Threatened rockfish species may have a long road to recovery

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What's happening?

Rockfish populations along the B.C. south coast remain depressed since a record low in the 1990s, following high levels of harvest from the 1970s through the 1990s.[1] Quillback rockfish, an inshore rockfish species listed as threatened by COSEWIC in 2009[2] and the focus of this article, have shown year-to-year variation in abundance both in inside waters of the Strait of Georgia and in outside waters of the West Coast of Vancouver Island since the mid-1990s (Figure 1 and 2). Longline surveys conducted by Fisheries and Oceans Canada (DFO) (some in collaboration with industry)[3] also show year-to-year variation in the abundance of quillback rockfish in inside and outside waters from 2003 to 2016. Only in areas on British Columbia's north

Adult quillback rockfish. (Photo: Lee Newman)

coast are indices of quillback rockfish populations showing a slight positive trend.

Quillback (and copper) rockfish were prime targets in the live market fishery of the 1980s, which led to their serial depletion on a reef-by-reef basis.[4] As quillback rockfish are one of the longest-lived rockfish species, recovery of this species may take decades of favourable environmental conditions coinciding with sufficient reproductive-age adults. An example of these two parameters coinciding occurred during a climate regime[5] between 2000 and 2010. During this period, observed quillback rockfish abundance was higher in inside waters than either before or after (Figure 2), primarily due to a high survival rate for young of the year rockfish in multiple years during that climate regime.[6] Abundant year classes do occur from time to time – we have received reports that 2016 was an exceptional year class for some rockfish species along large stretches of the Pacific Coast in outside waters. Perhaps related to this, high abundances of young yellowtail rockfish were observed in 2017 in inside waters, during Ocean Wise Rockfish Abundance Surveys.

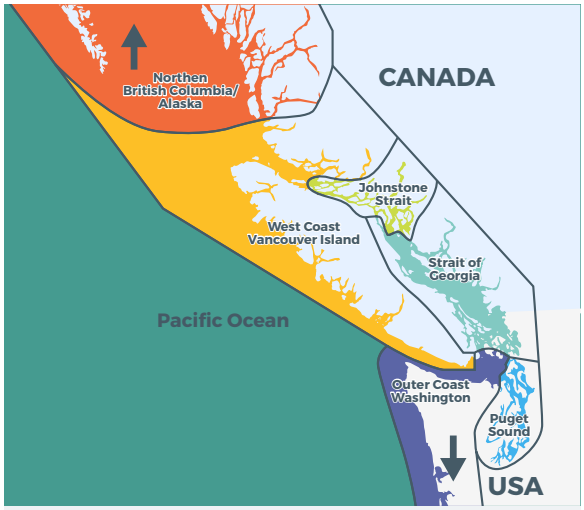


Figure 1. Zoogeographic map of regions along the B.C. coast (reproduced from Marliave et al. 2011). Inside waters refer to waters between Vancouver Island and the mainland of British Columbia, and everything else is generally referred to as outside waters.

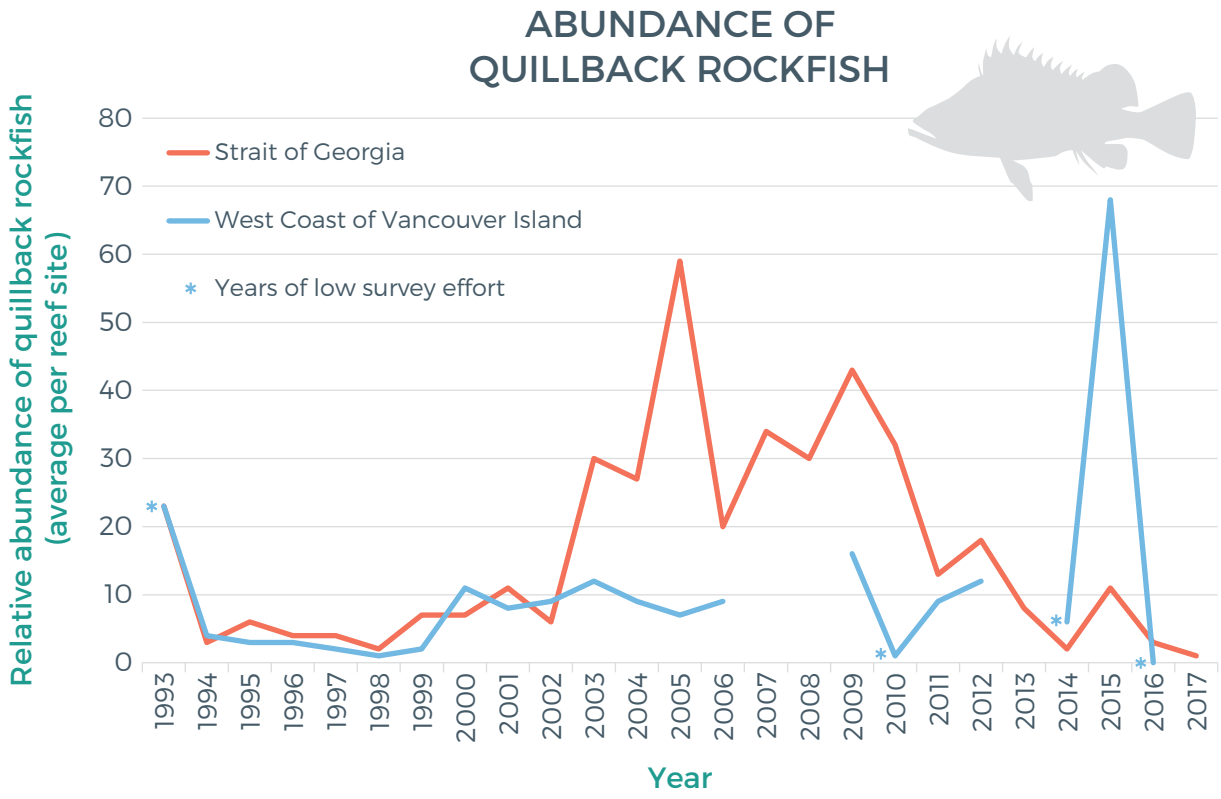


Figure 2. Relative abundance of quillback rockfish in the Strait of Georgia and the west coast of Vancouver Island between 1993 and 2017. Data presented, from citizen science surveys, are relative abundance based on survey enumeration methods used by Pacific Marine Life Surveys.[7] Years of low survey effort in the west coast of Vancouver Island (less than 10 surveys) are indicated. No surveys were conducted in 2007, 2008 or 2013. Average number of surveys per year, excluding years without surveys, in the region was 17. Average number of surveys per year in the Strait of Georgia through the same time period was 119, with a minimum of 71 surveys in any given year. Data source: Donna Gibbs, Pacific Marine Life Surveys.

Young rockfish abundance takes off in 2016

2016 marked an exceptional year class for some rockfish species. An unprecedented abundance of young of the year was documented by the diving community along the Pacific coast from Neah Bay, Washington to the central coast of British Columbia.[8] This booming year class highlights what can occur when the necessary environmental and food conditions are just right. Records of young rockfish counted during dive surveys based out of the Hakai Institute on B.C.'s central coast demonstrate a spike in abundance in 2016, such that counts more than doubled what had been observed in any of the three previous years (Figure 3, 4).

Figure 3. Unusually high abundances of young rockfish observed in 2016 on the central coast of B.C. (Video capture: Jenn Burt)

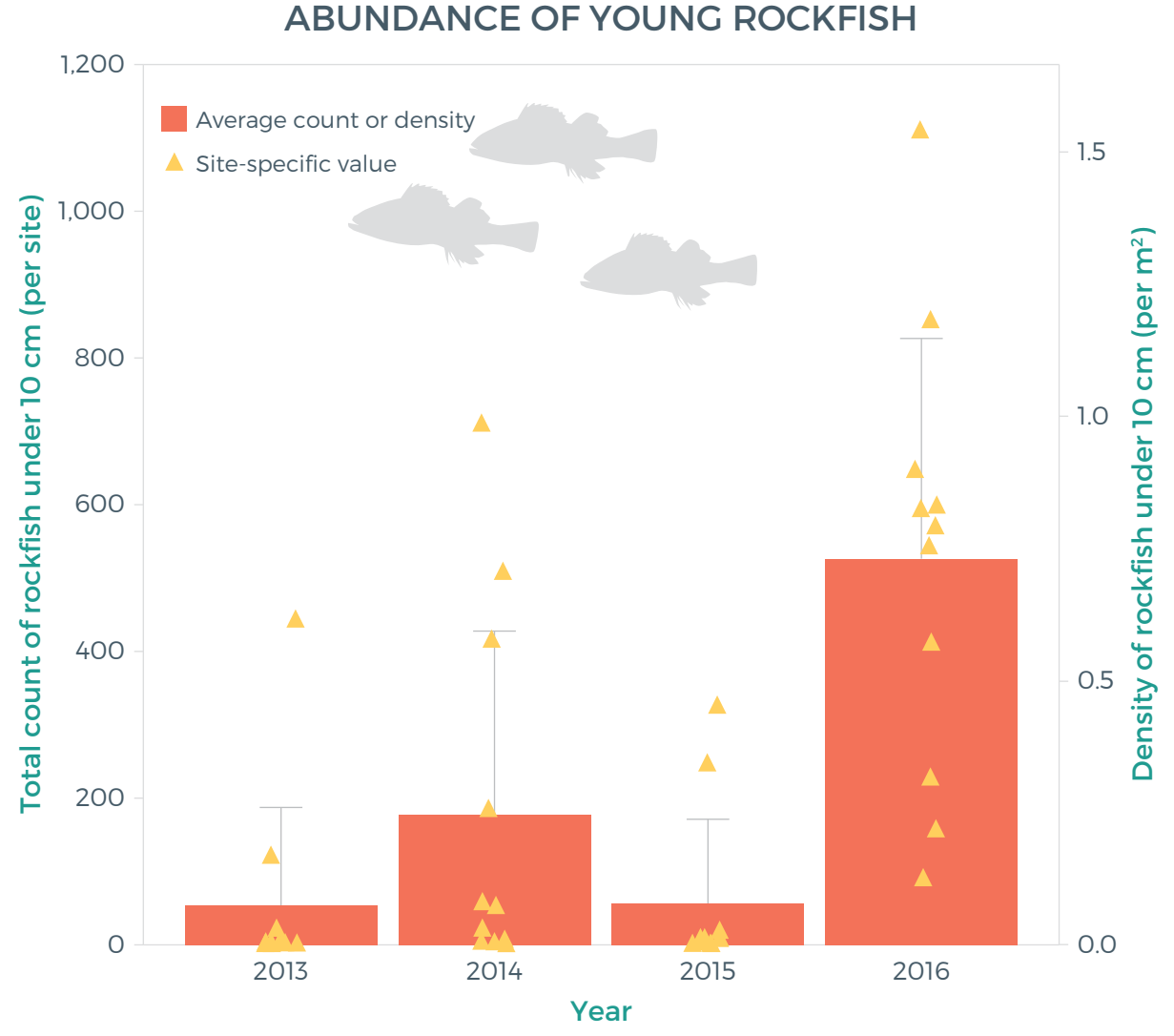


Figure 4. Abundance of young rockfish (10 cm or smaller) that were recorded by divers during scuba surveys at 11 rocky reef sites on the central coast of B.C. The bars indicate the average total count or density of young rockfish across all sites (+ standard deviation). The triangles show the actual values for each individual reef site. These data were collected by Jenn Burt and Anne Salomon as part of the reef monitoring surveys supported by Coastal Marine Ecology and Conservation Lab at Simon Fraser University and the Hakai Institute. For more information regarding these data, contact Anne.Salomon@sfu.ca.

Juvenile quillback rockfish. (Photo: Bernie Hanby)

Why is it important?

Thirty-seven species of rockfishes occur in British Columbia waters. Some species are only regionally abundant such as canary rockfish, China rockfish and deacon rockfish that predominantly occur on the outer coast. Some rockfishes have quite small home ranges and high site fidelity,[9] and many are long-lived species – quillback and yelloweye rockfishes live approximately a century – making them highly susceptible to overfishing.[10] As populations were severely depleted just 25 years ago, detectable population recovery may still be decades away.

Rockfishes are an important link in the rocky reef communities of the Northeast Pacific.[11] These mid-level predators eat crustaceans and small fishes and are consumed by larger reef fish and small marine mammals.

Is there a particular importance or connection to First Nations?

Quillback rockfish and other species of rockfish are an important component of Coastal First Nations' diets, as they provide food security year-round.[12] An archeological study conducted in Barkley Sound on the west coast of Vancouver Island recovered and examined skeletal remains of rockfish species, indicating regular use by First Nations communities for over 1,500 years.[13] In three communities in Barkley Sound, remains of rockfish species were found in 96 percent of excavation unit assemblages. Further supporting the importance of rockfish species to Coastal First Nations, a meta-analysis of 40 years' worth of zooarcheological data from this coast found widespread inclusion of rockfish in First Nations diets.[14]

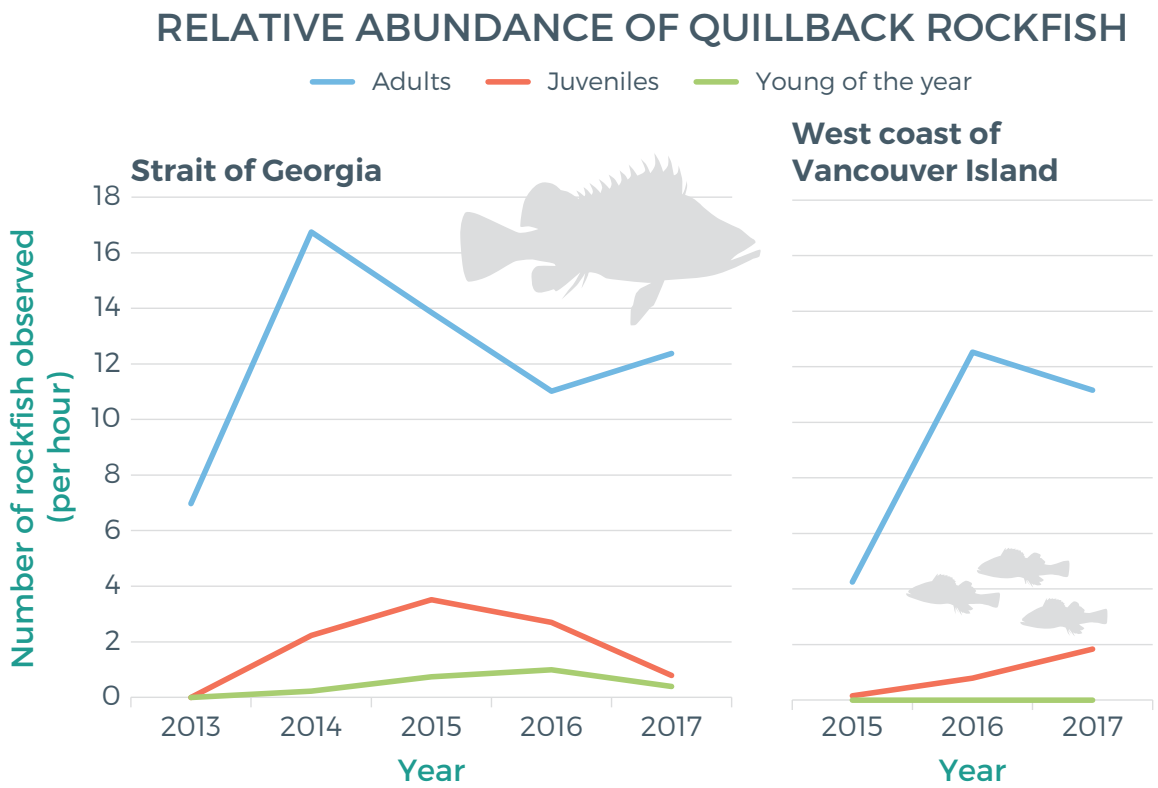


Figure 5. Relative abundance (individuals sighted per hour) of quillback rockfish of different life stages, observed in the Strait of Georgia (2013-2017) and the west coast of Vancouver Island (2015-2017). Data for 2013 and 2014 on the west coast of Vancouver Island is not available. Data Source: Roving diver biodiversity surveys, Howe Sound Research and Conservation, Coastal Ocean Research Institute, an Ocean Wise initiative.

What is the current status?

Long-term abundance records for quillback rockfish indicate little recovery since overfishing into the 1990s. Roving-diver biodiversity surveys from 1993 to 2017[15] show an average abundance (including adults, juveniles and young of the year[16]) of quillback rockfish of 10 and 16 individuals per reef site for the west coast of Vancouver Island and Strait of Georgia regions, respectively (Figure 2). (Note that counts as high as 1,000 fish per hour have been recorded for other species of rockfish in years of high abundance.) An apparent spike in abundance in the west coast of Vancouver Island for 2015 was the result of a very high count at one site on northeast Vancouver Island, demonstrating high site-to-site variability. Removing this outlier reduces the abundance score from 68 to 15 quillback rockfish for that year. Owing to the small home ranges of quillback rockfish, high site-to-site variability of abundances is expected.

A notable increase in observations of quillback rockfish in the Strait of Georgia occurred between 2002 and 2011, especially observations of juvenile and young of the year[17] (Figure 2). This decade-long increase began shortly after the millennial climate regime shift[18] and ended in about 2011. A climate regime shift for 2011 has been proposed, based in part on the period of increase observed for quillback rockfish, and in part on additional long-term biodiversity data.[19] Climate regimes are characterized by either warm or cold patterns in sea surface temperature (tracked by the National Oceanic and Atmospheric Administration's (NOAA) Oceanic Niño Index[20]) and can relate to trends in biodiversity.[21] The current climate regime starting in 2011 corresponds with lower recruitment success of quillback rockfish in the Strait of Georgia.[22] However, the relationship may not be causal. Not only do abiotic conditions need to be ideal, but biotic conditions, or food sources that rockfish rely on, need to be in abundance for each developmental stage of the rockfish in order to see significant year class success such as in 1926, 1946, and 1968. These quillback year classes supported the commercial fisheries for the latter half of the 20th century.

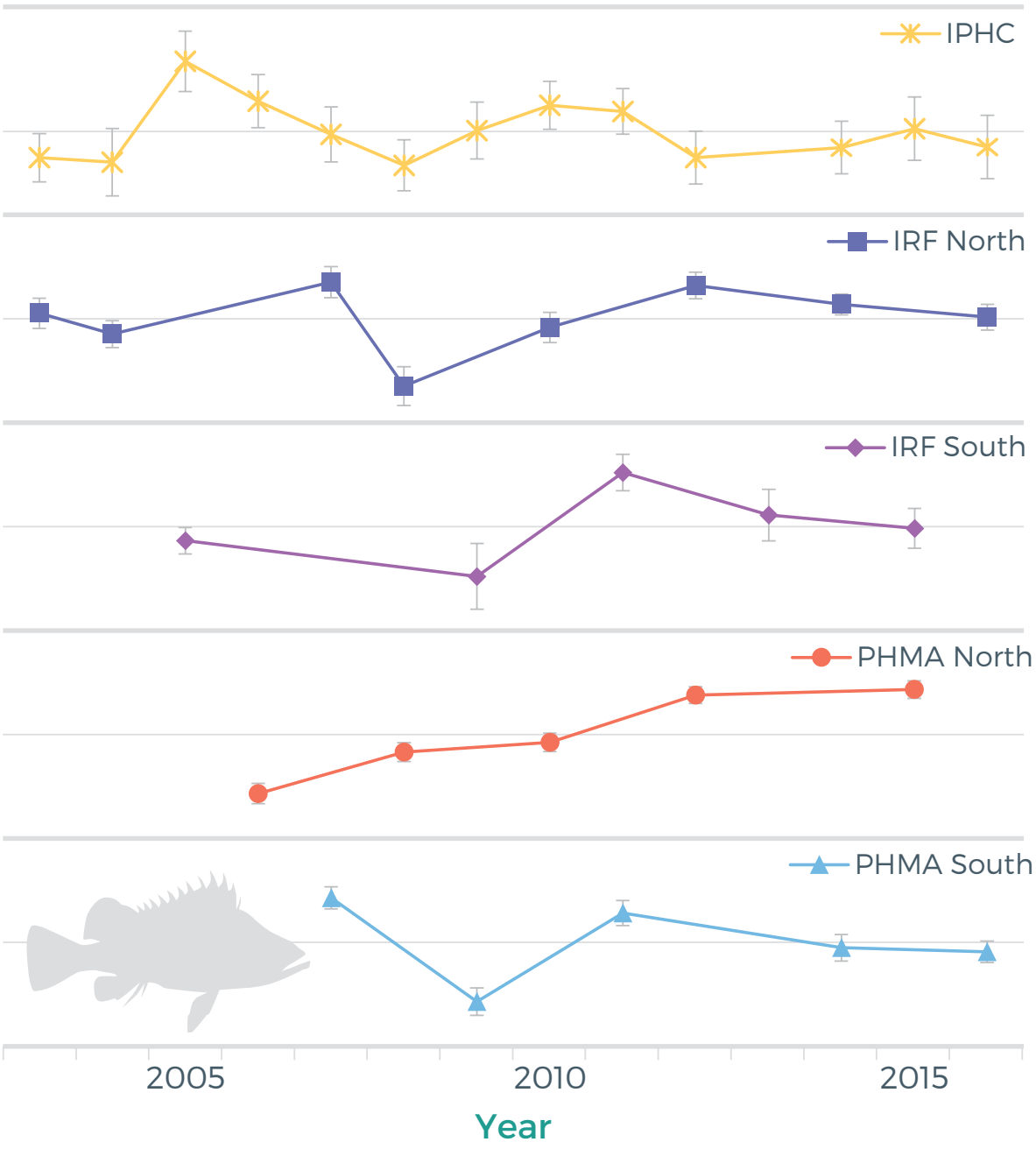
Limited years of data from an age-based survey of rockfish populations conducted by the Coastal Ocean Research Institute, an initiative of Ocean Wise, and citizen scientists indicate that quillback rockfish abundance in both the Strait of Georgia and the west coast of Vancouver Island has not changed significantly in the last few years (Figure 5). Both areas show evidence of low overall recruitment (indicated by low numbers of young of the year) and a predominantly adult population.

It is not surprising that indices from longline surveys undertaken by DFO (some surveys in collaboration with industry) also provide little evidence of consistent positive or negative trends in quillback rockfish abundance between 2003 and 2016 (Figure 6). The possible exception is the Pacific Halibut Management Association (PMHA) North longline survey that shows a slightly positive trend in the quillback rockfish index, but little change between 2012 and 2015. Trawl surveys do not provide a reliable index for quillback rockfish abundance, as the relative error associated with estimates provided by DFO indicated that most

estimates were unreliable. Therefore, trawl survey data are not included here.

The most recent stock assessment for quillback rockfish, from 2011,[25] concludes that both outside and inside stocks appear to be in the "cautious" zone using DFO's Precautionary Approach and Fisheries Reference Points framework – however, the uncertainty associated with these estimates is high. This assessment document also discusses recovery potential as estimated by the stock assessment model. Assuming catches occur at the level of 2017 total allowable catch (TAC) – 147 tonnes outside and 22 tonnes inside[26] – for 90 years hence, outside quillback stocks have about a 75 percent chance of recovering to the "healthy" zone, and inside stocks have about an 88 percent chance of similar recovery. If we are looking for 95 percent probability of recovery to the "healthy" zone in 90 years, the model estimates that catch must be lower than 60 tonnes outside and nil in inside waters.[27]

QUILLBACK ROCKFISH BIOMASS INDICES FROM LONGLINE SURVEYS



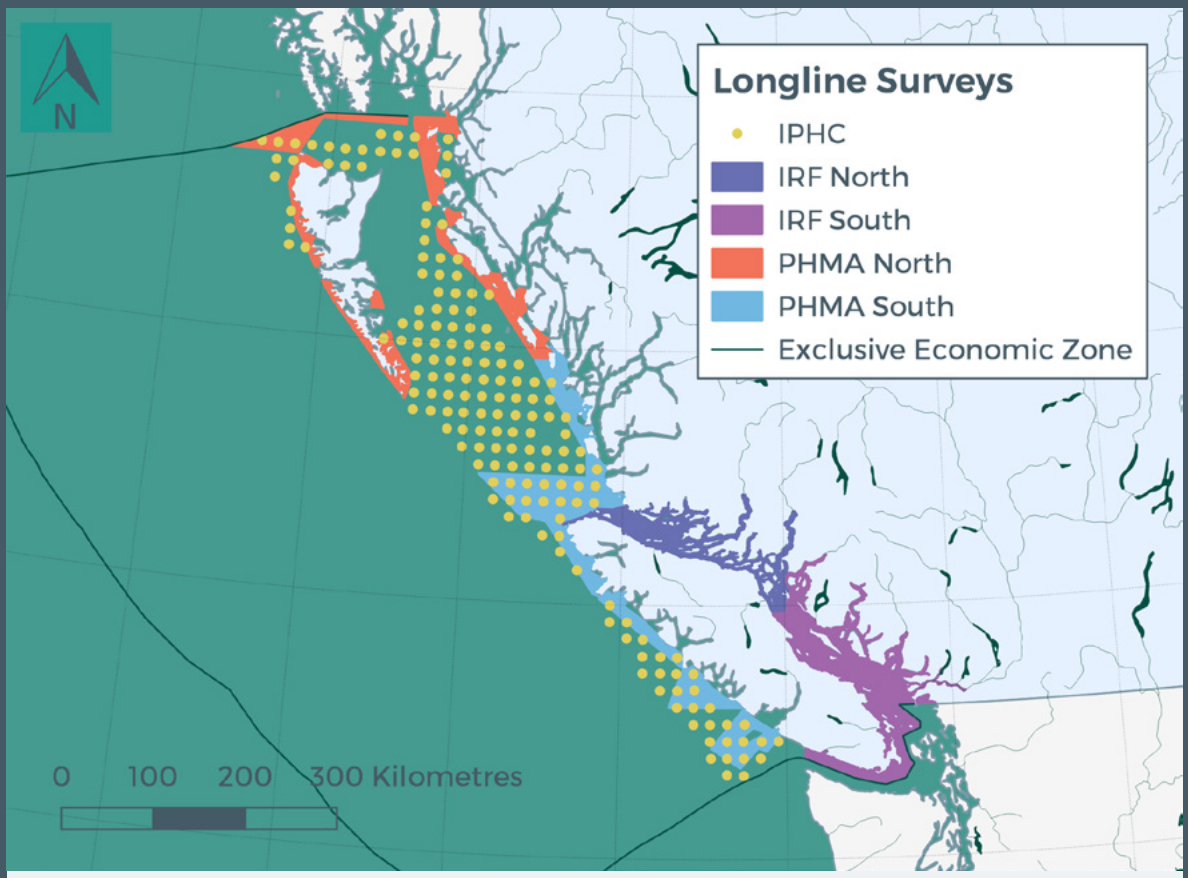


Figure 6. Quillback rockfish biomass indices (scaled anomalies[23]) from longline surveys that cover five areas. These surveys are named International Pacific Halibut Commission (IPHC), Inshore Rockfish North (IRF North), Inshore Rockfish South (IRF South), Pacific Halibut Management Association North (PHMA North), and Pacific Halibut Management Association South (PHMA South). Error bars illustrate relative error; all values are less than 0.4. Data provided by DFO.[24] Map: Corresponding longline survey areas.

What is being done?

In an effort to protect and recover declining rockfish populations, Fisheries and Oceans Canada (DFO) developed a management strategy for inshore rockfish in 2002. Implementation of 164 Rockfish Conservation Areas (RCAs) along the B.C. coast was completed in 2007.[28] Fifteen RCAs were designated in Johnstone Strait, 21 in central and northern B.C. including Haida Gwaii, 49 on the west coast of Vancouver Island, and the remaining 79 were located in the Strait of Georgia.[29] Only 10 years have elapsed since RCAs were put in place and, given the long life span of many rockfish species, it is too early to determine if RCAs or other conservation measures have had an impact on inshore rockfish recovery. One study has shown that sport fishery compliance with fishing restrictions in RCAs is low.[30]

Regional fishing closures put in place to conserve inshore rockfish, following the implementation of Rockfish Conservation Areas in 2007, including many on the South Coast have been renewed annually. Recreational and commercial catches are tracked by DFO and formal stock assessment is undertaken approximately every five years. Limits to commercial catch (i.e., total allowable catch [TAC]) of quillback rockfish are set annually in the Integrated Fisheries Management Plan for groundfish.[31] The 2011 quillback rockfish stock assessment recommended separating quillback rockfish allowable catch from that for an aggregate of rockfish species in order to strengthen commercial management and mitigate the possibility of overharvest. This change was implemented in 2015.[32] TACs are specific to Pacific Fishery Management Areas and gear type (i.e., hook-and-line versus trawl).

DFO actively monitors commercial groundfish fisheries to ensure high accountability for what and how much is caught. Since 2006, all fishing trips targeting groundfish are tracked spatially and 100 percent of the catch, whether it is destined for market or not, is accounted for against quotas. In 2009, DFO developed its Sustainable Fisheries Framework (SFF),[33] which includes policies such as the precautionary approach and ecosystem-based management. Implementation of these policies is a work in progress.[34]

The DFO's Offshore Assessment and Monitoring Section of the Aquatic Resources Research and Assessment Division runs the survey program, which includes the longline surveys mentioned in this article. The Coastal Ocean Research Institute (CORI) annually collects data on rockfish abundance through citizen science scuba surveys, known as the Rockfish Abundance Survey.

What can you do?

Individual and Organization Actions:

- Participate in citizen science SCUBA surveys.
- Report illegal fishing practices to DFO 604-666-3500 (1-800-465-4336).
- Follow posted fishing regulations.

Government Actions and Policy:

- Commit more resources to understanding the effects of RCAs. For example, monitor rockfish populations in RCAs with suitable habitat.
- Simplify regulations in RCAs.
- Increase public education and awareness of closures to commercial and recreational fisheries, and the status of rockfish populations.

Resources

COSEWIC report on Quillback Rockfish
https://www.sararegistry.gc.ca/virtual_sara/files/cosewic/sr_Quillback%20Rockfish_0810_e.pdf

Fisheries and Oceans Canada Rockfish Conservation Areas (RCAs), Pacific Region
www.pac.dfo-mpo.gc.ca/fm-gp/maps-cartes/rcaacs/index-eng.html

Integrated Fishery Management Plan - Groundfish
http://www.pac.dfo-mpo.gc.ca/fm-gp/mplans/2017/ground-fond-sm-2017-eng.html

Stock Assessment and Recovery Potential Assessment for Quillback Rockfish
http://www.dfo-mpo.gc.ca/Library/346320.pdf

Footnotes

[1] Yamanaka, K., and G. Logan. 2010. Developing British Columbia's Inshore Rockfish Conservation Strategy. Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science 2: 28-46. doi: 10.1577/C08-036.1.

[2] COSEWIC. 2009. COSEWIC assessment and status report on the Quillback Rockfish Sebastes maliger in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 71 pp. Accessed Dec 15, 2017 www.sararegistry.gc.ca/status/status_e.cfm.

[3] The PMHA survey is a random, depth-stratified survey that industry does in collaboration with DFO.

[4] Yamanaka and Logan 2010.

[5] A climate regime is a period of years, often a decade or so, when a set of climate conditions persist. Regimes are often characterized by either warm or cold patterns in sea surface temperature.

[6] Marliave, J.B., Senior Research Scientist, Coastal Ocean Research Institute, Personal Communication, 2017.

[7] The relative abundance of quillback rockfish observed during a dive was estimated visually and grouped into a numerical category: none = 0; few ≤ 10; some ≤ 25; many ≤ 50; very many ≤ 100; abundant ≤ 1,000; very abundant = thousands. To calculate annual averages, maximum values for each category were used (3,000 for "very abundant") and these values were summed and divided by the total number of dives to account for sighting frequency.

[8] Reports from Janna Nichols at Neah Bay and Jenn Burt on the central coast of B.C., personal communication with each by email in 2017. See photographs at https://www.eikojonesphotography.com/rockfish-explosion/

[9] Hannah, R.W., and P.S. Rankin. 2011. Site Fidelity and Movement of Eight Species of Pacific Rockfish at a High-Relief Rocky Reef on the Oregon Coast. North American Journal of Fisheries Management 31(3):483-494. https://doi.org/10.1080/02755947.2011.591239

[10] Love, M., Yoklavich, M. and L. Thorsteinson. 2002. The Rockfishes of the Northeast Pacific. Los Angeles, University of California Press.

[11] Frid, A., Connors, B., Cooper, A.B. and Marliave, J. 2013. Size-structured abundance relationships between upper- and mid-trophic level predators on temperate rocky reefs. Ethology, Ecology & Evolution. 25(3): 253-268.

[12] McGreer, M., and A. Frid. 2017. Declining size and age of rockfishes (Sebastes spp.) inherent to indigenous cultures of pacific Canada. Ocean & Coastal Management 145: 14-20.

[13] McKechnie I. 2007. Investigating the complexities of sustainable fishing at a prehistoric village on western Vancouver Island, British Columbia, Canada. Journal for Nature Conservation 15(3): 208-222.

[14] McKechnie, I. and M.L. Moss 2016. Meta-analysis in zooarchaeology expands perspectives on Indigenous fisheries of the Northwest Coast of North America. Journal of Archaeological Science: Reports. 8: 470-485.

[15] Data Source: Pacific Marine Life Surveys

[16] Small fish, from reproduction in the current year

[17] Marliave, J.B., Senior Research Scientist, Coastal Ocean Research Institute, Personal Communication, 2017.

[18] Marliave, J.B., C.J. Gibbs, D.M. Gibbs, A.O. Lamb & S.F.J. Young. 2011. Biodiversity stability of shallow marine benthos in Strait of Georgia, British Columbia, Canada through climate regimes, overfishing and ocean acidification, pp. 49-77 In: Biodiversity loss in a change planet, Oscar Grillo and Gianfranco Venora (Eds.), ISBN: 978-953-307-707-9.

[19] Marliave, J. B., D. M. Gibbs, L. A. Borden & C. J. Gibbs. (Accepted). Seabed Biodiversity shifts identify climate regimes: the 2011 climate regime shift. InTech Publishing, Positive signals in biodiversity protection.

[20] https://www.climate.gov/news-features/understanding-climate/climate-variability-oceanic-ni%C3%B10-index

[21] Marliave et al. 2011

[22] Marliave, J.B., Senior Research Scientist, Coastal Ocean Research Institute, Personal Communication, 2017.

[23] Anomalies shown are deviations from the mean biomass estimate for that survey over the time period illustrated. Error bars illustrate relative error of each estimate. We charted scaled anomalies to enable comparison of trends through time, regardless of relative abundance. Our illustration of the survey index data has been reviewed by DFO.

[24] The methodology for calculating abundance indices was developed for trawl surveys, and may not adequately index line surveys due to the different survey methodologies. The IPHC survey was designed for halibut, therefore caution is required when examining trends in other species. Relative error of estimates, a measure of precision, or the capability of a survey to track changes in a population over time, was provided with the data. Estimates with high relative error (greater than 0.4) are unreliable.

[25] DFO. 2012. Stock Assessment And Recovery Potential Assessment For Quillback Rockfish (Sebastes Maliger) Along The Pacific Coast Of Canada. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2011/072.

[26] TAC is documented in the Integrated Fisheries Management Plan: DFO. 2017. Pacific Region. Integrated Fisheries Management Plan. Groundfish. Effective February 21, 2017. http://www.pac.dfo-mpo.gc.ca/fm-gp/mplans/2017/ground-fond-sm-2017-eng.html

[27] The paragraph describing stock assessment and recovery potential was added by Karin Bodtker, editor of this Ocean Watch series, following an anonymous review. Karin has a background in Fisheries Science.

[28] http://www.pac.dfo-mpo.gc.ca/fm-gp/maps-cartes/rca-acs/index-eng.html

[29] Yamanaka and Logan 2010.

[30] Haggarty, D.R., S.J.D. Martell & J.B. Shurin. 2016. Lack of recreational fishing compliance may compromise effectiveness of Rockfish Conservation Areas in British Columbia. Canadian Journal of Fisheries and Aquatic Sciences 10.1139/cjfas-2015-0205.

[31] DFO 2017.

[32] DFO. 2015. Pacific Region. Integrated Fisheries Management Plan. Groundfish. Effective February 21, 2015. Accessed February 28, 2018. http://waves-vagues.dfo-mpo.gc.ca/Library/40596837.pdf

[33] DFO. 2016. Sustainable Fisheries Framework. Accessed January 23, 2018. http://www.dfo-mpo.gc.ca/reports-rapports/regs/sff-cpd/overview-cadre-eng.htm.

[34] Office of the Auditor General of Canada. 2016. Report 2 – Sustaining Canada's Major Fish Stocks – Fisheries and Oceans Canada. 2016 Fall Reports of the Commissioner of the Environment and Sustainable Development. Accessed February 28, 2018 http://www.oag-bvg.gc.ca/internet/English/parl_cesd_201610_02_e_41672.html