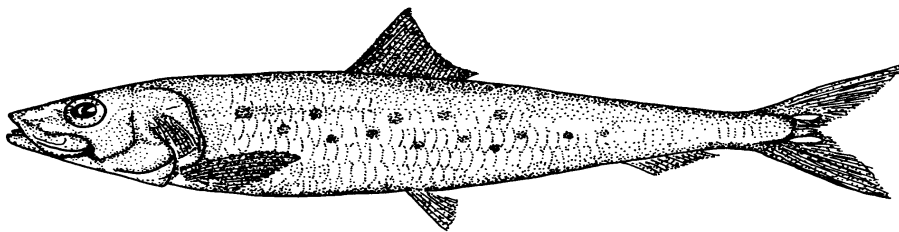


PACIFIC REGION

INTEGRATED FISHERIES MANAGEMENT PLAN

August 1, 2021 – May 31, 2024

PACIFIC SARDINE



Sardinops Sagax

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National Weblinks

- **Main Page:** www.dfo-mpo.gc.ca/
- **Acts, Orders, and Regulations:** <https://www.dfo-mpo.gc.ca/acts-lois/regulations-reglements-eng.htm>
- **Reports and Publications:** <http://www.dfo-mpo.gc.ca/reports-rapports-eng.htm>
- **Library Catalogue:** <https://science-libraries.canada.ca/eng/fisheries-oceans/>

Pacific Region Weblinks

- **Regional Main Page:** <http://www.pac.dfo-mpo.gc.ca/index-eng.html>
- **Oceans Program:** <http://www.pac.dfo-mpo.gc.ca/oceans/index-eng.html>
- **Recreational Fisheries:** <http://www.pac.dfo-mpo.gc.ca/fm-gp/rec/index-eng.htm>
- **Commercial Fisheries:** <https://www.pac.dfo-mpo.gc.ca/fm-gp/index-eng.html>
- **Fisheries Notices:** <http://www-ops2.pac.dfo-mpo.gc.ca/fns-sap/index-eng.cfm?>
- **Licencing:** <http://www.pac.dfo-mpo.gc.ca/fm-gp/licence-permis/index-eng.html>
- **Science Main Page:** <https://www.pac.dfo-mpo.gc.ca/science/index-eng.html>

FOREWORD

This document serves to communicate basic information on the Pacific sardine fishery and its management to Fisheries and Oceans Canada (DFO, the Department) staff, legislated co-management boards, First Nations and stakeholders. This IFMP provides a common understanding of the basic “rules” for the sustainable management of the fisheries resource.

This IFMP is not a legally binding instrument which can form the basis of a legal challenge. The IFMP can be modified at any time and does not fetter the Minister's discretionary powers set out in the *Fisheries Act*. The Minister can, for reasons of conservation or for any other valid reasons, modify any provision of the IFMP in accordance with the powers granted pursuant to the *Fisheries Act*.

Where DFO is responsible for implementing obligations under land claims agreements, the IFMP will be implemented in a manner consistent with these obligations. In the event that an IFMP is inconsistent with obligations under land claims agreements, the provisions of the land claims agreements will prevail to the extent of the inconsistency.

I OVERVIEW

I.1 Introduction

This Integrated Fisheries Management Plan (IFMP) for Pacific Sardine covers the period from August 1, 2021 to May 31, 2024.

The commercial fishery for Pacific Sardine remains closed. There have been no commercial fishery landings for Pacific Sardine in Canada since 2012, and no allocated quota since 2014 due to low biomass forecasts. Few or no sardines were observed in BC waters since 2013 in fisheries, surveys or from other sources. Harvest advice and stock assessment information is included in Appendix 1.

I.2 Background

The Pacific Sardine fishery is an opportunistic fishery dependent on the migration of sardines into Canadian waters. Sardine migration and population levels are heavily influenced by oceanic conditions that determine the survival and recruitment of juveniles into the adult stock. A sardine fishery in B.C. is dependent on favourable ocean conditions which support the growth and production of the Pacific Sardine stock.

From 1996 to 2001, there was a limited experimental harvest of Pacific Sardine by a small number of harvesters. Given the results of the experimental fishing, and the de-listing of Pacific Sardine by the Federal-Provincial Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as a species of “special concern” in May 2002, the seine component of the fishery moved to a commercial phase in 2002 consistent with the Department’s New Emerging Fisheries policy (NEFP). A one-year interim plan was developed in 2002 using a precautionary approach while providing opportunity for continued assessment of the viability of the fishery and the potential for future expansion. An experimental/exploratory phase was initiated to investigate the feasibility of alternative gear types and areas.

From 2003 to 2006, the Department developed a three year fishing plan that allowed for an incremental approach towards development of the fishery while continuing to follow the principles of the NEFP. From 2007 to 2011, the Department developed an annual Integrated Fisheries Management Plan to support growth of the fishery. Following the decline of the fishery, management plans have multi-year, reflecting the unnecessary of active management.

I.3 Type of Fishery and Participants

Indigenous People of British Columbia

In the 1990 Sparrow decision, the Supreme Court of Canada found that where an Aboriginal group has an Aboriginal right to fish for food, social and ceremonial (FSC) purposes, it takes priority, after conservation, over other uses of the resource. Fisheries are authorized via a Communal Licence issued by the Department under the *Aboriginal Communal Fishing Licences Regulations*.

In addition to fishing opportunities for FSC purposes and domestic purposes for treaty rights for the Maa-nulth First Nation (as of April 1, 2011) and the Tla'amin First Nation (as of April 5, 2016), DFO acknowledges that in *Ahousaht Indian Band et al. v. Canada and British Columbia*, the courts have found that five Nuu-chah-nulth First Nations located on the West Coast of Vancouver Island — Ahousaht, Ehattesaht, Hesquiaht, Mowachaht/Muchalaht, and Tla-o-qui-aht — have aboriginal rights to fish for any species of fish within their Fishing Territories and to sell that fish, with the exception of geoduck.

Recreational

Anglers may harvest sardine in the Pacific Region, although catch and effort levels are limited for the recreational sardine fishery. For more information about recreational fishing for Pacific Sardine, please visit:

<http://www.pac.dfo-mpo.gc.ca/fm-gp/rec/points/finfish-peche-eng.html>.

A British Columbia Tidal Waters Sport Fishing Licence is required for the recreational harvest of all species of fish in tidal waters. Tidal Waters Sport Fishing Licences are available online at: <http://www.pac.dfo-mpo.gc.ca/fm-gp/licence-permis/index-eng.htm>.

Commercial

There are a total of 50 licences for the Pacific Sardine fishery (25 commercial and 25 communal commercial licences). The fishery is managed by individual licence quotas. Licence holders are permitted to stack multiple licences and associated quota to the same vessel.

1.4 Location and timing of Fishery

With the exception of permanent and seasonal closures, the commercial Pacific Sardine fishery, when Total Allowable Catch is allocated, may open from June 1 to February 9 each year, in Pacific Fishery Management Areas (PFMAs) 3 – 13, 20, 23 to 27, 101 to 110, 121, 123 to 127, 130 and 142. When the commercial fishery was open the majority of harvest occurred from August to October.

Indigenous and recreational harvest may be permitted year round with appropriate authorizations. However, sardine is unlikely to be encountered in BC waters outside the late summer and early fall.

I.5 Governance

Management of Pacific Sardine is directed by the *Fisheries Act* and other acts and regulations including:

- The *Pacific Fishery Management Area Regulations*,
- The *Fishery (General) Regulations* and the *Pacific Fishery Regulations*, 1993,
- The *Aboriginal Communal Fishing Licence Regulations*,
- The *Maa-nulth First Nations Final Agreement Act*,
- The *Tla'amin Final Agreement Act*,
- The *British Columbia Sport Fishing Regulations*,
- The *Oceans Act*, and,
- The *Species at Risk Act*.

These documents are available at: <http://www.dfo-mpo.gc.ca/acts-loi-eng.htm>.

In addition, the national Sustainable Fisheries Framework contains policies for adopting an ecosystem based approach to fisheries management including:

- A Fishery Decision-Making Framework Incorporating the Precautionary Approach;
- Managing Impacts of Fishing on Benthic Habitat, Communities and Species;
- Policy on New Fisheries for Forage Species.
- Guidance for the Development of Rebuilding Plans under the Precautionary Approach Framework: Growing Stocks out of the Critical Zone
- Policy on Managing Bycatch
- Strategic Framework for Fishery Monitoring and Catch Reporting in the Pacific Fisheries
- Ecological Risk Assessment Framework (ERAF) for Coldwater Corals and Sponge Dominated Communities

For more information on the Sustainable Fisheries Framework, please visit: <http://www.dfo-mpo.gc.ca/reports-rapports/regs/sff-cpd/overview-cadre-eng.htm>

The national Fishery Monitoring Policy is available at: <http://www.dfo-mpo.gc.ca/reports-rapports/regs/sff-cpd/fishery-monitoring-surveillance-des-peches-eng.htm>.

I.6 Consultation

DFO has a broad mandate, with the authority to regulate and enforce activities, develop policy, provide services and manage programs. To help ensure the Department's policies and programs are aligned with its vision and effectively address the interests and preferences of Canadians, DFO supports consultations that are transparent, accessible and accountable. DFO Pacific Region undertakes consultations in order to meet the duty to consult with First Nations, improve departmental decision-making processes, promote understanding of fisheries, oceans and marine transport issues, and strengthen relationships.

I.7 Approval Process

This plan is approved by the Regional Director General for the Pacific Region.

2 STOCK ASSESSMENTS, SCIENCE AND INDIGENOUS KNOWLEDGE

2.1 Biological Synopsis

Sardines are schooling pelagic fish found in relatively warm waters of every ocean with a global distribution restricted from 60°N to 50°S. Scale-deposition studies have revealed hundreds and thousands of years of “boom and bust” cycles of Pacific Sardine populations off California (Baumgartner et al. 1992) and Chile (Valdes et al. 2008). The Pacific Sardine (*Sardinops sagax*) Northern Subpopulation occurring in the Northeast Pacific (and linked to the California Current ecosystem) has undergone long-term fluctuations in abundance for at least 2000 years. In the last century, large abundances occurred throughout the population’s range from the early 1900s to the late 1940s. This population was fished extensively from the early 1900s through the late 1940s. Following that period, their abundance declined and their distribution contracted to small pockets off southern California and Ensenada Mexico. The population gradually rebuilt in the 1980s and as the population size increased so did the northern extent of its distribution. A resurgence of sardine distribution into British Columbia (BC) waters was observed in the 1990s and since then the stock has showed considerable variability in abundance. Sardine population levels are heavily influenced by oceanic conditions that determine the survival and recruitment of juveniles into the adult stock and stock migration patterns into Canadian waters.

The main spawning grounds for the California Current Ecosystem sardine population are off California and northwest Baja, Mexico but during warm periods, such as during strong El Niño events, environmental conditions may be conducive to sardine spawning in more northern waters, such as off the Oregon, Washington and BC coasts. Adult sardines can spawn annually between 2 and 10 years of age and year class and recruitment success can vary greatly. A strong year class can have a large impact on the abundance of the coastwide population for several years. Sardines aged two to four generally range from 17 to 22 cm (fork length); whereas sardines aged four to ten years generally range from 20 to 25 cm.

Sardine movements and population structure are quite dynamic and several aspects of stock structure are poorly understood. Seasonal trends in geographic distribution and biological observations (length, age, parasite and historic tagging data) show that regional connectivity in the population is complex. In general, the majority of sardines seasonally observed off BC, Washington and Oregon are relatively large and represent older components of the population compared to sardines observed off California and Baja Mexico. Seasonal migrations are also complex, with timing and extent of movements affected by population size and structure and

oceanographic factors (Ware and Thompson 1991; McFarlane et al 2002). The northward migration appears to be constrained by the 12°C isotherm (Ware 2001). Sardines filter feed on phytoplankton and zooplankton and summer migrations into BC waters enable them to benefit from the marine productivity resulting from extended daylight and nutrient rich waters from oceanic upwelling and coastal run-off.

2.2 Ecosystem Interactions

Pacific Sardine occurrence in, and migrations to, waters of the Pacific Northwest of North America are mainly to feed on abundant plankton resources associated with summer months. The extent of the northward migration is in part related to oceanographic conditions, particularly sea surface temperature, such that stocks move further north during warmer years. Sea surface temperature has also been related to juvenile survival for recruitment to the adult spawning population with stronger recruitment occurring during warmer years.

Similar to other forage fish species in BC waters, sardine are eaten by a variety of predators, such as salmonids, sharks, sea lions, seals, Humpback whales, and seabirds. The seasonal distribution of sardine in BC waters corresponds with the foraging and migrating seasons of some of their predators, such as Coho and Chinook salmon and Humpback whales. Ongoing research is helping scientists and fisheries managers to develop a better understanding of ecosystem processes, including environmental effects on sardine recruitment, and the role that sardines play in ecosystem structure and function.

2.3 Precautionary Approach

The Department follows the Sustainable Fisheries Framework (SFF) – a toolbox of policies for DFO and other interests to sustainably manage Canadian fisheries in order to conserve fish stocks and support prosperous fisheries. The SFF includes a decision-making framework incorporating a precautionary approach to commercial, recreational, and food-social-ceremonial fishing (<http://www.dfo-mpo.gc.ca/reports-rapports/regs/sff-cpd/precaution-eng.htm>).

In general, the precautionary approach in fisheries management is about being cautious when scientific knowledge is uncertain, and not using the absence of adequate scientific information as a reason to postpone action or failure to take action to avoid serious harm to fish stocks or their ecosystem. This approach is widely accepted internationally as an essential part of sustainable fisheries management.

Applying the precautionary approach to fisheries management decisions entails establishing a harvest strategy that:

-
- identifies three stock status zones – healthy, cautious, and critical – according to upper stock reference points and limit reference points;
 - sets the removal rate at which fish may be harvested within each stock status zone; and
 - adjusts the removal rate according to fish stock status variations (i.e., spawning stock biomass or another index/metric relevant to population productivity), based on pre-agreed decision rules.

The framework requires that a harvest strategy be incorporated into respective fisheries management plans to keep the removal rate moderate when the stock status is healthy, to promote rebuilding when stock status is low, and to ensure a low risk of serious or irreversible harm to the stock.

More information related to the precautionary approach is available at: <http://www.dfo-mpo.gc.ca/reports-rapports/regs/sff-cpd/precautionary-precaution-eng.htm>

2.4 Stock Assessments

Stock assessments for Pacific Sardine are conducted by the United States (U.S.) National Marine Fisheries Service (NMFS) of the National Oceanic and Atmospheric Administration (NOAA). The U.S. NMFS has been annually assessing the status and population trends of the Pacific Sardine Northern Subpopulation of the eastern Pacific Ocean using versions of an age-structured model. Because of its geographic distribution that can range southward from the west coast of Baja California northward to southeast Alaska, it is also known as the California Current Ecosystem sardine stock. Information from fishery independent surveys, monitoring fishery catch and landings, and biological sampling has been used to inform stock assessment models. Stock assessment methods have changed over the years and are expected to further evolve over time as part of multi-year review processes facilitated by the US Pacific Fishery Management Council.

Catch data from the BC sardine fishery were collected for all years of the most recent commercial fishery (2003-2014), including an experimental period prior to 2002. These data include spatial and temporal information linked to fishery landings and biological information from catch samples (e.g, length, weight and sex). In addition to fishery information from other regions of the stock's spatial distribution, BC fishery information on monthly landings and fish size from biological sampling have been used to inform stock assessment efforts led by U.S. NMFS analysts.

Since 2011, one of the main sources of information informing sardine stock assessment efforts of the Northern Subpopulation has been from spring and summer acoustic-trawl surveys. These surveys have occurred annually since 2006 and are led by the U.S. NMFS (Demer et al 2018, Hill et al 2018). These surveys collect acoustic records through multi-frequency echosounder

sampling and information on species and size compositions through trawl catch sampling. In addition to biological sampling associated with the trawl catches, water sampling of eggs and larvae (ichthyoplankton) also occurs to compliment acoustic-trawl observations. The summer acoustic-trawl surveys have extended from waters off the northwest coast of Vancouver Island to the US and Mexican Pacific border to represent a foraging distribution, whereas the spring surveys have ranged from California to Oregon to represent a spawning distribution (Demer et al 2018).

From 1997 to 2014, data from summer DFO pelagic trawl surveys off the west coast of Vancouver Island were used to characterize the regional distribution, relative abundance, and biological information of sardine in BC waters. In 2006, 2008-2014 night trawling was conducted to reduce the variability in catch data of sardine and improve characterization of fish diet observations. Since 2014, no consistent DFO multi-year survey plan has been employed to specifically monitor sardine occurrence and ecology in BC waters but information is also collected from other DFO multi-species pelagic surveys off the west coast of Vancouver Island (and other areas) which may catch sardine.

2.5 Research and Other Activities

Collaboration between DFO and the U.S. NMFS is ongoing to exchange sardine information related to fisheries, stock assessments, and ecosystem monitoring and interactions. Listed below are examples of sardine research initiatives that have been led by U.S. and Canadian science teams.

The United States:

- Abundance indices, seasonal distribution and biological samples
 - Ichthyoplankton-trawl (and fecundity) spring surveys off California
 - Summer coastwide aerial surveys
 - Spring and summer acoustic-trawl surveys
 - Columbia River Plume pelagic trawl surveys
- Stock assessment modeling or assessment model components
 - Ageing research and developing age and length relationships
 - Recruitment and year class modeling
 - Characterizing fishery selectivities
 - Management strategy evaluation
 - Harvest control rule parameter estimates (e.g F_{MSY} and Distribution)
- Habitat modeling
 - Use of survey, fishery and oceanographic data to predict and test habitat models

Canada:

- Summer pelagic trawl research surveys
 - Trawl densities and regional distribution (relative abundance index)

-
- Species associations (sardine diet, sardine predator diet, putative sardine competitors)
 - Plankton and oceanographic (water) sampling
 - Scientific acoustic records - species groups abundance and distribution)
 - Marine mammal daytime observations
 - Ageing research and fat testing
 - Aerial survey feasibility trials
 - Regional ecosystem/trophic modeling

Although not explicitly listed as examples, collaboration and additional research is conducted by Mexican teams.

2.6 Indigenous Knowledge

Indigenous Knowledge has not been generally available on sardine. However, when available, it will be considered in science decisions and the management of the fishery.

3 SOCIAL, CULTURAL, AND ECONOMIC IMPORTANCE

3.1 Indigenous

Sardine fishing for Food, Social, and Ceremonial (FSC) purposes may be authorized upon request. Sardine fishing may also be permitted through the Maa-nulth Harvest Document, or through other treaty-related mechanisms.

3.2 Recreational

Recreational fishing may occur to provide food for personal use, as a leisure activity, or as a combination of the two. The recreational community includes local residents, multi-species charter operators and lodges, and visiting anglers and boaters. In the 2020/2021 recreational angling season, 238,600 anglers were licensed to fish in BC's tidal waters recreational fishery. Most (90%) were BC residents, with the remainder being Canadians from outside BC. Due to COVID-19, no licences were sold to visitors outside of Canada. These activities provide a range of benefits to the participants as well as contribute directly and indirectly to economic activity.

3.3 Commercial

The majority of the most recently active sardine vessels stacked licences and their associated quota. Based on the most recent (2009) financial profile of the fishery, the average vessel had an estimated boat return of approximately \$30,000. Five vessels accounted for just over half of all sardine licences (communal commercial and commercial). While vessels that have been active in the sardine seine fishery were also often active in the salmon and herring fisheries, the majority of their gross revenue (more than 50%) was from the harvest of sardines in 2009.

Between 2010 and 2012, the average landed value and wholesale value of BC Pacific Sardine was \$3.66 million and \$21.35 million, respectively. Based on this revenue, it is estimated that the 60 or so captain and crew involved in the 2012 season would have earned approximately \$1.1 million. Additional income earned by processing sector workers (employed mainly in Ucluelet, Delta, and Port Hardy) would have been in the range of \$2.5-\$3 million.

A notable future challenge in the sardine fishery, should commercial harvest resume, will be finding appropriate buyers for this product. The BC sardine harvest, like the much larger U.S. sardine harvest, is mostly destined as low value bait in the tuna high seas longline fishery. Past efforts to gain access to the higher value food product market have had mixed results.

4 OCEANS AND ECOLOGICAL CONSIDERATIONS

4.1 Gear Impacts

The commercial Pacific sardine fishery in Canada was conducted using seine gear. Under normal operating circumstances, there was minimal to no environmental impacts from gear used. Very little by-catch was observed, and there was little to no impact to marine mammals or sea birds.

In the spring of 2020, it became a condition of license for commercial harvesters in all fisheries to report lost and retrieved fishing gear. [Information](#) on the reporting system can be found here: <https://www.canada.ca/en/fisheries-oceans/news/2021/07/canada-continues-to-combat-ghost-gear-in-our-oceans-with-launch-of-new-reporting-system.html>. Additionally, DFO is supporting retrieval, collection and responsible disposal of lost or otherwise discarded fishing gear through the Sustainable Fisheries Solutions and Retrieval Support Contributions Program (a.k.a. The Ghost Gear Fund: <https://www.dfo-mpo.gc.ca/fisheriespeches/management-gestion/ghostgear-equipementfantome/program-programme/projectsprojets-eng.html>).

4.2 Other Species Concerns

Reporting

Harvesters are asked to report the following when observed:

- **Marine Mammal Incidents:** 1-800-465-4336 (reporting hotline) / DFO.ORR-ONS.MPO@dfo-mpo.gc.ca / VHF CHANNEL 16
- **Basking Shark Sightings:** 1-877-50-SHARK (1-877-507-4275) / BaskingShark@dfo-mpo.gc.ca / <http://www.pac.dfo-mpo.gc.ca/SharkSightings>
- **Whale or Turtle Sightings:** : 1-866-ISA.W.ONE (1-866-472-9663) / sightings@ocean.org / <http://wildwhales.org>

Additional Resources

Harvesters in any and all fisheries should be aware of potential impacts and considerations related to other marine species that may be present in areas where fishing occurs. In some cases there are obligations that may impact fishing operations.

- **Southern Resident Killer Whale management measures:** <https://www.pac.dfo-mpo.gc.ca/whales-baleines/srkw-measures-mesures-erseng.html>
- **Shark codes of conduct:** <https://dfo-mpo.gc.ca/species-especes/publications/sharks/coc/cocsharks/index-eng.html>

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- **Code of conduct for Basking Sharks:** <https://dfo-mpo.gc.ca/speciesespeces/publications/sharks/coc/coc-basking/index-eng.html>
 - **Shark identification guide:** <https://waves-vagues.dfo-mpo.gc.ca/Library/40757067.pdf>
 - **Whale entanglement brochure** (best practices to reduce entanglement and reporting an incident): <http://dev-public.rhq.pac.dfo-mpo.gc.ca/whales-baleines/docs/entanglementsempetremements-pub-eng.html>
 - **The Species at Risk Act (SARA) and the Species at Risk Public Registry:** <https://www.registrelep-sararegistry.gc.ca/>

4.3 Oceans and Habitat Considerations

The Government of Canada continues to work to protect Canada's oceans. The *Oceans Act* and Canada's Oceans Strategy (<http://www.dfo-mpo.gc.ca/oceans/index-eng.html>), the *Canada Wildlife Act*, and the *National Marine Conservation Areas Act* play particularly important roles shaping this work. The Government of Canada surpassed its milestone of protecting 10% of Canada's marine and coastal areas by 2020 and has further committed to protecting 25% by 2025, and working towards 30% by 2030 (<http://www.dfo-mpo.gc.ca/oceans/conservation/index-eng.html>). This work includes the establishment of Marine Protected Areas (MPAs) and "other effective area-based conservation measures" in consultation with Indigenous groups, industry, non-governmental organizations, and other interested parties.

More information on the background and drivers for Canada's marine conservation targets is available at: <http://www.dfo-mpo.gc.ca/oceans/conservation/index-eng.html>. An overview of these tools, including a description of the role of fisheries management measures that qualify as other measures is available at: <http://www.dfo-mpo.gc.ca/oceans/mpa-zpm-aoi-si-eng.html>.

Related initiatives on the Pacific coast include:

- **Pacific North Coast Integrated Management Area:** <https://www.dfo-mpo.gc.ca/oceans/managementgestion/pncima-zgicnp-eng.html>
- **Northern Shelf Bioregion MPA Network:** <http://www.mpanetwork.ca>
- **Endeavour Hydrothermal Vents (EHV) MPA:** <http://www.dfo-mpo.gc.ca/oceans/mpa-zpm/endeavour/index-eng.html>
- **SGaan Kinghlas-Bowie Seamount (SK-B) MPA:** <http://www.dfo-mpo.gc.ca/oceans/mpa-zpm/bowie-eng.html>
- **Hecate Strait and Queen Charlotte Sound Glass Sponge Reefs (HS/QCS) MPA:** <http://www.dfo-mpo.gc.ca/oceans/mpa-zpm/hecate>
- **Offshore Pacific Area of Interest:** <http://www.dfo-mpo.gc.ca/oceans/aoisi/offshore-hauturiere-eng.html>
- **Gwaii Haanas National Park Reserve, National Marine Conservation Area Reserve, and Haida Heritage Site:** <http://www.haidanation.ca/wp-content/uploads/2019/04/CHNFisheries-Management->

[DirectionsFINAL.pdf#:~:text=COUNCIL%20OF%20THE%20HAIDA%20NATION%20FI
SHERIES%20MA](#)

- **Southern Strait of Georgia National Marine Conservation Area Reserve (feasibility assessment):** <https://www.pc.gc.ca/en/amnc-nmca/cnamnc-cnnmca/dgs-ssg>
- **Strait of Georgia and Howe Sound Glass Sponge Reef Marine Refuges:** <https://www.dfompo.gc.ca/oceans/ceccsr-cerceef/closures-fermetures-eng.html>
- **Rockfish Conservation Areas:** <http://dfompo.gc.ca/rockfish-conservation>

5 ACCESS AND ALLOCATION

The Minister can, for reasons of conservation or for any other valid reason, modify access, allocations, and sharing arrangements as outlined in this IFMP in accordance with the powers granted pursuant to the *Fisheries Act*.

5.1 Indigenous

Indigenous harvest of Pacific Sardine for FSC or domestic purposes may occur coast wide where authorized by a communal licence or Harvest Document.

5.2 Recreational

Recreational harvest of Pacific sardine is permitted through a British Columbia Tidal Waters Sport Fishing Licence. The daily limit for Pacific sardine is 100 pieces and the possession limit is 200 pieces (Variation Order 2016-74).

5.3 Commercial

Commercial harvest of Pacific Sardine is not currently permitted.

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APPENDIX I: HARVEST ADVICE FOR PACIFIC SARDINE (*SARDINOPS SAGAX*) IN BRITISH COLUMBIA WATERS FOR 2021

Canadian Science Advisory Secretariat
Pacific Region
Science Response 2021/XXX – APPROVED PRE_PUBLICATION
2021

HARVEST ADVICE FOR PACIFIC SARDINE (*SARDINOPS SAGAX*) IN BRITISH COLUMBIA WATERS FOR 2021

Context

The northern subpopulation of Pacific Sardine (*Sardinops sagax*) in the eastern Pacific Ocean (California Current Ecosystem) has a distribution that can range between Baja California to southeast Alaska. In winter and spring months, most of this stock has the tendency to occur in waters off the California coast in association with spawning. Prior to, and during summer months, large aggregations of Pacific Sardine migrate from spawning habitat to more northern waters mainly to forage. Migratory patterns can be affected by age structure, population size and oceanographic conditions. Typically, most Pacific Sardines that migrate into British Columbia (BC) waters are the larger and older fish in the population. Pacific Sardine has not been fished in BC waters since 2012 due to reduced migration (a general absence of Pacific Sardine in BC waters) and formal fishery closures in 2015 to 2020.

Fisheries and Oceans Canada (DFO) adopted a harvest control rule in 2013 that applies a harvest rate to an estimate of age-1 year and older (age-1+) biomass that exceeds 150,000 t to calculate potential harvest options for the BC sardine fishery (DFO 2013). As described in the 2013 [Science Advisory Report](#), a range in harvest rates from 3-5% was selected to calculate potential harvest options. The age-1+ biomass estimate used in the harvest control rule is acquired from the stock assessment conducted by the United States (US) National Marine Fisheries Service (NMFS) of the National Oceanic and Atmospheric Administration (NOAA). The 2021 assessment of the northern subpopulation of Pacific Sardine by the U.S. NMFS occurred in April 2021. The coastal pelagics acoustic-trawl survey that was intended to be a main source of information in assessment efforts was cancelled in 2020 due to the coronavirus disease (COVID-19) pandemic. Recognizing the information gaps from not having survey information, a catch-only projection model was planned for generating results for use in 2021. However, due to complications associated with fitting a catch-only model with catch information for Mexico, the catch-only assessment method was not endorsed and results from the 2020 base assessment were recommended for use in 2021 instead (Kuriyama et al. 2020, Pacific Fishery Management Council 2021).

DFO Fisheries Management requested that Science Branch incorporate the most recent stock assessment estimate of age-1+ biomass for the northern subpopulation of Pacific Sardine into the DFO sardine harvest control rule.

The objectives of this report are to:

1. Report the results of applying the harvest control rule for a range of harvest rates from 0.03 to 0.05 in increments of 0.01, if the expected stock biomass is above the escapement buffer of 150,000 tonnes; and
2. Identify uncertainties associated with this harvest advice.

A formal Canadian stock assessment was not conducted in 2021 so the following advice is based on the multi-year method approved in 2013 (DFO 2013). As such, for a full understanding of Science recommendations, uncertainties, and future considerations, readers are referred to DFO (2013).

This Science Response reports results from the Science Response process of May 31, 2021 on the Stock Assessment of Pacific sardine and harvest advice for 2021/22.

Background

Population assessment

The U.S. NMFS assesses the status and population trends of the Pacific Sardine northern subpopulation in the eastern Pacific Ocean (also known as the California Current Ecosystem stock) using a statistical catch-at-age model on the Stock Synthesis platform (Methot and Wetzel 2013; Kuriyama et al. 2020). Since 2014, the annual Pacific Sardine stock assessment process has been conducted and updated in the spring, incorporating recent science survey and fishery catch information. However due to recent sardine fishing restrictions in US and Canadian waters and the lack of a 2020 acoustic-trawl survey, the main source of new information available to update the 2020 stock assessment was from sardine landings in Mexican waters, which were approximately three times greater than preliminary expectations of catch. Although a catch-only projection assessment was conducted in 2021 (Kuriyama et al. 2021), it was not endorsed by the US Pacific Fishery Management Council process because it generated unrealistically high estimates of fishing mortality and past year recruitment and it did not accomplish the objective of informing stock abundance in the period following the previous assessment.

Results from the U.S. NMFS 2020 assessment model were recommended and endorsed during the U.S. Pacific Fishery Management Council process as the preferred stock assessment option for providing 2021 sardine management advice. This is an alternative to the catch-only projection method and is considered an interim measure in the absence of other defensible stock assessment options. The methods, results, uncertainties and recommendations from the 2020 process were described in the 2020 harvest advice for Pacific Sardine in BC waters (DFO 2020).

For 2022, it is anticipated that new information will be available from the 2021 U.S. NMFS summer acoustic-trawl survey, 2020 and 2021 fishery independent nearshore surveys (collectively referred to as being part of a California Coastal Pelagic Species Survey, or CCPSS survey efforts); fishery landings, and fishery-dependent and independent biological samples. With the collection of new information, there is interest in having an updated stock assessment process in 2022, followed by a benchmark assessment in 2023, which would include evaluations of several assessment model assumptions.

BC Pacific Sardine fishery harvest control rule

DFO Fisheries Management adopted a harvest control rule in 2013 that incorporates a July estimate (forecast) of the population's age-1+ biomass, a cutoff value of 150,000 tonnes, and a harvest rate. The cutoff value of 150,000 tonnes is consistent with the cutoff value used in the US harvest guideline. The harvest rate is applied to the difference between the estimated age-1+ biomass above the cutoff and the cutoff biomass. As described in the 2013 review (DFO 2013), a range of harvest rates (h) of 3-5% was selected in the calculation of potential harvest allowances. The equation for the calculation of a fishing season's potential total allowable (TAC_t , tonnes) for a season starting in year " t " is:

$$TAC_t = h (B_{1+,t} - 150,000),$$

where

h = harvest rate

$B_{1+,t}$ = forecast age-1+ biomass (tonnes), July

150,000 = cutoff value (tonnes)

No harvest is recommended when the forecast of age-1+ biomass ($B_{1+,t}$) is less than 150,000 tonnes.

This Science Response provides the recommended 2021 BC Pacific Sardine fishery harvest options based on the use of this harvest control rule and the 2020 U.S. NMFS forecast for the stock's July 2021 age-1+ biomass.

Analysis and Response

Biomass

Estimates of recent age-1+ Pacific Sardine biomass of the northern subpopulation from both the 2021 catch-age model projection estimates and the 2020 base assessment model are reported below, followed by a brief overview of trends in sardine observations made in BC waters.

From the 2021 catch-only projection model, the maximum likelihood estimate of age-1+ forecasted biomass in July 2021 was 140,111 tonnes (Kuriyama et al. 2021). The coefficient of variation (CV) around this estimate was 0.58. Kuriyama et al. (2021) also conducted and reported on model sensitivities regarding recruitment and southern (MexCal) fishery fleet landing assumptions, which forecasted age 1+ biomass estimates of 14,456 tonnes (using recruitment averaged over 2010-2019), 32,647 tonnes (using recruitment averaged over 2005-2019) and 21,678 tonnes (using 2019-2020 fishing mortality approximately equal to 2018-2019 estimates from the 2020 base assessment).

From the 2020 base assessment model, the maximum likelihood estimate of age-1+ forecasted biomass in July 2020 was 28,276 tonnes. The CV around this estimate was 67%, demonstrating considerable uncertainty in the 2020 assessment process (Kuriyama et al. 2020). DFO research trawl surveys, which are a source of sardine observations in BC waters, were cancelled in 2020 due to the COVID-19 pandemic and no sardine observations were reported in BC waters in 2020 from other sources. Prior to 2020, few or no sardines have been observed in BC waters from 2013 to 2019 in fisheries, surveys or from other sources, which is consistent with curtailed migration and/or stock size. Average estimates of Pacific Sardine trawl catch densities (a catch per unit effort index) from a west coast of Vancouver Island summer pelagic ecosystem night trawl survey in 2006, and 2008-2014 showed a decreasing trend from 2006 with no sardines

observed in 2013 or 2014. During the summers of 2015, 2016, 2018 and 2019, small amounts of sardine were detected off the west coast of Vancouver Island in trawl catches from other multi-species surveys (i.e., led by DFO or NOAA) and none were detected in 2017.

Although uncertainty associated with stock assessment results has increased given the absence of reliable information to update the assessment process in 2021, there is no evidence that the age-1+ Pacific Sardine stock biomass of the northern subpopulation has approached or exceeded the cutoff of 150,000 tonnes in the last 5 years, nor is there evidence to show that sardine have been in BC waters in sufficient amounts since 2012 to support a fishery.

BC fishery exploitation

The commercial BC sardine fishery was reinitiated in 2002 following closure since 1947 (Ware 1999; DFO 2012). Most fishing occurred from July to October in association with seasonal sardine migratory behaviour (DFO 2012). During the 2002-2012 period, the annual total allowable catch (TAC) generally increased as a result of management decisions (DFO 2012). Prior to 2008, landings were relatively low (less than 5,000 tonnes), then increased considerably from 2007 to 2012 (up to a maximum of 22,223 tonnes in 2010) but were zero in 2013 through to 2020, with fishery closures from 2015 to 2020 (Table 1). Since 2002, total landings of the northern subpopulation (catches from BC, Washington, Oregon, California and Ensenada Mexico combined) were highest in 2007 and lowest in 2016. Annual BC fishery exploitation rates were estimated as the annual BC fishery landings (C_t) divided by the estimated age-1+ biomass in July of year t . These estimates show an increase from $\leq 1\%$ prior to 2009 to a peak in 2012 (between 5 and 6%), followed by 0% in 2013-2020 (Table 1).

Table 1: A summary of recent Pacific Sardine fishery BC TAC, BC landings and total landings of the northern subpopulation for the west coast of North America (BC, Washington, Oregon, California and Ensenada Mexico). Also shown are Kuriyama et al. (2020) estimates of July age-1+ population biomass ($B_{1+, July}$) and coefficients of variation (CV), and BC fishery exploitation for years 2005-2020, where the 2020 estimate was a forecast. Total landings for 2002-2005 are from Hill et al. (2016) and total landings for 2006-2018 are from Kuriyama et al. (2020). Total landings in 2019 are from Kuriyama et al. (2021) and 2020 landing information is not available (hence NA). TAC, landings, and biomass values are in metric tonnes.

Calendar Year	BC TAC	BC Landings (C)	Total Landings	Biomass (B ₁₊ , July)	CV (%) (B ₁₊ , July)	BC Exploitation (% C/B ₁₊ , July)
2002	5,040	822	96,344	--	--	--
2003	9,000	1,006	84,311	--	--	--
2004	15,000	4,259	87,699	--	--	--
2005	15,200	3,266	94,149	1,352,337	12.18%	0.24%
2006	13,500	1,558	92,413	1,683,806	9.68%	0.09%
2007	19,800	1,507	134,365	1,342,647	8.09%	0.11%
2008	12,491	10,435	112,959	1,313,490	6.77%	0.79%
2009	18,196	15,334	100,085	719,186	6.10%	2.13%
2010	23,166	22,223	97,876	506,747	5.98%	4.39%
2011	21,917	20,719	91,890	560,523	6.30%	3.70%
2012	27,279	19,129	121,950	365,815	8.83%	5.23%
2013	25,477	0	73,595	195,396	13.08%	0.00%
2014	17,174	0	23,581	110,660	16.55%	0.00%
2015	0	0	2,994	68,147	15.04%	0.00%
2016	0	0	644	72,077	13.14%	0.00%
2017	0	0	7,252	55,289	14.88%	0.00%
2018	0	0	6,275	49,449	14.64%	0.00%
2019	0	0	33,834	35,186	19.03%	0.00%
2020	0	0	NA	28,276	67.03%	0.00%

Uncertainties

The absence of reliable information to update the assessment process for 2021 is a key uncertainty in the assessment. Related uncertainties associated with the 2020 and 2021 U.S. NMFS assessment of the northern subpopulation of Pacific Sardine identified in Kuriyama et al. (2020, 2021), STAR (2020), and PFMC (2021) are:

1. A lack of 2020 acoustic-trawl survey information to estimate recent abundance and to obtain biological samples to represent size and age compositions;
2. Basing catch and biomass assignment between the northern and southern subpopulations of Pacific Sardine in California and Mexican waters on a surface water temperature (16.7°C) partitioning methodology;
3. Estimating catch near Ensenada and off the northwest coast of the Baja Peninsula in the terminal seasons of an assessment when catch data are not available in time to inform current stock assessment efforts;
4. Estimating catchability (Q) within and outside the acoustic-trawl survey area and assigning species identification and species target strength to acoustic trawl survey observations (when available);
5. A general lack of reliable age composition information to convert length composition data to age composition data in order to characterise spatial and temporal dynamics of the stock;
6. Nearshore CPSS survey methods and observations, such as: a) the use of purse seine point sets to ground truth visual estimates; b) limitations to the spatial and temporal range of the survey; c) the ability to collect biological samples to confirm species compositions;
7. The validity of the CalCoFI temperature index to inform fishery management procedures; and
8. A lack of reliable methods to characterize or project recruitment abundance.

Uncertainties and concerns identified in past DFO CSAS reviews related to BC Pacific Sardine fishery harvest advice (e.g. DFO 2013) include:

1. Unknown effects of setting harvest allowances independently of the US and Mexico;
2. Unknown effects of fisheries regionally targeting different age components of the population on stock structure and reproductive capacity;
3. Concerns about incidental capture of other species in the sardine fishery; and
4. Concerns about the effects of removing sardine from important foraging habitat of sardine predators.

Harvest options

At present, there is no evidence that the age-1+ Pacific Sardine stock biomass of the northern subpopulation has approached or exceeded the cutoff of 150,000 tonnes in the last 5 years, nor is there evidence to show that sardine have been in BC waters in sufficient amounts since 2012 to support a fishery.

Conclusions

Since the 150,000 tonne biomass cutoff value for age-1+ Pacific Sardine has not been reached, it is recommended that no allowable targeted harvest of Pacific Sardine occur in BC waters in 2021.

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