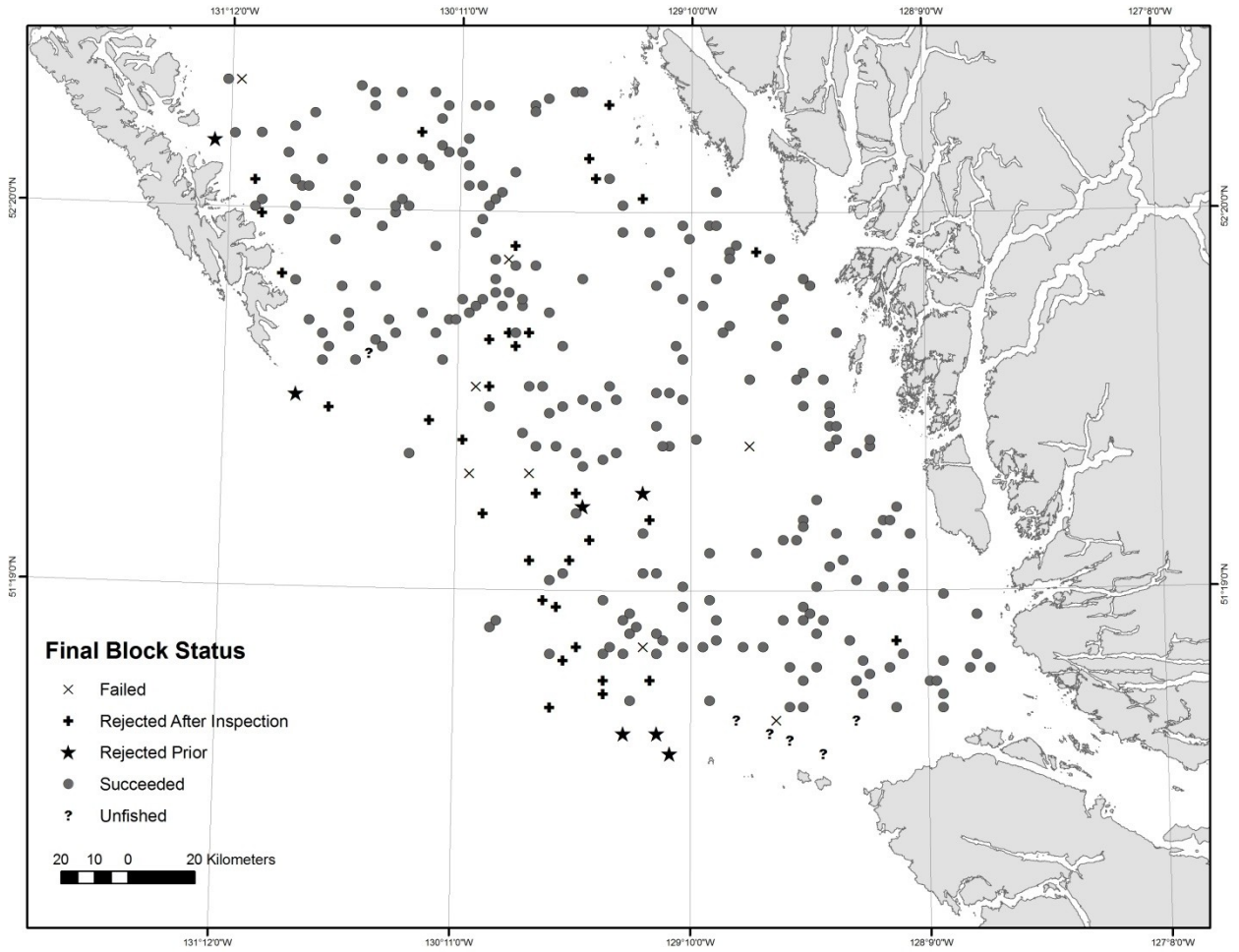

Figure 4. Final status of the allocated blocks for the 2015 Queen Charlotte Sound Multi-Species Synoptic Bottom Trawl Survey.

Table 10. 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 2015 Queen Charlotte Sound Multi-Species Synoptic Bottom Trawl Survey.

Species	Scientific Name	Num. Tows	Catch (kg)	Biomass (t)	Rel. Error
Arrowtooth Flounder	*Reinhardtius stomias*	225	19602	14099	0.15
Pacific Ocean Perch	*Sebastes alutus*	159	19504	14715	0.23
Silvergray Rockfish	*Sebastes brevispinis*	139	8072	5169	0.33
Walleye Pollock	*Theragra chalcogramma*	145	2727	2107	0.31
Rex Sole	*Glyptocephalus zachirus*	201	2725	2151	0.12
Dover Sole	*Microstomus pacificus*	168	2704	2190	0.17
Yellowtail Rockfish	*Sebastes flavidus*	51	2421	1561	0.34
Redstripe Rockfish	*Sebastes proriger*	58	2296	1555	0.31
Sablefish	*Anoplopoma fimbria*	134	2249	1952	0.11
Canary Rockfish	*Sebastes pinniger*	43	2098	1447	0.44
Flathead Sole	*Hippoglossoides elassodon*	94	1847	1526	0.33
Rougheye Rockfish	*Sebastes aleutianus*	58	1842	1848	0.4
Pacific Cod	*Gadus macrocephalus*	125	1617	1144	0.28
Shortspine Thornyhead	*Sebastolobus alascanus*	94	1556	1287	0.12
Yellowmouth Rockfish	*Sebastes reedi*	45	1405	1013	0.41
Pacific Hake	*Merluccius productus*	62	1308	1159	0.18
Spotted Ratfish	*Hydrolagus colliei*	202	1279	1336	0.23
Pacific Halibut	*Hippoglossus stenolepis*	90	1117	1080	0.31
Redbanded Rockfish	*Sebastes babcocki*	103	1075	778	0.25
English Sole	*Parophrys vetulus*	79	785	755	0.23
North Pacific Spiny Dogfish	*Squalus suckleyi*	106	577	447	0.18
Sharpchin Rockfish	*Sebastes zacentrus*	70	562	392	0.4
Longnose Skate	*Raja rhina*	62	561	441	0.13
Splitnose Rockfish	*Sebastes diploproa*	46	493	333	0.45
Greenstriped Rockfish	*Sebastes elongatus*	66	415	276	0.27

Table 11. Number of fish sampled for biological data during the 2015 Queen Charlotte Sound Multi-Species Synoptic Bottom Trawl Survey showing the number of lengths and age structures that were collected by species.

Species	Scientific Name	Lengths Collected	Age Structures Collected
North Pacific Spiny Dogfish	*Squalus suckleyi*	75	0
Aleutian Skate	*Bathyraja aleutica*	2	0
Big Skate	*Raja binoculata*	12	0
Sandpaper Skate	*Bathyraja interrupta*	19	0
Longnose Skate	*Raja rhina*	126	0
Spotted Ratfish	*Hydrolagus colliei*	885	0
Eulachon	*Thaleichthys pacificus*	1043	0
Pacific Cod	*Gadus macrocephalus*	965	778
Pacific Hake	*Merluccius productus*	462	76
Pacific Tomcod	*Microgadus proximus*	18	0
Walleye Pollock	*Theragra chalcogramma*	1439	216
Rougheye Rockfish	*Sebastes aleutianus*	332	332
Pacific Ocean Perch	*Sebastes alutus*	2249	1344
Redbanded Rockfish	*Sebastes babcocki*	495	332
Shortraker Rockfish	*Sebastes borealis*	39	39
Silvergray Rockfish	*Sebastes brevispinis*	1362	770
Darkblotched Rockfish	*Sebastes crameri*	31	0
Splitnose Rockfish	*Sebastes diploproa*	212	0
Greenstriped Rockfish	*Sebastes elongatus*	513	24
Widow Rockfish	*Sebastes entomelas*	67	32
Yellowtail Rockfish	*Sebastes flavidus*	396	232
Rosethorn Rockfish	*Sebastes helvomaculatus*	155	0
Shortbelly Rockfish	*Sebastes jordani*	8	0
Quillback Rockfish	*Sebastes maliger*	88	57
Bocaccio	*Sebastes paucispinis*	6	6
Canary Rockfish	*Sebastes pinniger*	318	258
Redstripe Rockfish	*Sebastes proriger*	491	320
Yellowmouth Rockfish	*Sebastes reedi*	282	194
Yelloweye Rockfish	*Sebastes ruberrimus*	60	60
Harlequin Rockfish	*Sebastes variegatus*	5	0
Pygmy Rockfish	*Sebastes wilsoni*	103	0
Sharpchin Rockfish	*Sebastes zacentrus*	655	137
Shortspine Thornyhead	*Sebastolobus alascanus*	1686	283
Longspine Thornyhead	*Sebastolobus altivelis*	45	29
Sablefish	*Anoplopoma fimbria*	1228	349
Lingcod	*Ophiodon elongatus*	89	31
Pacific Sanddab	*Citharichthys sordidus*	258	0
Arrowtooth Flounder	*Reinhardtius stomias*	3805	1291
Petrale Sole	*Eopsetta jordani*	279	161
Rex Sole	*Glyptocephalus zachirus*	3230	292
Flathead Sole	*Hippoglossoides elassodon*	1654	134
Pacific Halibut	*Hippoglossus stenolepis*	214	0
Southern Rock Sole	*Lepidopsetta bilineata*	377	177
Slender Sole	*Lyopsetta exilis*	321	0
Dover Sole	*Microstomus pacificus*	1660	626
English Sole	*Parophrys vetulus*	927	451