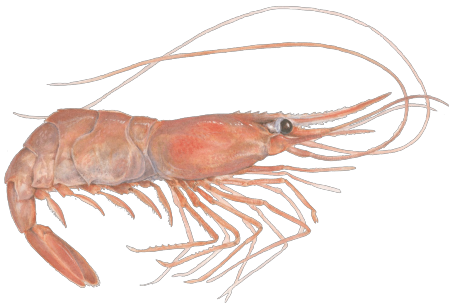
Coldwater shrimp

Northern shrimp (*Pandalus borealis*)
Ocean shrimp (*Pandalus jordani*)
Sidestripe shrimp (*Pandalopsis dispar*)
Spot shrimp (*Pandalus platyceros*)



British Columbia - Northeast Pacific

Bottom trawls, Traps

Seafood Watch Consulting Researcher

Published March 5, 2018, Updated October 6, 2021 – see Appendix for more information
Seafood Watch Standard used in this assessment: Fisheries Standard v3

Table of Contents

About Seafood Watch

Monterey Bay Aquarium's Seafood Watch program evaluates the ecological sustainability of wild-caught and farmed seafood commonly found in the United States marketplace. Seafood Watch defines sustainable seafood as originating from sources, whether wild-caught or farmed, which can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems. Seafood Watch makes its science-based recommendations available to the public in the form of regional pocket guides that can be downloaded from www.seafoodwatch.org. The program's goals are to raise awareness of important ocean conservation issues and empower seafood consumers and businesses to make choices for healthy oceans.

Each sustainability recommendation on the regional pocket guides is supported by a Seafood Watch Assessment. Each assessment synthesizes and analyzes the most current ecological, fisheries and ecosystem science on a species, then evaluates this information against the program's conservation ethic to arrive at a recommendation of "Best Choices," "Good Alternatives" or "Avoid." This ethic is operationalized in the Seafood Watch standards, available on our website here. In producing the assessments, Seafood Watch seeks out research published in academic, peer-reviewed journals whenever possible. Other sources of information include government technical publications, fishery management plans and supporting documents, and other scientific reviews of ecological sustainability. Seafood Watch Research Analysts also communicate regularly with ecologists, fisheries and aquaculture scientists, and members of industry and conservation organizations when evaluating fisheries and aquaculture practices. Capture fisheries and aquaculture practices are highly dynamic; as the scientific information on each species changes, Seafood Watch's sustainability recommendations and the underlying assessments will be updated to reflect these changes.

Parties interested in capture fisheries, aquaculture practices and the sustainability of ocean ecosystems are welcome to use Seafood Watch assessments in any way they find useful.

Guiding Principles

Seafood Watch defines sustainable seafood as originating from sources, whether fished[1] or farmed that can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems.

The following guiding principles illustrate the qualities that fisheries must possess to be considered sustainable by the Seafood Watch program (these are explained further in the Seafood Watch Standard for Fisheries):

- Follow the principles of ecosystem-based fisheries management.
- Ensure all affected stocks are healthy and abundant.
- Fish all affected stocks at sustainable levels.
- Minimize bycatch.
- Have no more than a negligible impact on any threatened, endangered or protected species.
- Managed to sustain the long-term productivity of all affected species.
- Avoid negative impacts on the structure, function or associated biota of aquatic habitats where fishing occurs.
- Maintain the trophic role of all aquatic life.
- Do not result in harmful ecological changes such as reduction of dependent predator populations, trophic cascades, or phase shifts.
- Ensure that any enhancement activities and fishing activities on enhanced stocks do not negatively affect the diversity, abundance, productivity, or genetic integrity of wild stocks.

These guiding principles are operationalized in the four criteria in this standard. Each criterion includes:

- Factors to evaluate and score
- Guidelines for integrating these factors to produce a numerical score and rating

Once a rating has been assigned to each criterion, we develop an overall recommendation. Criteria ratings and the overall recommendation are color coded to correspond to the categories on the Seafood Watch pocket guide and online guide:

Best Choice/Green: Buy first; they're well managed and caught or farmed responsibly.

Good Alternative/Yellow: Buy, but be aware there are concerns with how they're caught, farmed or managed.

Avoid/Red: Take a pass on these for now; they're overfished, lack strong management or are caught or farmed in ways that harm other marine life or the environment.

[1] "Fish" is used throughout this document to refer to finfish, shellfish and other invertebrates

Summary

This report focuses on the commercial coldwater shrimp fisheries of British Columbia (BC). The following four species of shrimp are reviewed: trap-caught spot shrimp (commonly known as spot prawn [*Pandalus platyceros*]), bottom trawl-caught ocean shrimp (commonly known as pink shrimp *(Pandalus jordani),* northern shrimp *(Pandalus borealis),* and sidestripe shrimp (*Pandalopsis dispar*).

The spot prawn stock assessment is based on a spawner escapement index that incorporates standardized CPUE data and ensures that a minimum number of female spawners are available at time of egg hatch. Minimum monthly indices (MMIs) represent a buffered management reference point that when reached will trigger a management area closure. These MMIs are typically not exceeded; however, the BC spot prawn stock has exhibited a moderate decline since 2011. The spot prawn trap fishery received a "moderate" concern for abundance due to recent declines in the abundance indices and a "low" concern for fishing mortality associated with a responsive in-season management strategy to ensure fishing mortality does not exceed reference points.

The trawl fishery is managed via a more traditional stock assessment that incorporates biomass estimates and precautionary reference points. Trawl shrimp stock status is assessed by fishery independent surveys pre- and post-season by management area. Following declines in 2016, the majority of management areas ranked "cautious" or "critical" in BC, and overall the stock status of trawl-caught shrimp scored a "moderate" concern for abundance. Trawl landings have typically been well under catch ceilings since the early 2000's due to a limited market. Market conditions changed in the 2014/2015 seasons along the US west coast with a boom in pink shrimp numbers, and the BC trawl shrimp fishery responded with increased harvests in 2015 and 2016.

The BC trap and trawl fisheries are managed by the Minister of Fisheries and Oceans and Department of Fisheries and Oceans (DFO). The commercial fisheries are limited entry, with seasonal closures, in-season area closures, gear limits, gear marking requirements (tags), trap/net mesh size requirements, minimum size limits, daily fishing time restrictions and haul limits. Reducing bycatch is a primary management goal for both fisheries; there are escape mechanism and bycatch-related gear requirements, and ongoing research. However, there are limited data available on fleetwide bycatch in the trawl fishery. Bycatch of eulachon (Committee on the Status of Endangered Wildlife in Canada or COSEWIC endangered/special concern) continues to be a priority for the trawl fishery, while reducing bycatch of quillback rockfish (COSEWIC threatened) is a priority for the spot prawn trap fishery. Enforcement, regulation transparency, and stakeholder inclusion are key qualities in the BC shrimp fisheries.

Spot prawn trap fisheries tend to occur over rocky or hard bottoms that include glass-sponge reefs and coral beds; trap gear can damage this type of vulnerable habitat. The trawl fishery occurs over soft bottom environments, which are more robust to benthic alteration by fishing gear. Both fisheries have minimized the negative impacts of fishing gear on the substrate through reducing gear footprint with area closures to conserve ecosystem function, threatened rockfish species, and vulnerable habitat such as the sponge reef areas. Marine protected areas and ecological reserves also serve to protect bottom habitat and preserve ecosystem function through ecosystem-based management.

The BC trawl shrimp and spot prawn trap fisheries receive a "yellow" or "**good alternative**" rating.

Final Seafood Recommendations

SPECIES | FISHERY	CRITERION 1 TARGET SPECIES	CRITERION 2 OTHER SPECIES	CRITERION 3 MANAGEMENT	CRITERION 4 HABITAT	OVERALL RECOMMENDATION
Northern shrimp | Northeast Pacific | Bottom trawls | Canada | British Columbia	3.413	1.526	4.000	3.162	**Good Alternative (2.849)**
Ocean shrimp | Northeast Pacific | Bottom trawls | Canada | British Columbia	3.413	1.526	4.000	3.162	**Good Alternative (2.849)**
Sidestriped shrimp | Northeast Pacific | Bottom trawls | Canada | British Columbia	3.413	1.526	4.000	3.162	**Good Alternative (2.849)**
Spot shrimp | Northeast Pacific | Traps (unspecified) | Canada | British Columbia	3.413	1.732	4.000	3.162	**Good Alternative (2.941)**

Summary

Coldwater shrimp caught in British Columbia, Canada, with traps and bottom trawls is a "Good Alternative." Shrimp stocks in Canada have been declining, but there are precautionary policies in place that prevent overfishing. Overall bycatch rates are low in the pot fishery, but potential entanglement of humpback whales is a serious concern. Trap fishing takes place over rocky or hard bottom habitat, and the gear can damage vulnerable glass-sponge reefs and coral beds. Closed areas reduce overall habitat impacts, and there are some policies in place to protect the ecosystem. Bycatch information in the trawl fishery is generally unknown, and this fishery may be impeding the recovery of eulachon, an ecologically important forage fish listed as "endangered" or "special concern" by region. The conservation measures are rated highly effective overall, but bycatch management is rated moderately effective. Bottom trawling takes place over more resilient soft bottom seafloor, and closed areas reduce overall habitat impacts. There are some policies in place to protect the ecosystem.

Scoring Guide

Scores range from zero to five where zero indicates very poor performance and five indicates the fishing operations have no significant impact.

Final Score = geometric mean of the four Scores (Criterion 1, Criterion 2, Criterion 3, Criterion 4).

Best Choice/Green = Final Score >3.2, and no Red Criteria, and no Critical scores

Good Alternative/Yellow = Final score >2.2-3.2, and neither Harvest Strategy (Factor 3.1) nor Bycatch Management Strategy (Factor 3.2) are Very High Concern2, and no more than one Red Criterion, and no Critical scores

Avoid/Red = Final Score ≤2.2, or either Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern or two or more Red Criteria, or one or more Critical scores.

[2] Because effective management is an essential component of sustainable fisheries, Seafood Watch issues an Avoid recommendation for any fishery scored as a Very High Concern for either factor under Management (Criterion 3).

Introduction

Scope of the analysis and ensuing recommendation

This report focuses on the commercial coldwater shrimp fisheries of British Columbia, Canada (BC). Four species of shrimp are reviewed: spot shrimp or spot prawn *(Pandalus platyceros)* caught by trap, and ocean shrimp or pink shrimp *(Pandalus jordani)*, northern shrimp *(Pandalus borealis)* and sidestripe shrimp *(Pandalopsis dispar)* caught by bottom trawl. Although less common, dock shrimp *(Pandalus danae)* and coonstriped *(Pandalus hypsinotus)* are also incidentally retained in the trawl fishery. However, coonstriped and dock shrimp landings are minimal, and they are not reviewed in this assessment.

Species Overview

Shrimp along the Pacific west coast are typically benthic omnivores, feeding on organic surface sediments, diatoms, infaunal polychaetes, gastropods, and crustaceans (Owens 2006). Some shrimp species, such as spot prawns, undergo diurnal feeding migrations, moving shoreward along the bottom into shallower waters at night and back to deeper waters during the day (Butler 1980) (Quinn et al. 2014). Shrimp distributions are principally determined by temperature, salinity, and bottom type (Cadrin et al. 2004). Environmental factors have profound influence on life histories within and among shrimp populations {Anderson & Piatt 1999} (Hannah 2011). For instance, ocean climate and ice cover have been shown to have significant effects on shrimp population dynamics and fishery yields (Cadrin et al. 2004). While adult spot prawns and coonstripe shrimp can be found on rocky habitats, pink, northern, and sidestripe shrimp are typically found over muddy or sandy substrates (Quinn et al. 2014) (DFO 2017) (DFO 2017a).

All species reviewed in this assessment are *pandalid* shrimp. Pandalid shrimp are protandric hermaphrodites, beginning life as males and becoming females at a later stage (Quinn et al. 2014). In contrast to many marine species that broadcast gametes into the water column, pandalid shrimp have internal fertilization, and females brood eggs until larvae are hatched (Cadrin et al. 2004). Overall fecundity (number of eggs produced) and ontogeny vary by species. Shrimp are particularly challenging to age because shrimp growth is a discontinuous process and is associated with molting of the exoskeleton (Cadrin et al. 2004), so age estimates are uncertain. On average, pandalids may reach maturity between one to three years and female pandalids may brood from to 1,000 to 2,000 eggs per reproductive cycle (Cadrin et al. 2004). Spot prawns are the longest-lived of the pandalid shrimp, and studies from BC suggest they can live four to five years (and even longer in other regions) (Butler 1980) (DFO 2017a) (Quinn et al. 2014).

Production Statistics

Shellfish fisheries in BC are an important contributor to Canada's Pacific Region commercial fisheries. The 2015 landed value was $14 million and $32.7 million for shrimp and spot prawns, respectively (shrimp landed value increased 563% from 2014 to 2015) (Ministry of Agriculture 2017). The wholesale value (includes imports with value-added in BC) in 2015 was $24.2 million for shrimp (representing a 236% increase from 2014) and $47.8 million for spot prawns based on the 2015 Seafood Industry Review (Ministry of Agriculture 2017). The 2015 value of BC shrimp exports was $49.9 million (Ministry of Agriculture 2017). It is important to note that wild BC shrimp composes a relatively small percentage of the overall shellfish value and production in BC (Figure 1).

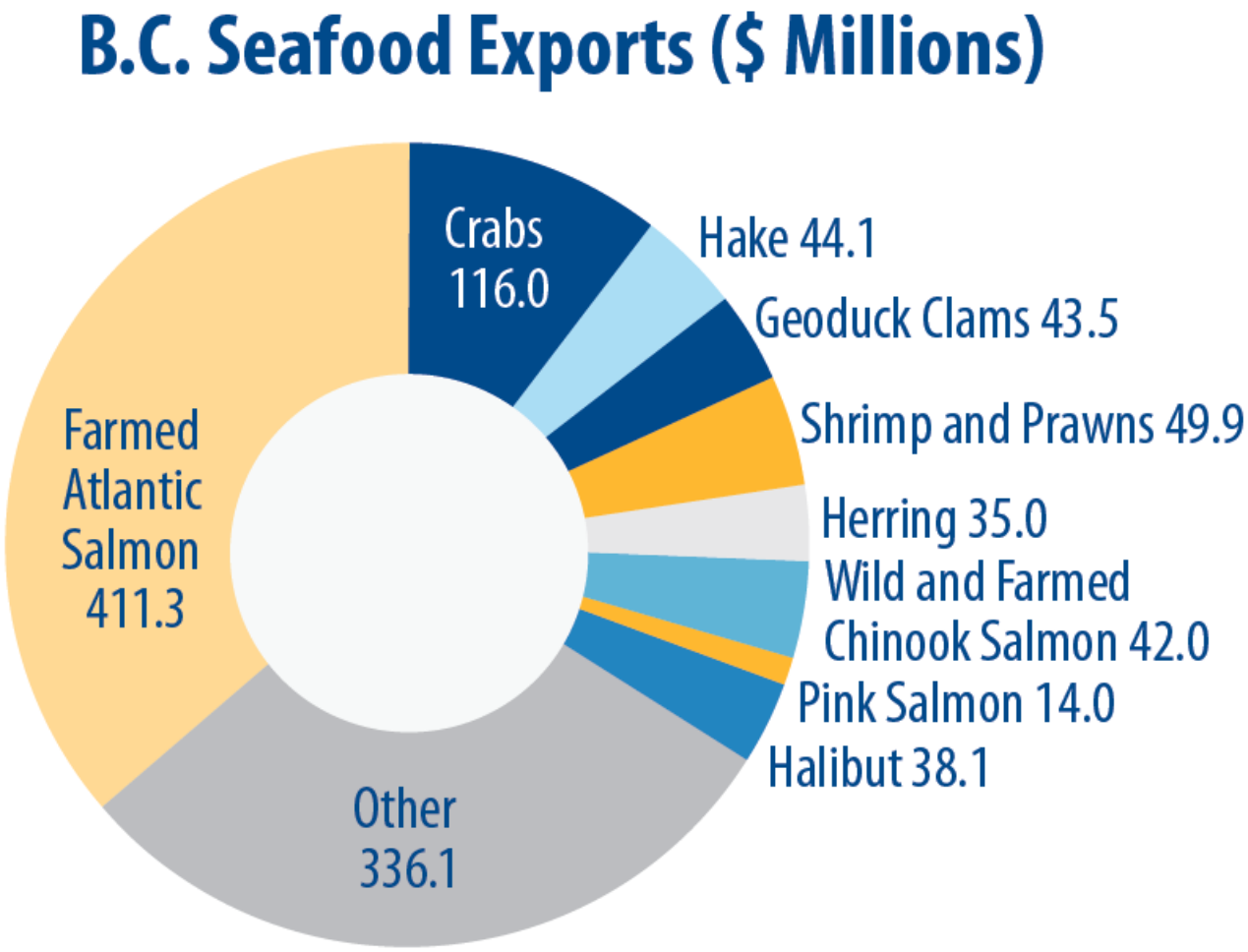


Figure 1: British Columbia shellfish wholesale value ($ Millions)(Ministry of Agriculture 2017)

.

Leading importers of Canadian seafood include the US, China, Japan, Hong Kong, and the Ukraine (Figure 2), and Vietnam imports the most shellfish by species.

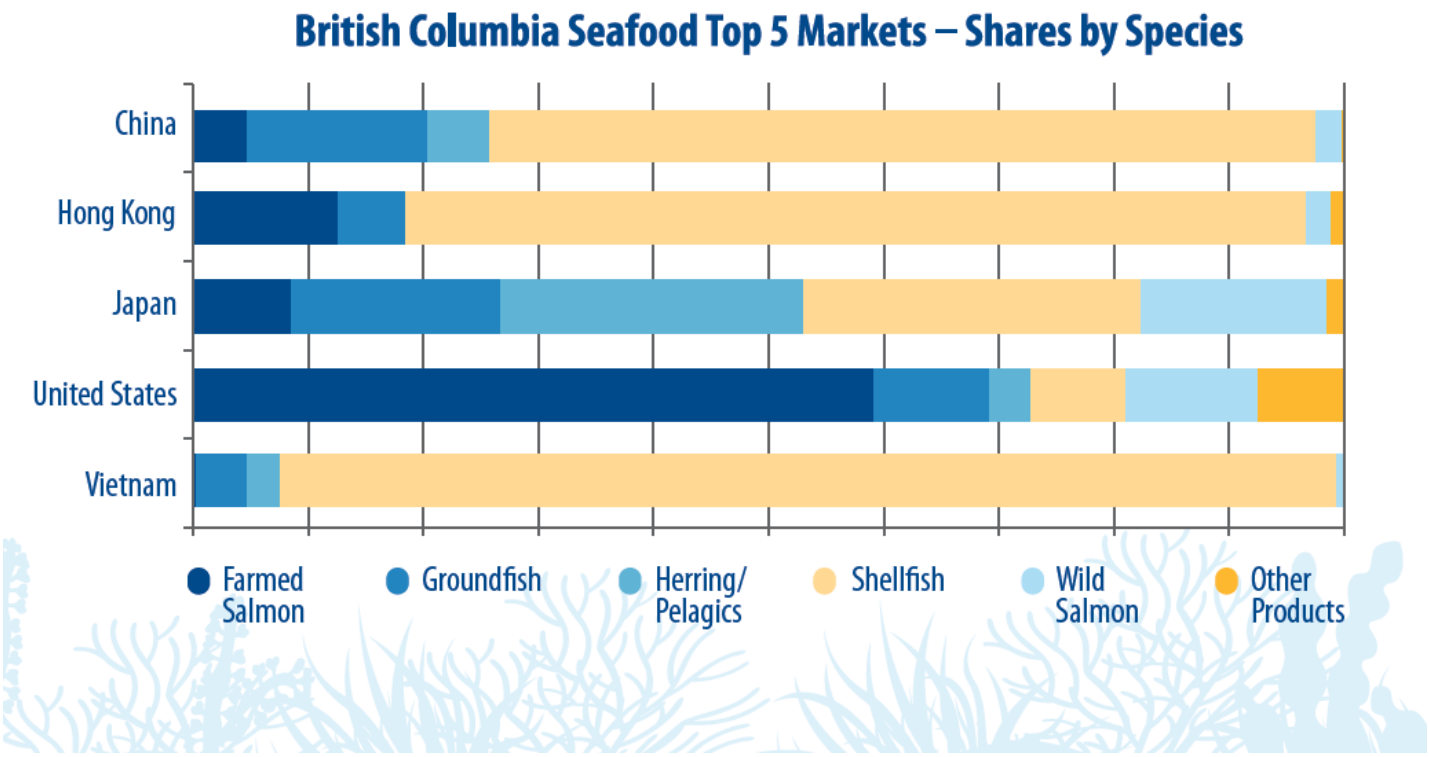


Figure 2: British Columbia seafood top 5 export markets- Shares by Species (Ministry of Agriculture 2017)

.

Trap: The commercial prawn and shrimp by trap fishery is one of the most valuable fisheries in the Pacific Region. With an estimated landed value of $28.9 million, it was the 5th most valuable wild capture fishery in 2015 in the Pacific Region after the halibut, crab, sablefish and geoduck/horseclam fisheries {DFO logbook and sales slips data; DFO 2017a}. The prawn fishery added $17 million to Canada Gross Domestic Product (GDP) in 2011, representing 12.5% of capture fisheries' GDP in that year. From 2007 to 2011 the prawn fishery, on average, accounted for 9.6 to 10.6% of capture fisheries' GDP (DFO 2017a). In 2015, the wholesale value of prawns processed in BC was $48 million, however, some of this value may have been tied to imported prawns (DFO 2017a).

Landed value of spot prawns in 2011 was the highest of the past decade due to the combination of high price and volume (Figure 3; DFO 2017a). While price remained at the higher levels until 2015, lower harvest volume between 2012 and 2014 resulted in lower landed value for the fishery. In 2015, price dropped sharply by over 20%, and fell further by over 10% in 2016. Landed volume was stable between 2012 and 2015; however, initial volume estimates for 2016 show a sharp decline in volume. The combination of a lower price and volume suggest 2016 may have been the lowest value prawn fishery in the past two decades (DFO 2017a).

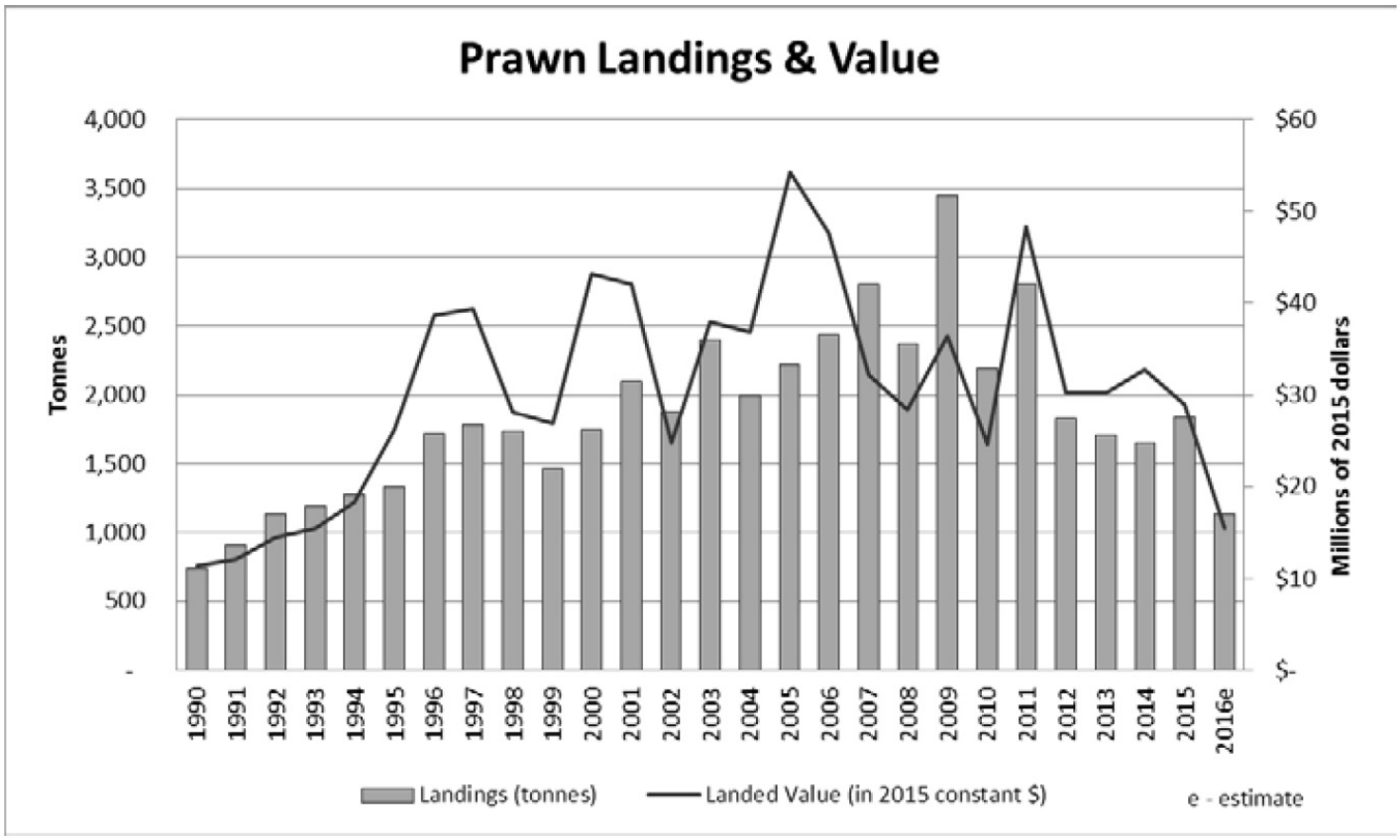


Figure 3: Landings from logbooks; value 1990-2011 from BC Ministry of Agriculture, value from 2012 to present based on price from fish slips and does not include post-season price adjustments. 2016 estimated value (DFO 2017a).

.

Trawl: The majority of the BC shrimp trawl fleet consists of smaller vessels that harvest modest volumes of shrimp during day trips. High fuel prices, low landed value, and continuing decreasing participation contributed to continued poor economic performance for the shrimp trawl fishery in 2014/15. Large trawl vessels were generally not active in the BC shrimp fishery until mid-2015 (DFO 2017). The BC industry, with low volumes and high production costs, is less competitive than large-scale shrimp fisheries in Oregon/Washington and eastern Canada. In 2015, a large pink shrimp catch ceiling on the West Coast of Vancouver Island and the availability of freezing capacity allowed the industry to harvest larger volumes of pink shrimp and freeze them for processing elsewhere (DFO 2017) (Figure 4). Beginning in 1997, landings declined due to precautionary management changes, including gear modification requirements, and total allowable catch (TAC) limits. The total estimated value of shrimp landed by the shrimp trawl fishery in the 2015 calendar year was $13,779,060 based on logbook landings of 9.6 million lb and average price from fish slips of $3.16 per kg (pers. comm., Clark, DFO 2017).

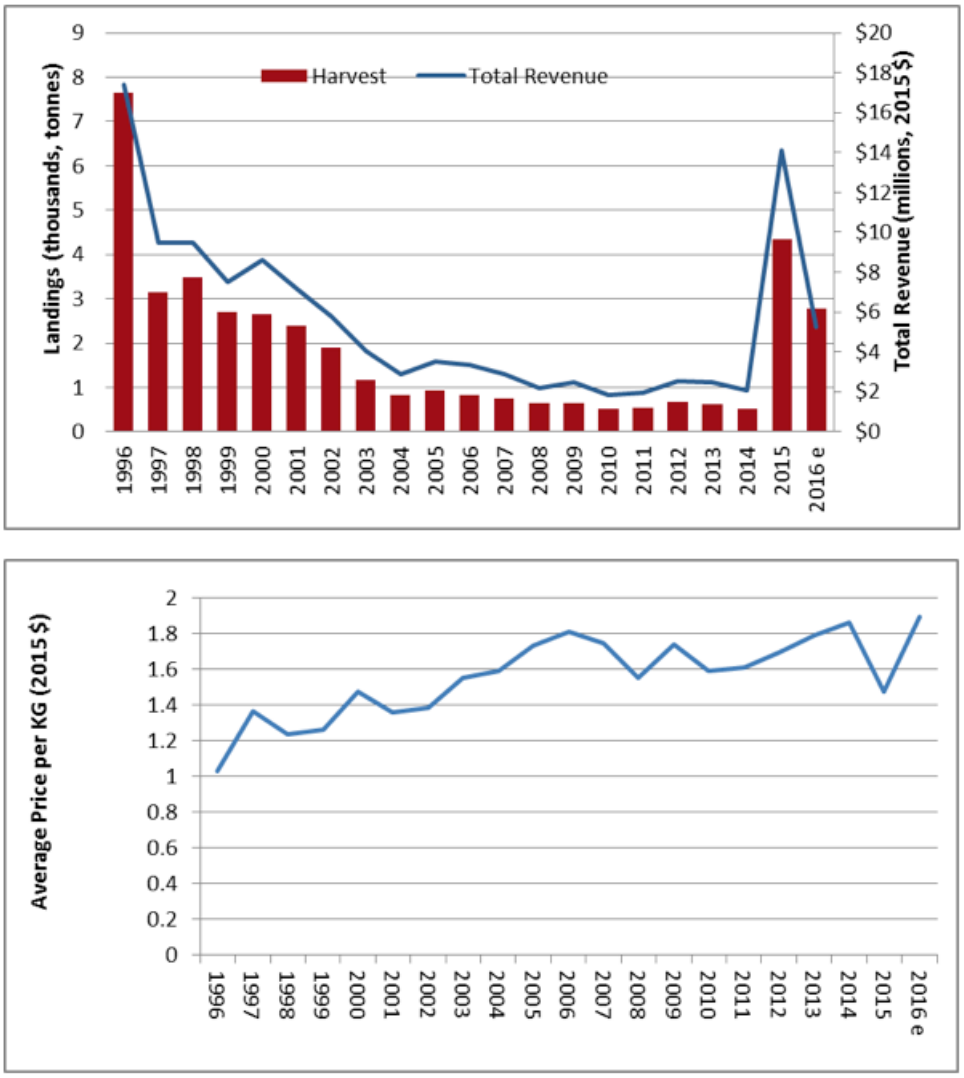


Figure 4: Landings, Landed Value, and Price for all shrimp since 1996 by calendar year. (Sources: Logbooks with matched Sale Slip data, Economics Unit.) 2016 is a preliminary estimate and is subject to change (DFO 2017).

.

Importance to the US/North American market.

Shrimp is the most popular seafood item in the United States. Average annual per capita consumption of shrimp in the US doubled since the mid-1980s and has generally been greater than or equal to 4 lb since 2003. The US is the world's leading shrimp importer. The quantity of shrimp imported in 2015 was 1.3 billion lb, 40 million lb more than the quantity imported in 2014. Valued at $5.4 billion, shrimp imports accounted for 28.9% of the value of total edible imports in 2015 (NMFS 2016).

The majority (~90%) of shrimp consumed in the large US market is imported warmwater shrimp, primarily from Asia (India, Indonesia, Thailand) and South America (Ecuador) (Figure 5). The majority of imported shrimp in the US are farmed shrimp (Figure 6) (NMFS 2016). In 2014, imported coldwater shrimp (primarily from Canada, Argentina, and Denmark) accounted for just 0.6% of imported shrimp (tonnes) as compared to overall imports (NOAA 2014). The value of imported coldwater shrimp in 2014 was roughly $36 million, a fraction of the value of overall shrimp imports ($6.7 billion in 2014). In summary, the market for Canadian coldwater shrimp in the US is small in comparison to the overall shrimp market, which is comprised largely of warmwater farmed shrimp from Asia. Price competition from farmed warmwater shrimp has depressed global and US demand for coldwater imported shrimp (NMFS 2016).

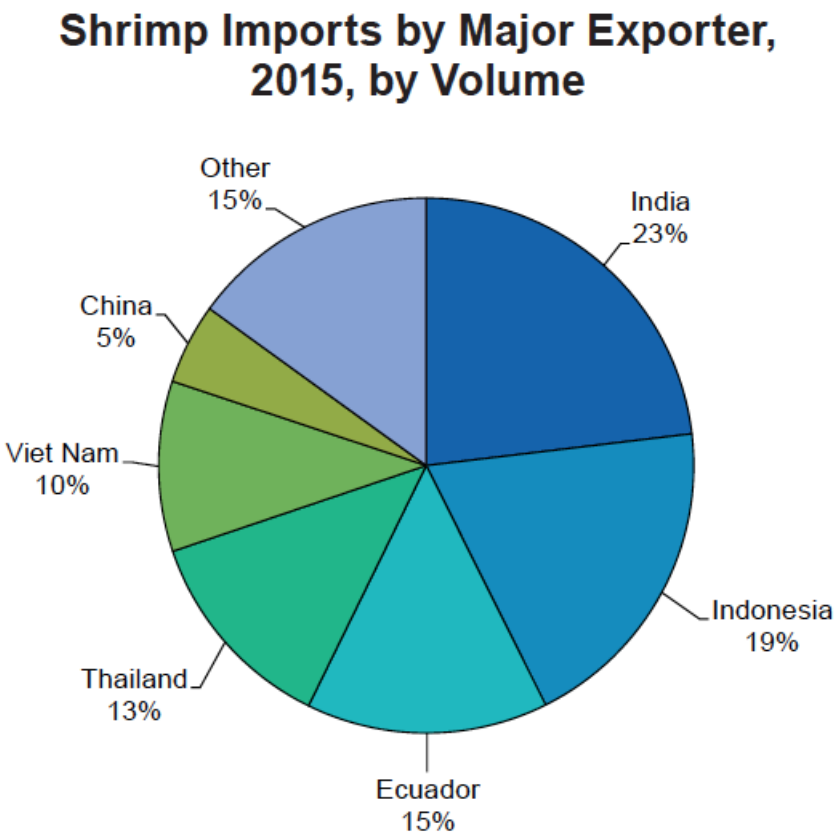


Figure 5: US shrimp imports by country (NMFS 2016)

.

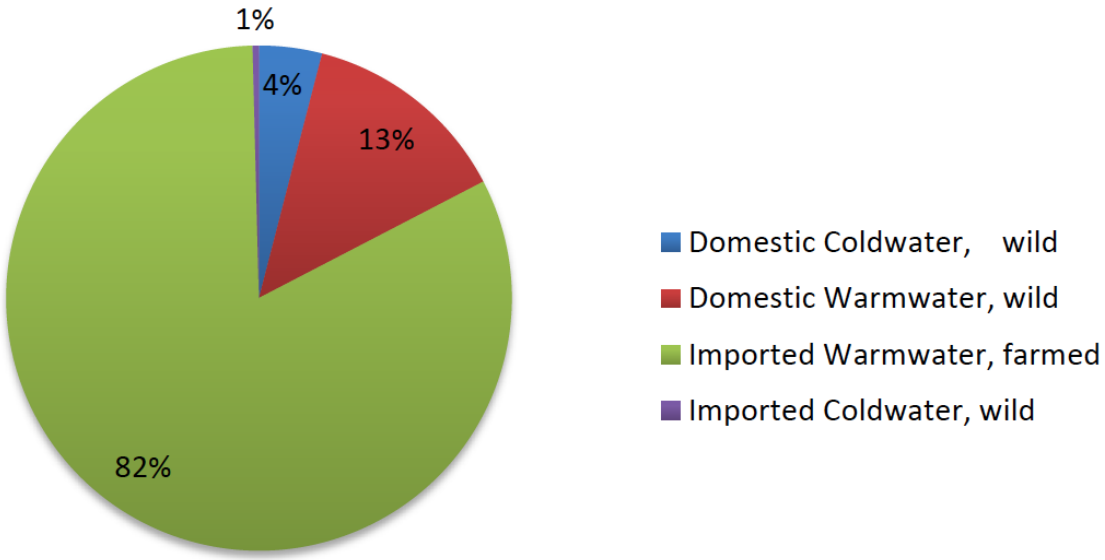


Figure 6: Imported coldwater shrimp are primarily from Canada and Argentina. Domestic coldwater shrimp are from the Atlantic and North Pacific Oceans. Domestic warmwater shrimp are harvested in the Gulf of Mexico and Atlantic Ocean. Imported warmwater shrimp are primarily farmed shrimp from Asia (NMFS 2016).

.

Common and market names.

Common names vary by region, but this report will adhere to the nomenclature listed below (Figure 7). Market names for coldwater shrimp tend to vary and are not well-regulated.

Table 1: Coldwater Pacific coast shrimp fisheries (not globally comprehensive). Common names used in this report appear in bold. Species assessed in this report are denoted by ***.

Common Names US/Canada	Scientific Name	Range	US/Canada fishery location
Atlantic			
Northern shrimp, pink shrimp, northern prawn, salad shrimp, Pacific pink shrimp	*Pandalus borealis*	Gulf of Maine to North Sea	Baffin Bay to Gulf of Maine
Striped shrimp	*Pandalus motagui*	Gulf of Maine to North Sea/Barents Sea	Primarily incidental in northern shrimp fishery; small quota in Atlantic Canada
Common shrimp, brown shrimp, shrimp (UK)	*Crangon crangon*	Northeast Atlantic (Europe and Scandinavia)	NA
Argentinean shrimp	*Pelticus muelleria*	Southwest Atlantic	NA
Pacific			
***Northern shrimp**, pink shrimp, great northern shrimp, salad shrimp, Pacific pink shrimp	*Pandalus borealis*	Washington to Russia, patchy distribution off California and Japan	Davis Strait off Labrador to the Gulf of Maine
***Pink shrimp**, ocean shrimp, smooth pink shrimp, Oregon pink shrimp	*Pandalus jordani*	Aleutian Islands to Baja California	Vancouver Island, British Columbia to Point Arguello, California
***Spot prawn**, spot shrimp, spot, prawn	*Pandalus platyceros*	Gulf of Alaska to Baja California, Japan	Alaska to Southern California
***Pacific ridgeback prawn**	*Sicyonia ingentis*	Monterey, California to Baja California	Santa Barbara area
***Coonstripe shrimp**, humpback shrimp, king shrimp	*Pandalus hypsinotus*	Washington to Japan	Gulf of Alaska, northern California
***Sidestripe shrimp**	*Pandalus dispar*	North America west coast nearshore	Gulf of Alaska
***Dock shrimp** (Oregon, Alaska, Canada, coonstripe shrimp (California)	*Pandalus danae*	British Columbia to Baja California	Primarily incidental in other shrimp fisheries
Striped shrimp	*Pandalus montagui*	California to Japan	
Rough patch shrimp	*Pandalus stenolepsis*	Alaska to Washington	
Humpy shrimp	*Pandalus goniurus*	Washington to northern Japan	
Generally not for human consumption			
Bay shrimp, grass shrimp	*Crangon francisorum*	Alaska to Southern California	San Francisco area
Red rock shrimp	*Lysmata californica*	Santa Barbara to Baja California	NA
Blue mud shrimp, crawfish, mud prawn, ghost shrimp, mud shrimp	*Upogebia pugettensis*	Alaska to Baja California	
Ghost shrimp, Pacific intertidal shrimp, crawfish, mud prawn, burrowing shrimp, red ghost shrimp, orange mud shrimp	*Callianassa californiensis*	Alaska to Baja California	
Brine shrimp, sea monkey, fairy shrimp	*Artemia salina, Artemia fransciscana*	Salty lakes in Utah and West Coast	

Primary product forms

Primary product forms for coldwater Pacific shrimp are either raw or cooked and include the following options, depending on the species and its size (NMFS 2016):

- Frozen block whole
- Frozen block peeled (machine or hand)
- Frozen IQF (individual quick frozen)
- Fresh not frozen

Assessment

This section assesses the sustainability of the fishery(s) relative to the Seafood Watch Standard for Fisheries, available at www.seafoodwatch.org. The specific standard used is referenced on the title page of all Seafood Watch assessments.

Criterion 1: Impacts on the species under assessment

This criterion evaluates the impact of fishing mortality on the species, given its current abundance. When abundance is unknown, abundance is scored based on the species' inherent vulnerability, which is calculated using a Productivity-Susceptibility Analysis. The final Criterion 1 score is determined by taking the geometric mean of the abundance and fishing mortality scores. The Criterion 1 rating is determined as follows:

- ***Score >3.2=Green or Low Concern***
- ***Score >2.2 and ≤3.2=Yellow or Moderate Concern***
- ***Score ≤2.2 = Red or High Concern***

Rating is Critical if Factor 1.3 (Fishing Mortality) is Critical.

Guiding principles

- *Ensure all affected stocks are healthy and abundant.*
- *Fish all affected stocks at sustainable level*

Criterion 1 Summary

NORTHERN SHRIMP			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Northeast Pacific | Bottom trawls | Canada | British Columbia	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)

OCEAN SHRIMP			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Northeast Pacific | Bottom trawls | Canada | British Columbia	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)

SIDESTRIPED SHRIMP			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Northeast Pacific | Bottom trawls | Canada | British Columbia	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)

SPOT SHRIMP			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Northeast Pacific | Traps (unspecified) | Canada | British Columbia	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)

Criterion 1 Assessments

SCORING GUIDELINES

Factor 1.1 - Abundance
Goal: Stock abundance and size structure of native species is maintained at a level that does not impair recruitment or productivity.

- *5 (Very Low Concern) — Strong evidence exists that the population is above an appropriate target abundance level (given the species' ecological role), or near virgin biomass.*
- *3.67 (Low Concern) — Population may be below target abundance level, but is at least 75% of the target level, OR data-limited assessments suggest population is healthy and species is not highly vulnerable.*
- *2.33 (Moderate Concern) — Population is not overfished but may be below 75% of the target abundance level, OR abundance is unknown and the species is not highly vulnerable.*
- *1 (High Concern) — Population is considered overfished/depleted, a species of concern, threatened or endangered, OR abundance is unknown and species is highly vulnerable.*

Factor 1.2 - Fishing Mortality

Goal: Fishing mortality is appropriate for current state of the stock.

- *5 (Low Concern) — Probable (>50%) that fishing mortality from all sources is at or below a sustainable level, given the species ecological role, OR fishery does not target species and fishing mortality is low enough to not adversely affect its population.*
- *3 (Moderate Concern) — Fishing mortality is fluctuating around sustainable levels, OR fishing mortality relative to a sustainable level is uncertain.*
- *1 (High Concern) — Probable that fishing mortality from all source is above a sustainable level.*

Northern shrimp

Factor 1.1 - Abundance

Northeast Pacific | Bottom trawls | Canada | British Columbia

Moderate Concern

The DFO manages pink and northern shrimp as one stock, referred to as "pink shrimp." The trawl fishery occurs in 34 of 36 Shrimp Management Areas (SMAs) in BC, and area-swept trawl surveys are conducted on a fixed schedule to index pink shrimp biomass and to monitor trends in abundance over time in 10 to 12 SMAs annually (pers. comm., Clark, DFO 2017). Several pink shrimp stocks were either in the Cautious or Critical zone (Table 1). Shrimp stocks tend to show high annual variation, and variable stock sizes over the long term are considered the norm for these species (DFO 2017). BC shrimp SMAs saw mixed trends in abundance in 2018 through 2021, and not all SMAs are assessed annually. Natural fluctuations in shrimp biomass are well documented in this fishery, and SMAs are closed to fishing when designated Critical following surveys. Therefore, the fishery receives a "moderate" concern for abundance.

Justification:

Area-swept trawl surveys are conducted on a fixed schedule/annual basis to index shrimp biomass and to monitor trends in shrimp abundance over time in a number of BC SMAs (Figure 8,11). Strong stock recruit relationships are not evident for west coast shrimp stocks; therefore, a proxy for B_{MSY}, the natural log of the average biomass is used (B_{PROX}). Shrimp biomass is assigned to one of three categories: "critical," "cautious," or "healthy" based on biomass estimates by SMA (Figure 9,12). These zones are defined by an upper stock reference point (USR=80% B_{PROX}) and a limit reference point (LRP= 40% B_{PROX})(DFO 2017).

SMA	Survey	Biomass (species)	Status	Source
GSTE	2020/21	36.77 t (*P. jordani*)	Critical Zone	(DFO 2021a)
PRD	2020	467.2 t (*P. borealis*); 823.8 t (*P. jordani*); 1,261.3 t (*P. dispar*)	Healthy Zone	(DFO 2020b)
23OFF+21OFF+23IN	2019	7,452.5 t (*P. jordani*); 15.8 t (*P. dispar*)	Stock status zones undefined	(DFO 2019a)
124OFF	2019	244.5 t (*P. jordani*)	Critical Zone	(DFO 2019a)
125OFF	2019	185.8 t (*P. jordani*)	Critical Zone	(DFO 2019a)
16	2019	12.2 t (*P. borealis*); 4.2 t (*P. jordani*); 9.2 (*P. dispar*)	Critical Zone	(DFO 2019b)
12IN	2019	1,034 t (*P. borealis*); 288.4 (*P. dispar)*	Healthy Zone	(DFO 2019c)
14	2019	269.8 t (*P. jordani*); 2.8 t (*P. dispar*)	Healthy Zone; Critical Zone	(DFO 2019d)
FR	2019	123.1 t (*P. dispar*); 78.1 t (*P. borealis*); 3.2 t (*P. jordani*)	Cautious; Critical; Critical	(DFO 2019e)
18	2018	1.4 t (*P. borealis*); 3.8 t (*P. dispar*)	Critical Zone	(DFO 2018a)
19	2018	44.0 t (*P. borealis*); 30.6 t (*P. jordani*); 6.7 t (*P. dispar*)	Critical Zone	(DFO 2018a)

Table 1. Status of sidestripe shrimp (*Pandalopsis dispar*), spiny pink shrimp (*Pandalus borealis*), and smooth pink shrimp (*Pandalus jordani*) in various SMAs in BC from 2018 to 2021.

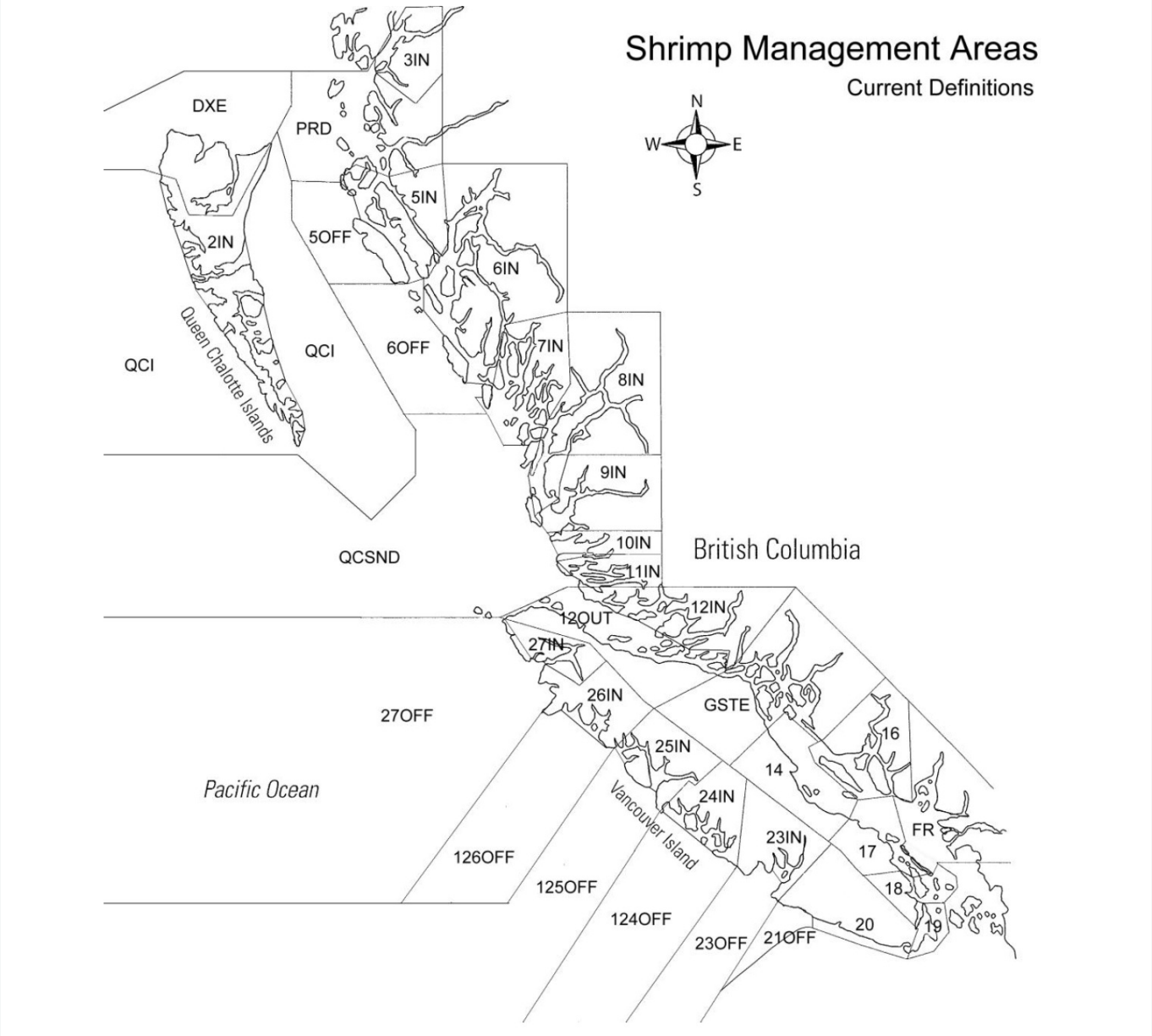


Figure 7: Map showing the BC Shrimp Management Areas (SMA) for the shrimp trawl fishery (Rutherford et al. 2013).

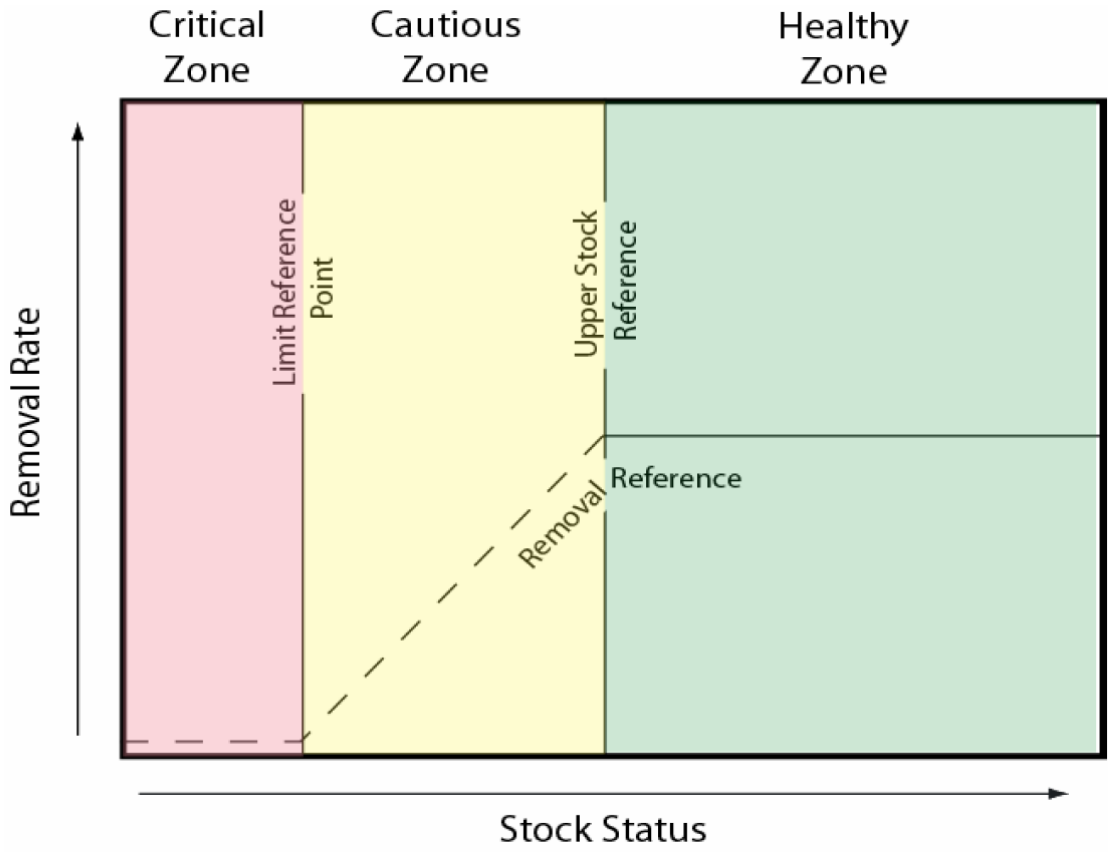


Figure 8: Adjustments to Removal Rate (harvest rate) when Stock Status is in Critical Zone (zero), Cautious Zone (0 to 35%) or Healthy Zone (35%). Healthy and Cautious zone is delineated by Upper stock reference point. Cautious and Critical zone delineated by Limit Reference Point.

Factor 1.2 - Fishing Mortality

Northeast Pacific | Bottom trawls | Canada | British Columbia

Low Concern

The 2015/2016 season saw the highest landings since the mid-1990s (DFO 2017), but landings returned to near the long-term mean in 2017 and 2018 following the closure of several SMAs (DFO 2020c). Overall, total landings have been well below catch ceilings since 2000/2001 season, with the exception of the 2016/2017 season (Figure 10,13). For the 2016/2017 season, an overage occurred due to an in-season management decision to reduce annual TACs mid-season. This regulatory change was associated with eulachon bycatch levels and mid-year fishery independent survey results (pers. comm., Clark, DFO 2017). In response to the 2016/2017 season overage, fishery managers did not reopen SMAs where overages occurred until after biomass estimates associated with the May 2017 fishery-independent survey were available. A comprehensive stock assessment program informs the conservative management approach taken in the BC shrimp trawl fishery; it is probable that fishing mortality from all sources is at or below a sustainable level. Therefore, the BC shrimp trawl fishery receives a "low" concern for fishing mortality.

Justification:

The annual stock assessment and estimated B_{MSY} (or B_{PROXY}) inform the Provisional Harvest Control Rules (HCRs) in accordance with Canada's precautionary management approach. HCRs are currently set at a maximum 35% of the estimated total biomass in each SMA (DFO 2017){DFO 2002c}, representing a conservative approach to stock management. It is important to note that landings are self-reported and are not validated by an independent third party (pers. comm., Clark, DFO 2017). The Total Allowable Catch (TAC) is defined and set annually based on the stock assessment, which forms the biological basis for the catch ceilings. If TACs are reached for any species, the SMA will be closed in-season, making it unlikely that fishing mortality will be above a sustainable level.

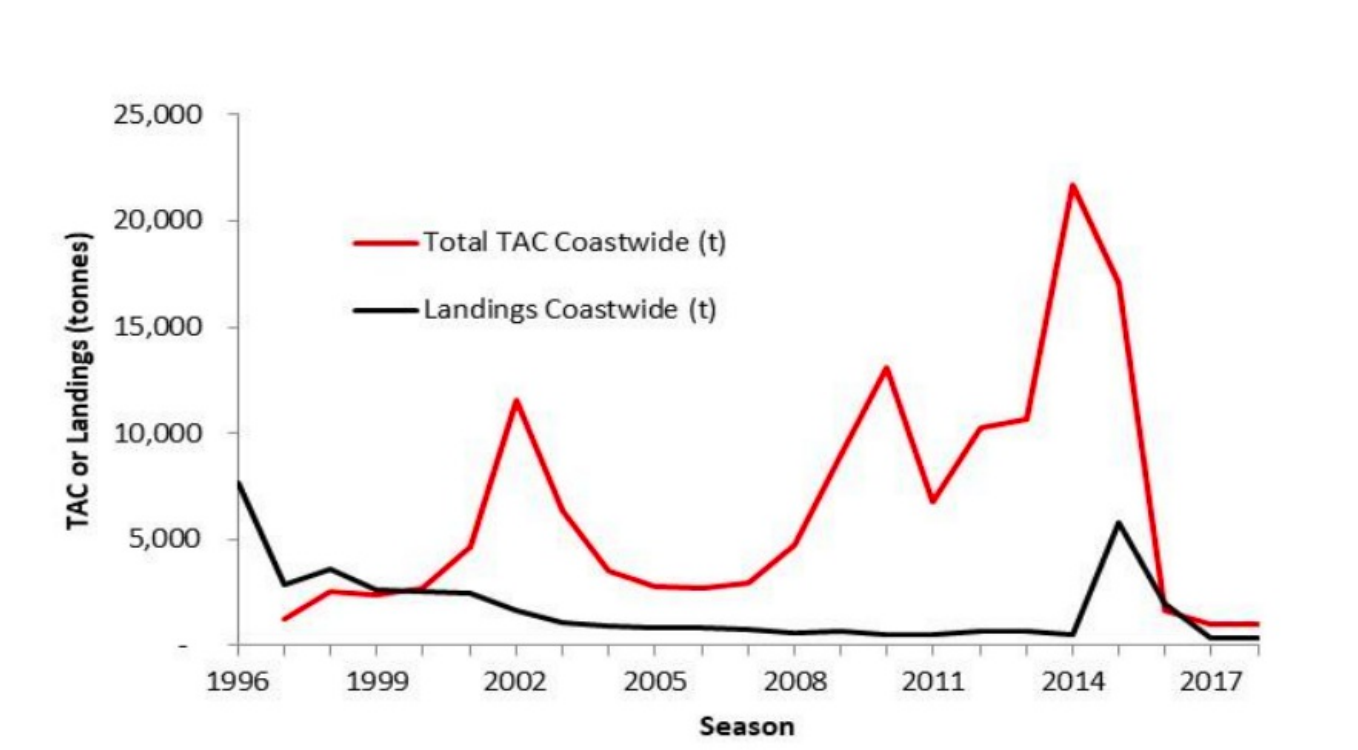


Figure 9: BC Shrimp trawl landings (black line) and Total Allowable Catch (red line), 1996-2018 {DFO 2020}

Ocean shrimp

Factor 1.1 - Abundance

Northeast Pacific | Bottom trawls | Canada | British Columbia

Moderate Concern

The DFO manages pink and northern shrimp as one stock, referred to as "pink shrimp." The trawl fishery occurs in 34 of 36 Shrimp Management Areas (SMAs) in BC, and area-swept trawl surveys are conducted on a fixed schedule to index pink shrimp biomass and to monitor trends in abundance over time in 10 to 12 SMAs annually (pers. comm., Clark, DFO 2017). Several pink shrimp stocks were either in the Cautious or Critical zone (Table 1). Shrimp stocks tend to show high annual variation, and variable stock sizes over the long term are considered the norm for these species (DFO 2017). BC shrimp SMAs saw mixed trends in abundance in 2018 through 2021, and not all SMAs are assessed annually. Natural fluctuations in shrimp biomass are well documented in this fishery, and SMAs are closed to fishing when designated Critical following surveys. Therefore, the fishery receives a "moderate" concern for abundance.

Justification:

Area-swept trawl surveys are conducted on a fixed schedule/annual basis to index shrimp biomass and to monitor trends in shrimp abundance over time in a number of BC SMAs (Figure 8,11). Strong stock recruit relationships are not evident for west coast shrimp stocks; therefore, a proxy for B_{MSY}, the natural log of the average biomass is used (B_{PROX}). Shrimp biomass is assigned to one of three categories: "critical," "cautious," or "healthy" based on biomass estimates by SMA (Figure 9,12). These zones are defined by an upper stock reference point (USR=80% B_{PROX}) and a limit reference point (LRP= 40% B_{PROX})(DFO 2017).

SMA	Survey	Biomass (species)	Status	Source
GSTE	2020/21	36.77 t (*P. jordani*)	Critical Zone	(DFO 2021a)
PRD	2020	467.2 t (*P. borealis*); 823.8 t (*P. jordani*); 1,261.3 t (*P. dispar*)	Healthy Zone	(DFO 2020b)
23OFF+21OFF+23IN	2019	7,452.5 t (*P. jordani*); 15.8 t (*P. dispar*)	Stock status zones undefined	(DFO 2019a)
124OFF	2019	244.5 t (*P. jordani*)	Critical Zone	(DFO 2019a)
125OFF	2019	185.8 t (*P. jordani*)	Critical Zone	(DFO 2019a)
16	2019	12.2 t (*P. borealis*); 4.2 t (*P. jordani*); 9.2 (*P. dispar*)	Critical Zone	(DFO 2019b)
12IN	2019	1,034 t (*P. borealis*); 288.4 (*P. dispar)*	Healthy Zone	(DFO 2019c)
14	2019	269.8 t (*P. jordani*); 2.8 t (*P. dispar*)	Healthy Zone; Critical Zone	(DFO 2019d)
FR	2019	123.1 t (*P. dispar*); 78.1 t (*P. borealis*); 3.2 t (*P. jordani*)	Cautious; Critical; Critical	(DFO 2019e)
18	2018	1.4 t (*P. borealis*); 3.8 t (*P. dispar*)	Critical Zone	(DFO 2018a)
19	2018	44.0 t (*P. borealis*); 30.6 t (*P. jordani*); 6.7 t (*P. dispar*)	Critical Zone	(DFO 2018a)

Table 1. Status of sidestripe shrimp (*Pandalopsis dispar*), spiny pink shrimp (*Pandalus borealis*), and smooth pink shrimp (*Pandalus jordani*) in various SMAs in BC from 2018 to 2021.

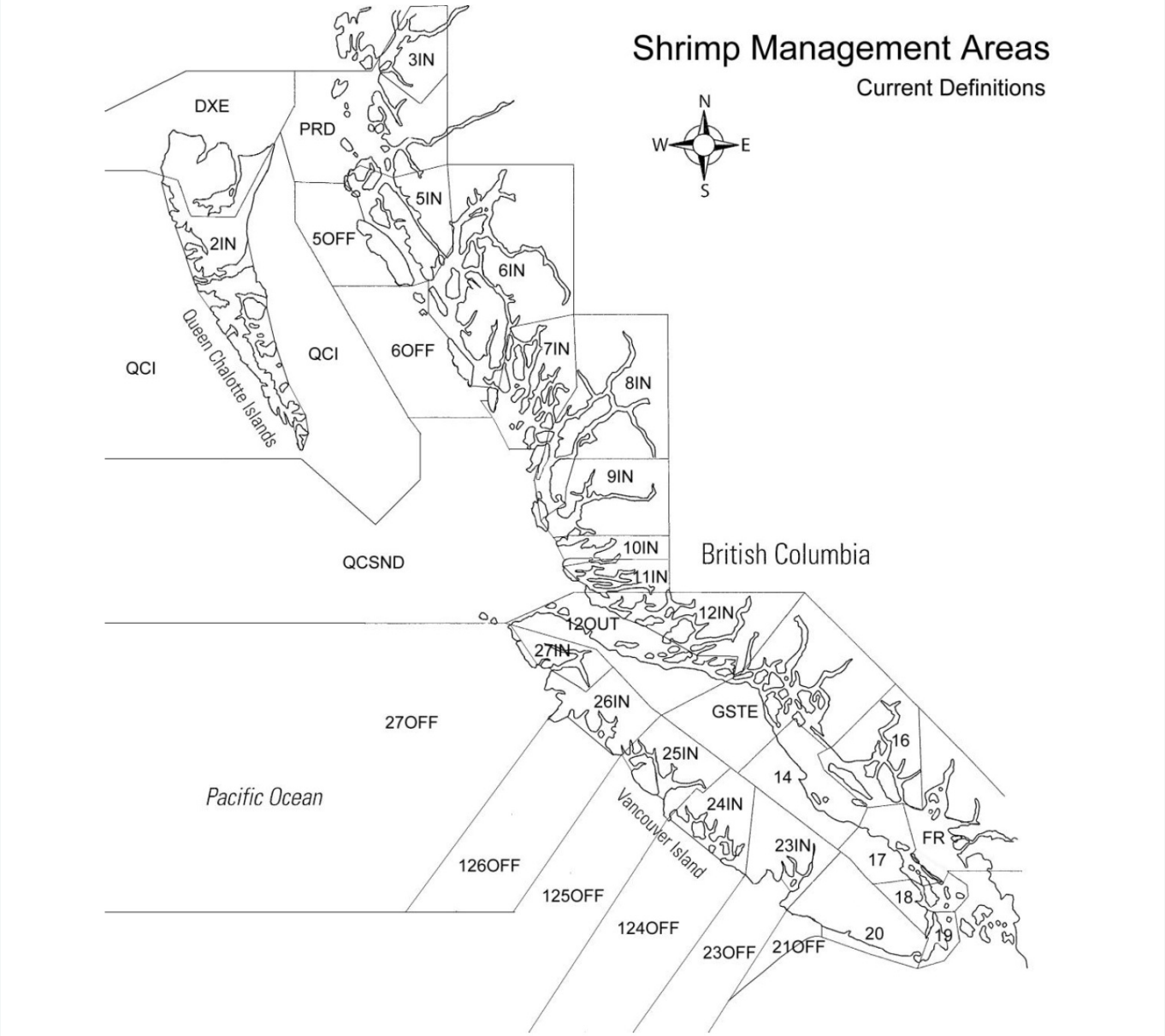


Figure 7: Map showing the BC Shrimp Management Areas (SMA) for the shrimp trawl fishery (Rutherford et al. 2013).

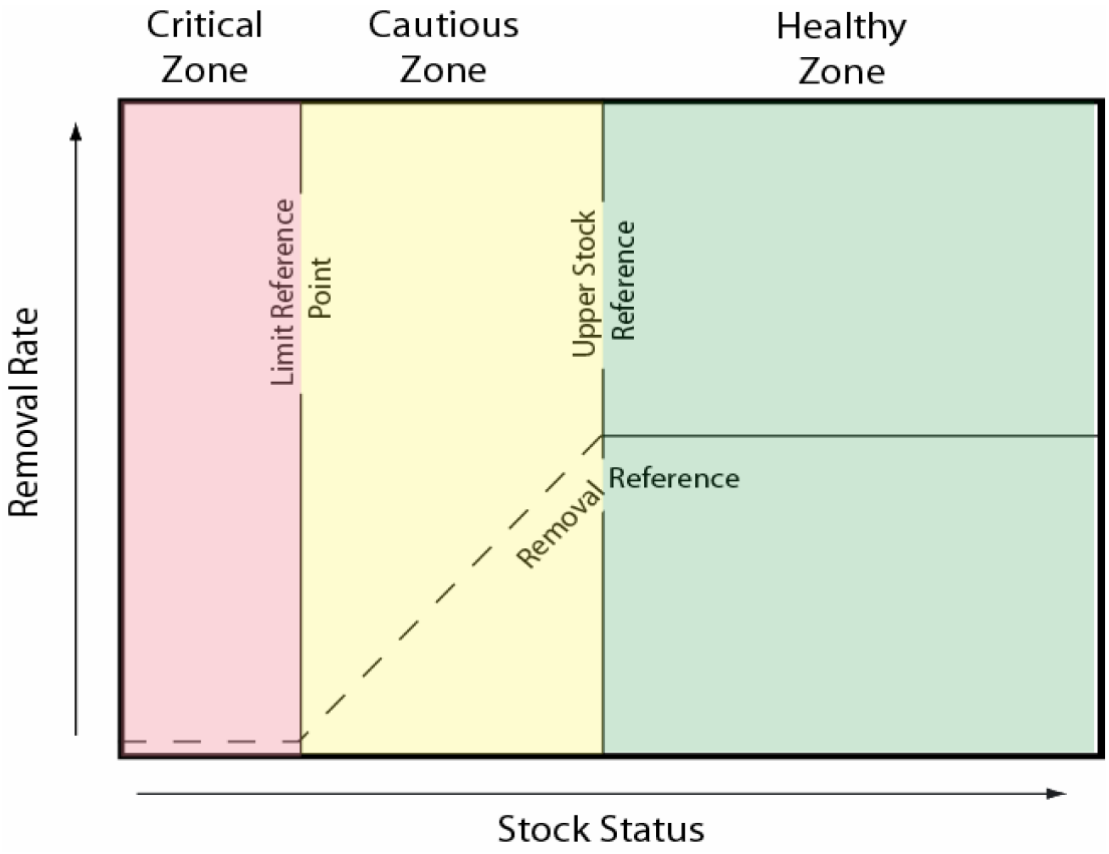


Figure 8: Adjustments to Removal Rate (harvest rate) when Stock Status is in Critical Zone (zero), Cautious Zone (0 to 35%) or Healthy Zone (35%). Healthy and Cautious zone is delineated by Upper stock reference point. Cautious and Critical zone delineated by Limit Reference Point.

Factor 1.2 - Fishing Mortality

Northeast Pacific | Bottom trawls | Canada | British Columbia

Low Concern

The 2015/2016 season saw the highest landings since the mid-1990s (DFO 2017), but landings returned to near the long-term mean in 2017 and 2018 following the closure of several SMAs (DFO 2020c). Overall, total landings have been well below catch ceilings since 2000/2001 season, with the exception of the 2016/2017 season (Figure 10,13). For the 2016/2017 season, an overage occurred due to an in-season management decision to reduce annual TACs mid-season. This regulatory change was associated with eulachon bycatch levels and mid-year fishery independent survey results (pers. comm., Clark, DFO 2017). In response to the 2016/2017 season overage, fishery managers did not reopen SMAs where overages occurred until after biomass estimates associated with the May 2017 fishery-independent survey were available. A comprehensive stock assessment program informs the conservative management approach taken in the BC shrimp trawl fishery; it is probable that fishing mortality from all sources is at or below a sustainable level. Therefore, the BC shrimp trawl fishery receives a "low" concern for fishing mortality.

Justification:

The annual stock assessment and estimated B_{MSY} (or B_{PROXY}) inform the Provisional Harvest Control Rules (HCRs) in accordance with Canada's precautionary management approach. HCRs are currently set at a maximum 35% of the estimated total biomass in each SMA (DFO 2017){DFO 2002c}, representing a conservative approach to stock management. It is important to note that landings are self-reported and are not validated by an independent third party (pers. comm., Clark, DFO 2017). The Total Allowable Catch (TAC) is defined and set annually based on the stock assessment, which forms the biological basis for the catch ceilings. If TACs are reached for any species, the SMA will be closed in-season, making it unlikely that fishing mortality will be above a sustainable level.

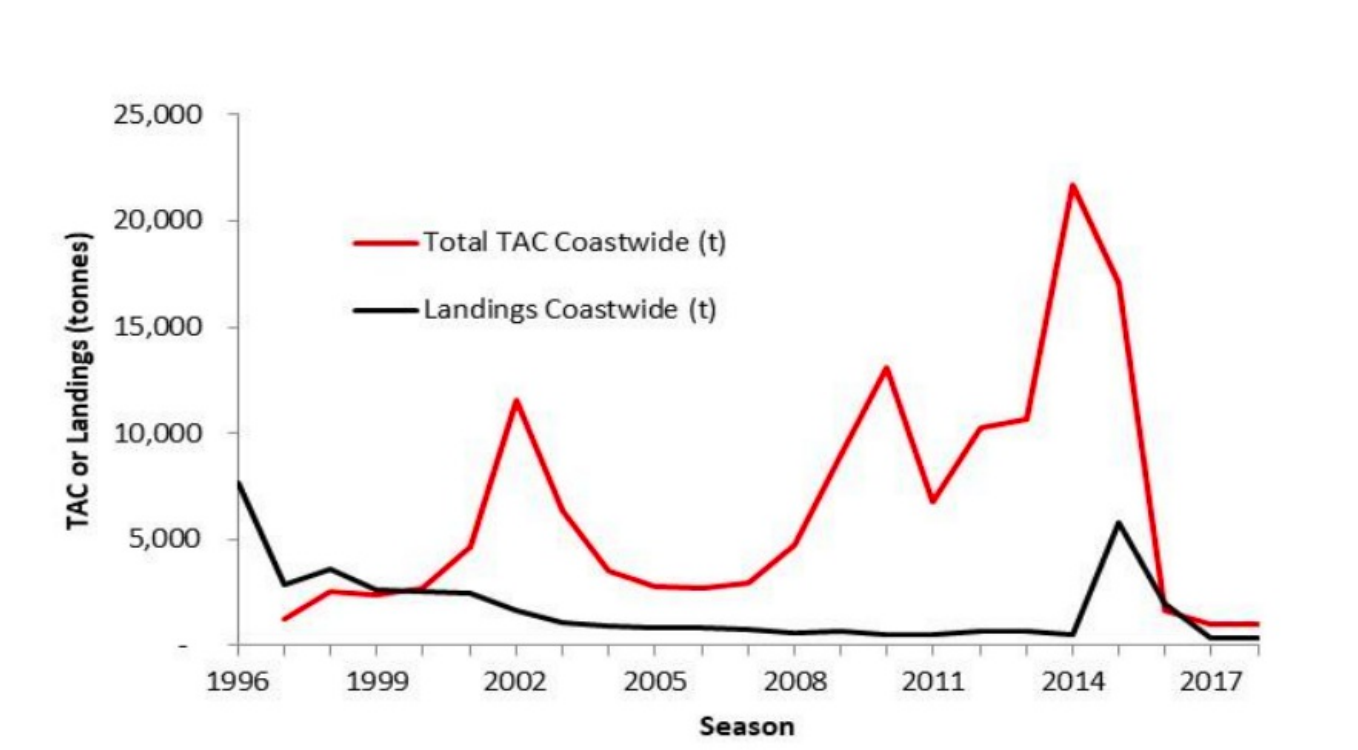


Figure 9: BC Shrimp trawl landings (black line) and Total Allowable Catch (red line), 1996-2018 {DFO 2020}

Sidestriped shrimp

Factor 1.1 - Abundance

Northeast Pacific | Bottom trawls | Canada | British Columbia

Moderate Concern

The trawl fishery occurs in 34 of 36 SMAs in BC, and area-swept trawl surveys are conducted on a fixed schedule/annual basis to index sidestripe shrimp biomass and to monitor trends in abundance over time in a number SMAs (DFO 2017). While sidestripe shrimp abundance is evaluated at the SMA level, sidestripe shrimp are considered one stock in BC. Estimated sidestripe shrimp stocks in 2018-2021 had mixed statuses: of the surveyed areas (approximately 10 to 12 areas annually), five were “Critical”, one was “Cautious”, two were “Healthy” and three were undefined (Table 3). Many surveys were cancelled in 2020 due to the COVID-19 pandemic (pers. comm. Clark, DFO 2021). SMAs that fall into the Critical zone are closed until the stock assessment is completed and more information is available. Similar to pink shrimp, natural variability in sidestripe shrimp populations is the norm in long term data sets (Martell et al. 2000) (DFO 2012) (DFO 2017). A number of BC sidestripe shrimp SMAs still fell into "Cautious" or "Critical" zones in recent years, and the BC sidestripe shrimp fishery receives a “moderate" concern for abundance.

Justification:

SMA	Species	B_{prox} (tonnes)	LRP (40%)	USR (80%)
PRD	Sidestripe	587.4	235.0	469.9
	Pinks[1]	977.6	391.0	782.1
9IN	Sidestripe	66.5	26.6	53.2
	Smooth pink	115.0	46.0	92.0
QCSND	Sidestripe	191.5	76.6	153.2
	Smooth pink	3006.7	1202.7	2405.4
12IN	Sidestripe	68.9	27.6	55.1
	Spiny pink	191.4	76.6	153.1
14	Sidestripe	69.8	27.9	55.9
	Smooth pink	313.3	125.3	250.6
GSTE	Sidestripe	78.6	31.4	62.9
	Smooth pink	367.9	147.2	294.3
16	Sidestripe	27.3	10.9	21.8
	Pinks[1]	114.8	45.9	91.9
FR	Sidestripe	171.0	68.4	136.8
	Pinks[1]	222.6	89.0	178.1
18	Sidestripe	23.7	9.5	19.0
	Spiny pink	94.7	37.9	75.7
19	Sidestripe	10.5	4.2	8.4
	Spiny pink	75.6	30.2	60.5
23IN	Sidestripe	35.1	14.0	28.1
	Smooth pink	330.2	132.1	264.1
121OFF+123OFF	Smooth pink	1796.8	718.7	1437.4
124OFF+125OFF	Smooth pink	2928.7	1171.5	2342.9

[1] Mixed pink shrimp species (*P. borealis* + *P. jordani*)

Figure 10: Table 2. Summary of Bprox (tonnes), limit reference point (LRP) and upper stock reference (USR) points for sidestripe shrimp (Pandalopsis dispar), spiny pink shrimp (Pandalus borealis) and smooth pink shrimp (P. jordani) by shrimp management area (SMA) (DFO 2009).

SMA	Survey	Biomass (species)	Status	Source
GSTE	2020/21	11.41 t (*P. dispar*)	Critical Zone	(DFO 2021a)
PRD	2020	467.2 t (*P. borealis*); 823.8 t (*P. jordani*); 1,261.3 t (*P. dispar*)	Healthy Zone	(DFO 2020b)
23OFF+21OFF+23IN	2019	7,452.5 t (*P. jordani*); 15.8 t (*P. dispar*)	Stock status zones undefined	(DFO 2019a)
16	2019	12.2 t (*P. borealis*); 4.2 t (*P. jordani*); 9.2 (*P. dispar*)	Critical Zone	(DFO 2019b)
12IN	2019	1,034 t (*P. borealis*); 288.4 (*P. dispar)*	Healthy Zone	(DFO 2019c)
14	2019	269.8 t (*P. jordani*); 2.8 t (*P. dispar*)	Healthy Zone; Critical Zone	(DFO 2019d)
FR	2019	123.1 t (*P. dispar*); 78.1 t (*P. borealis*); 3.2 t (*P. jordani*)	Cautious; Critical; Critical	(DFO 2019e)
18	2018	1.4 t (*P. borealis*); 3.8 t (*P. dispar*)	Critical Zone	(DFO 2018a)
19	2018	44.0 t (*P. borealis*); 30.6 t (*P. jordani*); 6.7 t (*P. dispar*)	Critical Zone	(DFO 2018a)

Table 3. Status of sidestripe shrimp (*Pandalopsis dispar*), spiny pink shrimp (*Pandalus borealis*), and smooth pink shrimp (*Pandalus jordani*) in various SMAs in BC from 2018 to 2021.

Factor 1.2 - Fishing Mortality

Northeast Pacific | Bottom trawls | Canada | British Columbia

Low Concern

With the exception of the 2016/2017 season, total sidestripe landings have generally been below catch ceilings since the early 2000s in most SMAs. A few exceptions to this occurred in SMAs 18/19 in 2007 and 2008. Fishing has been prohibited in SMA 18/19 since 2010) where the TAC was reached {DFO 2011}. It's important to note that landings are self-reported and not validated by an independent third-party (pers. comm., Clark, DFO 2017). Precautionary management measures are in place to ensure that sidestripe fishing mortality from all sources is likely at or below a sustainable level, and the sidestripe shrimp trawl fishery receives a "low" concern score for fishing mortality.

Spot shrimp

Factor 1.1 - Abundance

Northeast Pacific | Traps (unspecified) | Canada | British Columbia

Moderate Concern

Pandalid shrimp abundance shows natural variability; however, recent declines from 2011 to 2018 in spot prawn landings may suggest that the spot prawn stock is not as robust as historical levels. The spot prawn fishery is managed to ensure spot prawn escapement meets target reference points, and the spot prawn fishery receives a "moderate" concern for stock abundance.

Justification:

The commercial spot prawn fishery has been assessed since 1979 using an escapement-based model, referred to as the Spawner Index Model {Boutillier and Bond 2000} (DFO 2017a). Growth and mortality parameters for the model are determined each year based on fishery dependent and fishery independent data. The escapement-based model (one of the few used on a non-salmonid) is a standardized CPUE model that ensures a minimum number of female spawners are available at the time of egg hatch.

The number of spawners is measured using a spawner escapement index (SI) is represented by the catch rate of prawns that would contribute to the spawning population (DFO 2008). The Limit Reference Point (LRP) for prawns is defined in SI units and was established based on work by Boutillier and Bond (2001). They estimated B_{MSY} for prawns in a study site in Howe Sound to be SI=3.9. Using the default formulas in DFO (2008) this would set the LRP to be 1.56 (40% B_{MSY}). Applying the default formulas the upper stock reference (USR) point is assigned a value of 3.12 (80% B_{MSY}) (Figure 15).

The escapement model is not used to estimate an overall biomass for spot prawns; however, fishery landings serve as proxy of overall stock abundance from a management standpoint {DFO 2017a). While landings generally increased through 2010, annual landings have been variable to moderately declining from 2011 to 2018 (Figure 16). In 2018, preliminary commercial landings estimates (not all logbooks were available at the time of publication) were up from the two previous years (DFO 2020a).

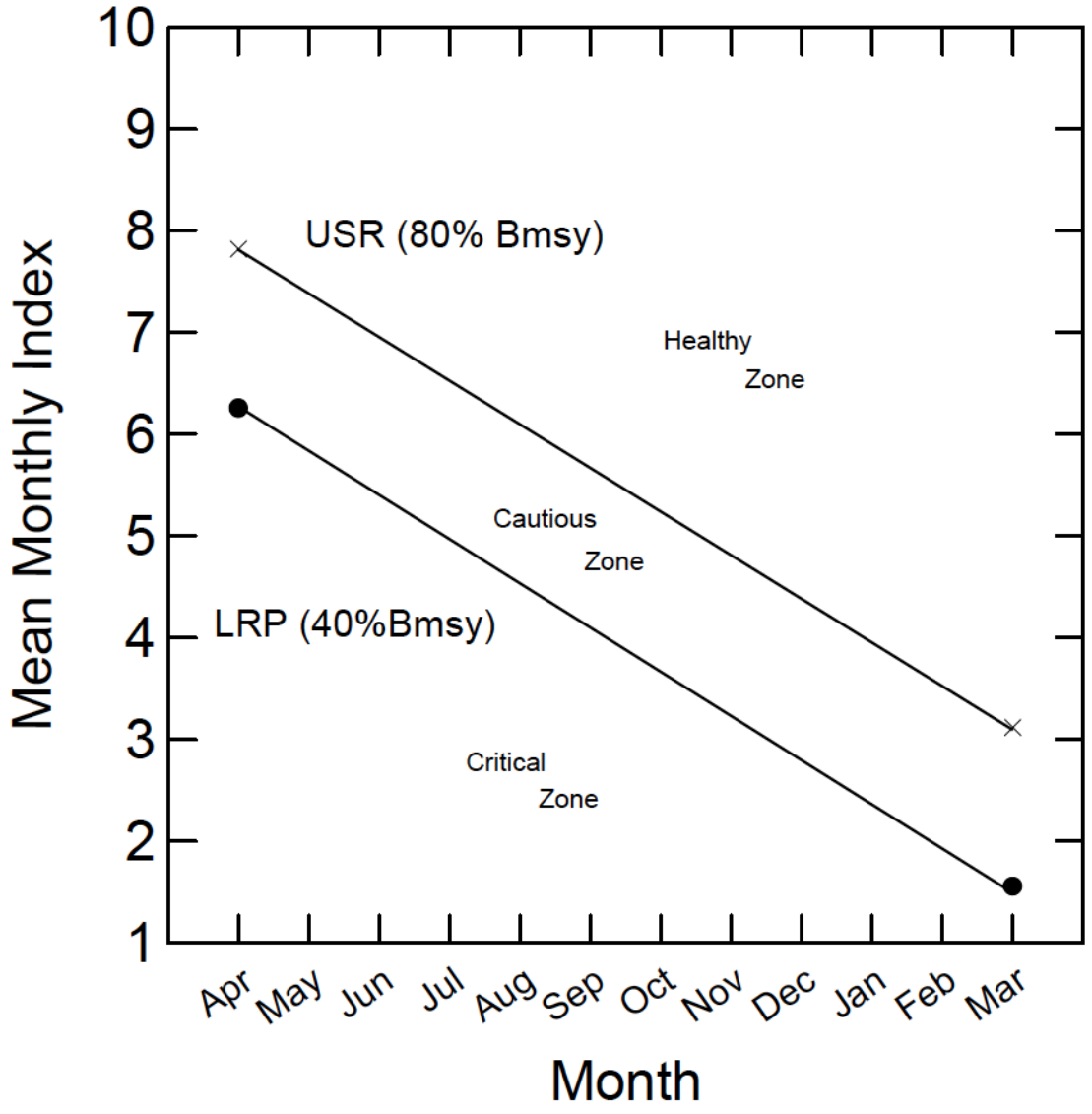


Figure 11: Pacific Fishery Management sub-area Stage 1 reference points for Pacific prawn (DFO 2008).

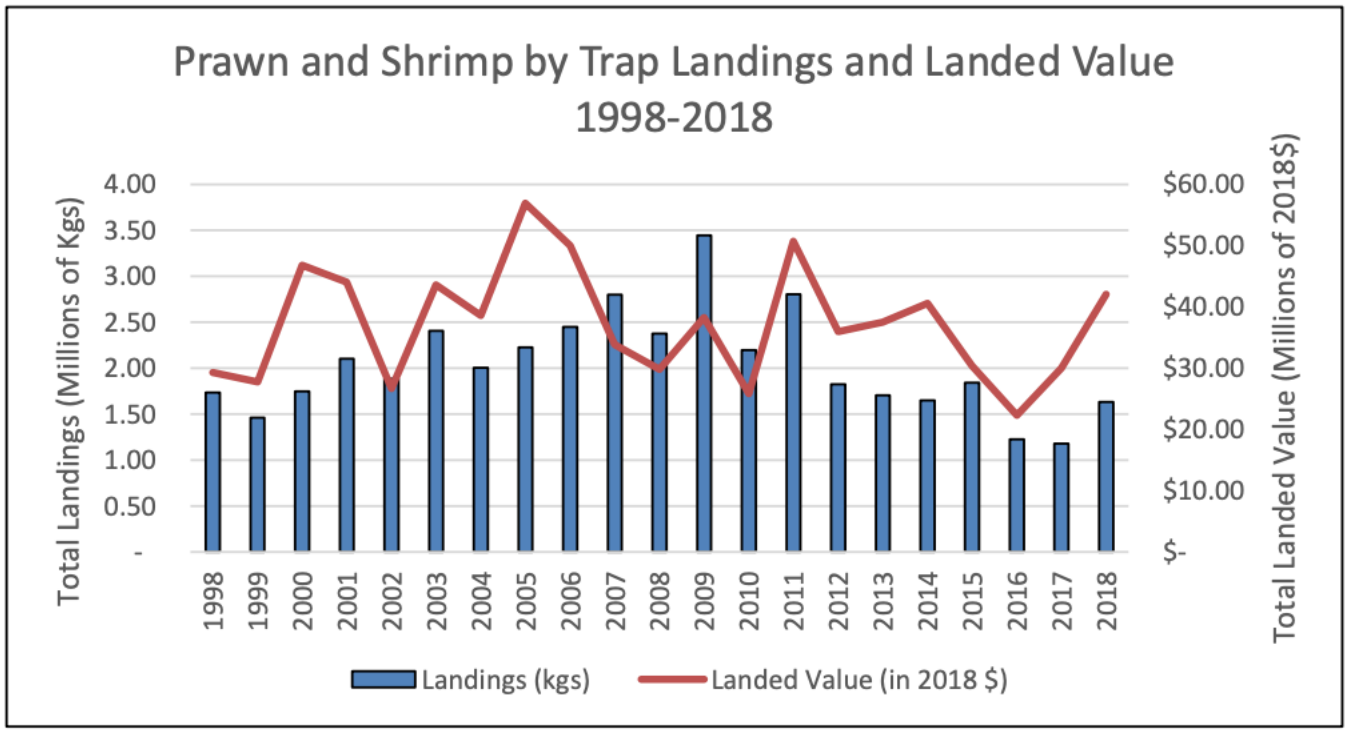


Figure 12: Landings from logbooks; value 1998-2018 from BC Ministry of Agriculture, value from 2012 to present based on price from fish slips and does not include post-season price adjustments. 2018 estimated value (DFO 2020a).

Factor 1.2 - Fishing Mortality

Northeast Pacific | Traps (unspecified) | Canada | British Columbia

Low Concern

It is not possible to estimate a standard fishing mortality. The management reference point (for triggering a closure) is generally 10% higher than the Minimum Monthly Indices (MMI) to ensure that the coastwide LRP is not exceeded (pers. comm., Convey, DFO 2017) {Boutellier & Bond 2000}. Triggered closures also ensure there are no reference point overages by the Pacific Fishery Management subarea (Figure 17). The closure protects the remaining egg bearing females from commercial fishing mortality through to the end of the larval hatching period (DFO 2017a). This precautionary, in-season approach to managing the fishery renders it highly likely that fishing mortality is at a sustainable level based on the ecological role of spot prawns in BC.; therefore, the spot prawn fishery receives a "low" concern for fishing mortality.

Justification:

As stated above, target reference points as escapement goals are generated each year based on commercial fishery and independent survey data. These reference points, established under the Provisional Harvest Control Rules (HCRs), are expressed as monthly base spawner index values. Seasonal closures are implemented as fishing effort approaches the index value. Once implemented, the subarea remains closed to commercial fishing to the end of the spawning cycle and the opening date of the commercial season the following year. It's important to note that spot prawns are also harvested in aboriginal and recreational fisheries that occur throughout the year. Although these landings do not count towards commercial landings, there are daily catch limits, trap limits, and seasonal closures (DFO 2017a) (pers. comm., Convey, DFO 2017).

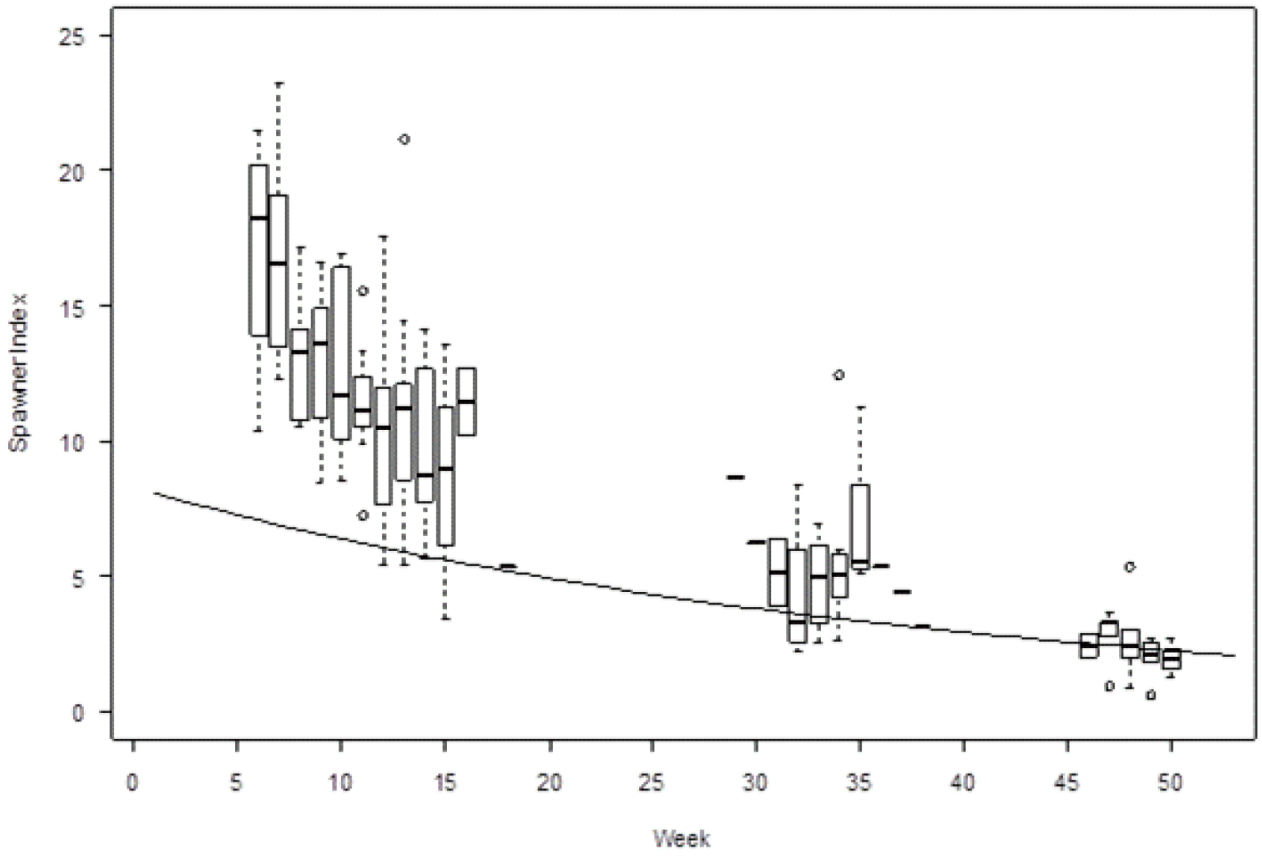


Figure 13: Weekly escapement-based management strategy (status quo) for the commercial prawn fishery in Howe Sound, B.C. (black line). Weeks are initialized such that April 1st is week one, such that the last week of March where spawning event occurs is week zero. Distribution of weekly SI data collected from the commercial fishery (May-July, weeks 6-16) and from the DFO surveys (October-November and February-March) in 2000-2010 includes median SI and interquartile (IQR) range (horizontal box-lines), full data range within 1.5*IQR (whiskers) and outliers (open circles)(Smith 2008).

Criterion 2: Impacts on Other Species

All main retained and bycatch species in the fishery are evaluated under Criterion 2. Seafood Watch defines bycatch as all fisheries-related mortality or injury to species other than the retained catch. Examples include discards, endangered or threatened species catch, and ghost fishing. Species are evaluated using the same guidelines as in Criterion 1. When information on other species caught in the fishery is unavailable, the fishery's potential impacts on other species is scored according to the Unknown Bycatch Matrices, which are based on a synthesis of peer-reviewed literature and expert opinion on the bycatch impacts of each gear type. The fishery is also scored for the amount of non-retained catch (discards) and bait use relative to the retained catch. To determine the final Criterion 2 score, the score for the lowest scoring retained/bycatch species is multiplied by the discard/bait score. The Criterion 2 rating is determined as follows:

- ***Score >3.2=Green or Low Concern***
- ***Score >2.2 and ≤3.2=Yellow or Moderate Concern***
- ***Score ≤2.2 = Red or High Concern***

Rating is Critical if Factor 2.3 (Fishing Mortality) is Crtitical

Guiding principles

- *Ensure all affected stocks are healthy and abundant.*
- *Fish all affected stocks at sustainable level.*
- *Minimize bycatch.*

Criterion 2 Summary

Criterion 2 score(s) overview

This table(s) provides an overview of the Criterion 2 subscore, discards+bait modifier, and final Criterion 2 score for each fishery. A separate table is provided for each species/stock that we want an overall rating for.

NORTHERN SHRIMP			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Northeast Pacific | Bottom trawls | Canada | British Columbia	1.526	1.000: < 100%	Red (1.526)

OCEAN SHRIMP			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Northeast Pacific | Bottom trawls | Canada | British Columbia	1.526	1.000: < 100%	Red (1.526)

SIDESTRIPED SHRIMP			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Northeast Pacific | Bottom trawls | Canada | British Columbia	1.526	1.000: < 100%	Red (1.526)

SPOT SHRIMP			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Northeast Pacific | Traps (unspecified) | Canada | British Columbia	1.732	1.000: < 100%	Red (1.732)

Criterion 2 main assessed species/stocks table(s)

This table(s) provides a list of all species/stocks included in this assessment for each 'fishery' (as defined by a region/method combination). The text following this table(s) provides an explanation of the reasons the listed species were selected for inclusion in the assessment.

NORTHEAST PACIFIC | BOTTOM TRAWLS | CANADA | BRITISH COLUMBIA			
SUB SCORE: 1.526	DISCARD RATE: 1.000	**SCORE: 1.526**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Benthic inverts	2.330: Moderate Concern	1.000: High Concern	Red (1.526)
Finfish	2.330: Moderate Concern	1.000: High Concern	Red (1.526)
Forage fish	2.330: Moderate Concern	1.000: High Concern	Red (1.526)
Corals and other biogenic habitats	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Eulachon	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Northern shrimp	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)
Ocean shrimp	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)
Sidestriped shrimp	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)

NORTHEAST PACIFIC | TRAPS (UNSPECIFIED) | CANADA | BRITISH COLUMBIA			
SUB SCORE: 1.732	DISCARD RATE: 1.000	**SCORE: 1.732**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Humpback whale	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Quillback rockfish	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Squat lobster	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Spot shrimp	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)

The bycatch and discarded species caught in the shrimp trawl fishery are generally unknown, with the exception of eulachon smelt. Although observer data are limited in the BC shrimp trawl fishery, observer effort has focused on bycatch of eulachon, and estimates suggest that eulachon constitutes approximately 0.6% of the overall trawl catch (Rutherford et al. 2013). Though eulachon bycatch represents a relatively small amount of the overall catch, eulachon are listed as COSEWIC "endangered" or "special concern" by region, are regularly caught in the shrimp trawl fishery, and reduction of eulachon bycatch is a main priority for the DFO (DFO 2017). Therefore, eulachon were included as a main species for the BC shrimp trawl fishery. Additional species retained in the trawl fishery include prawns, squid, and octopus; however, there is not enough evidence to assess each species individually as a main species, so they were grouped together and assessed as "invertebrates" using the unknown bycatch matrix (DFO 2017) (Rutherford et al. 2013). DFO and licence holders had planned to increase at-sea observer coverage to 100% for 2017/18, but this did not come to fruition (DFO 2020c).

For the other taxa included as main species for the BC shrimp trawl fishery, bycatch is scored according to the Seafood Watch Unknown Bycatch Matrices, based on a synthesis of peer reviewed literature and expert opinion on the bycatch impacts of each gear type. The Unknown Bycatch Matrices rank the bycatch susceptibility of different taxonomic groups in various gear types. More information is available in Appendix 2 of the Seafood Watch Standard for Fisheries.

The taxa that are most likely to interact with the BC shrimp trawl fisheries include: forage fish (including eulachon), finfish, corals and other biogenic habitats and benthic invertebrates (including prawns, squid, and octopus). For the shrimp trawl fishery, forage fish, finfish and invertebrates limit the score for Criterion 2 due to their unknown stock status and high potential to interact with trawl gear.

Main species were determined for the spot prawn trap fishery based on a fishery independent study conducted in BC from 1999 to 2008, where 17,210 traps (856 trap strings) were monitored for bycatch. Overall bycatch rates were low; however, the ratio of squat lobsters to spot prawn landings was approximately 0.08/1 (Favaro et al. 2010), so squat lobsters were included as a main species for the spot prawn trap fishery. No other species comprised >=5% of the total catch or landings. Quillback rockfish were included as a main species for the trap fishery because, although overall catch of quillback rockfish relative to prawns was quite low (<0.5%) (Rutherford et al. 2010), juvenile quillback rockfish are the most frequently encountered rockfish species in the trap fishery, and they are listed as COSEWIC "threatened." Although entanglement data are limited, humpback whales were also included as a main species due to high trap entanglement rates in 2015 and 2016 in BC and along the US west coast and due to their COSEWIC "special concern" status (DFO 2013). For the prawn trap fishery, humpback whales limit the score for Criterion 2 due to their high vulnerability, threatened stock status, and potential to interact with trap gear.

Criterion 2 Assessment

SCORING GUIDELINES

Factor 2.1 - Abundance
(same as Factor 1.1 above)

Factor 2.2 - Fishing Mortality
(same as Factor 1.2 above)

Factor 2.3 - Modifying Factor: Discards and Bait Use
Goal: Fishery optimizes the utilization of marine and freshwater resources by minimizing post-harvest loss. For fisheries that use bait, bait is used efficiently.

Scoring Guidelines: The discard rate is the sum of all dead discards (i.e. non-retained catch) plus bait use divided by the total retained catch.

Ratio of bait + discards/landings	Factor 2.3 score
<100%	1
>=100	0.75

Benthic inverts

Factor 2.1 - Abundance

Northeast Pacific | Bottom trawls | Canada | British Columbia

Moderate Concern
According to (Rutherford et al. 2013), there is evidence of catch of several invertebrate taxa including sea cucumbers, urchins, anenomes, prawns, squid and octopus. However, due to the very low observer coverage (0.5%-3.4%), there is too much uncertainty in the amounts of each taxon to assess them individually. Because there is no evidence that the benthic invertebrates caught in this fishery are endangered, threatened or depleted, abundance of unknown benthic invertebrates is scored as "moderate" concern as described in the 2017 Seafood Watch Unknown Bycatch Matrix.

Factor 2.2 - Fishing Mortality

Northeast Pacific | Bottom trawls | Canada | British Columbia

High Concern
There is evidence that many invertebrate taxa are caught in this fishery (Rutherford et al. 2013), but because of very low observer coverage (0.5%-3.4%), species-level impacts are not available. The population impacts are unknown, so the score was calculated using the Unknown Bycatch Matrix. Benthic invertebrates are highly susceptible to interactions with bottom trawl gear and are thus awarded a score of "high" concern.

Corals and other biogenic habitats

Factor 2.1 - Abundance

Northeast Pacific | Bottom trawls | Canada | British Columbia

High Concern
We included this taxonomic group based on results of the Seafood Watch Unknown Bycatch Matrix. This taxonomic group was scored as "high" concern because most of the species in this group are highly vulnerable to interactions with fishing gear.

Factor 2.2 - Fishing Mortality

Northeast Pacific | Bottom trawls | Canada | British Columbia

Moderate Concern
Observer data show that corals and glass sponges are caught in the fishery, however, due to the very low observer coverage (0.5%-3.4%), the amount of corals and sponges taken by the fishery relative to the total population is unknown. (Agbayani et al 2015) suggest that there is more fishing effort over hard substrate than previously thought. However, areas that are known to contain sponge reefs are closed to bottom contact fishing, DFO is actively expanding its efforts to protect these reefs (DFO 2020c)(DFO 2018b) and fishers tend to avoid fishing over hard substrate because of the high potential for gear damage. Because sponge reef mortality is unknown and the fishery is managed in a way that reduces impact, a score of "moderate" concern is awarded.
Justification:
Seafood Watch considers fisheries not to be a substantial contributor to fishing mortality when the fishery operates or is managed in a way that reduces its impact. In recent years, nine sponge reef complexes have been discovered in the Strait of Georgia and Howe Sound. Upon discovery of these sites, DFO requested fishers to voluntarily avoid these areas while the agency consulted with stakeholders on formal protection measures; following the consultation period, DFO closed all nine areas to all bottom-contact fishing (DFO 2018b). In subsequent years, more reefs were discovered and DFO initiated the same process. Effective April 1, 2019, all bottom-contact gear is prohibited within portions of Subareas 28-22 and 28-4 to protect Howe Sound reefs as marine refuges--this brings the current total to 17 closures specifically implemented to protect sponge reefs (DFO 2020c) and DFO continues to survey and identify possible reef sites (Miller et al. 2020). Additionally, the Hecate Strait and Queen Charlotte Sound Glass Sponge Reefs Marine Protected Area (MPA) was created in 2017 and is closed to all bottom-contact, the MPA covers approximately 2,410 km^2 (DFO 2020c).

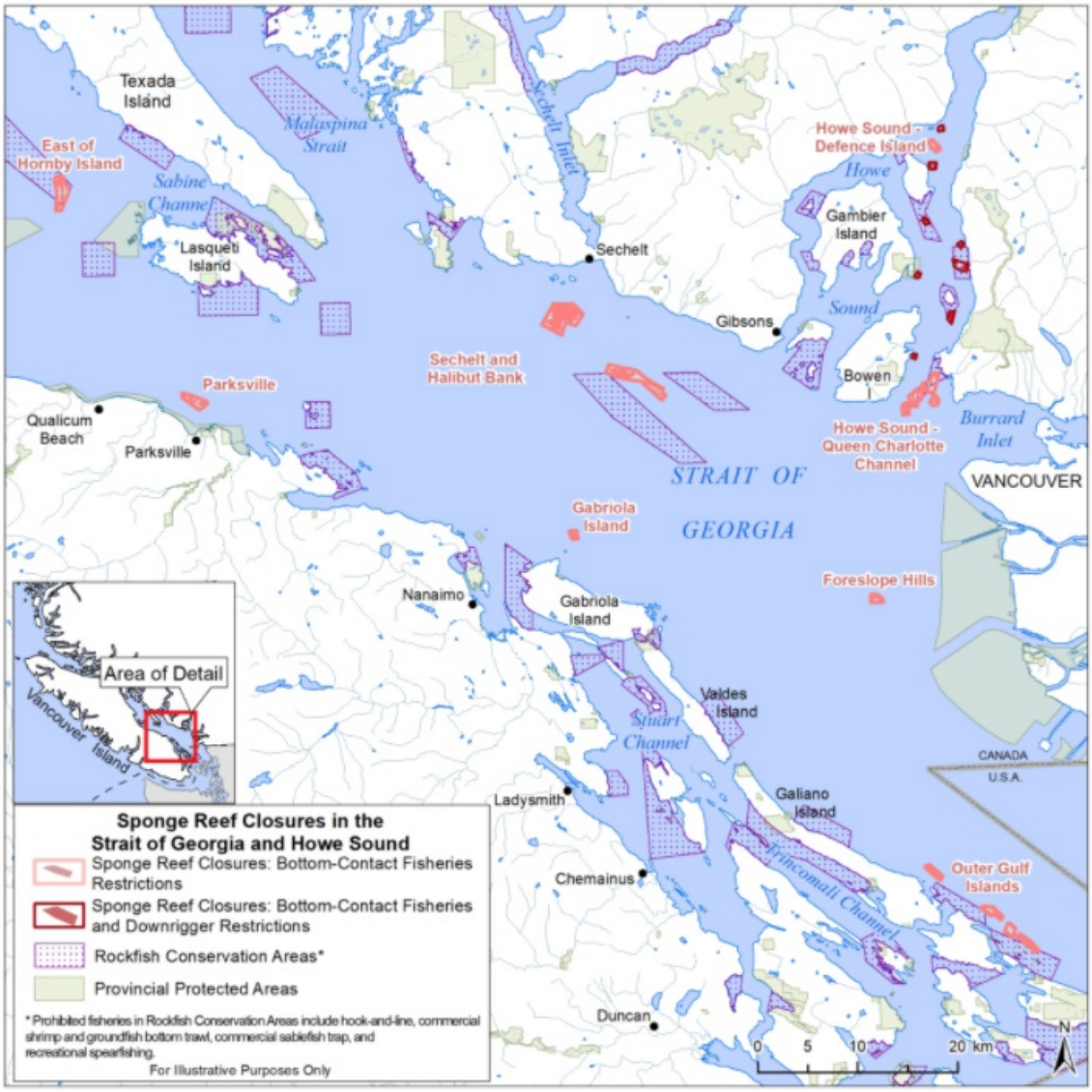


Figure 14: Strait of Georgia Glass Sponge Reef Marine Refuges.

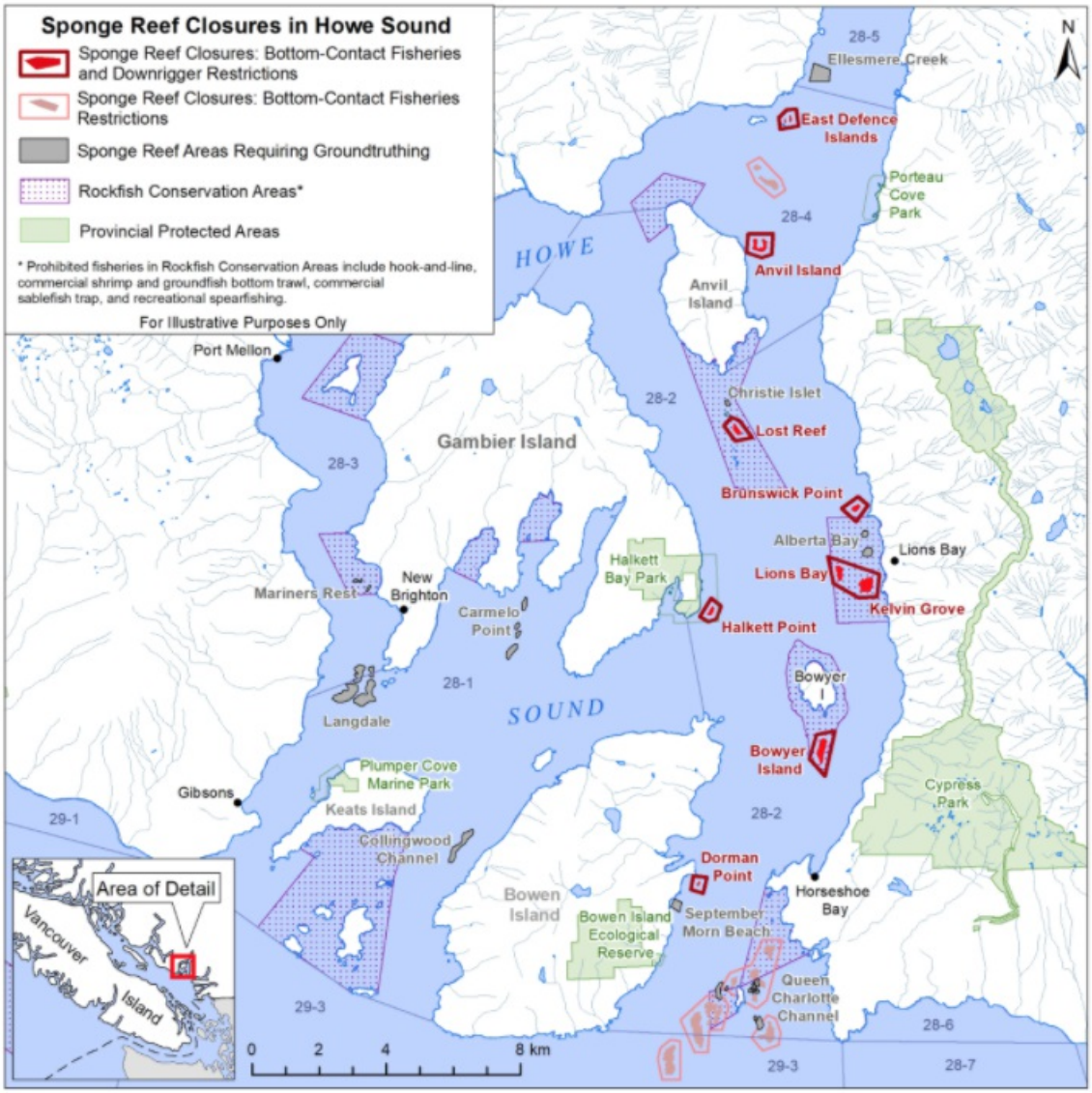


Figure 15: Howe Sound Glass Sponge Reef Marine Refuges.

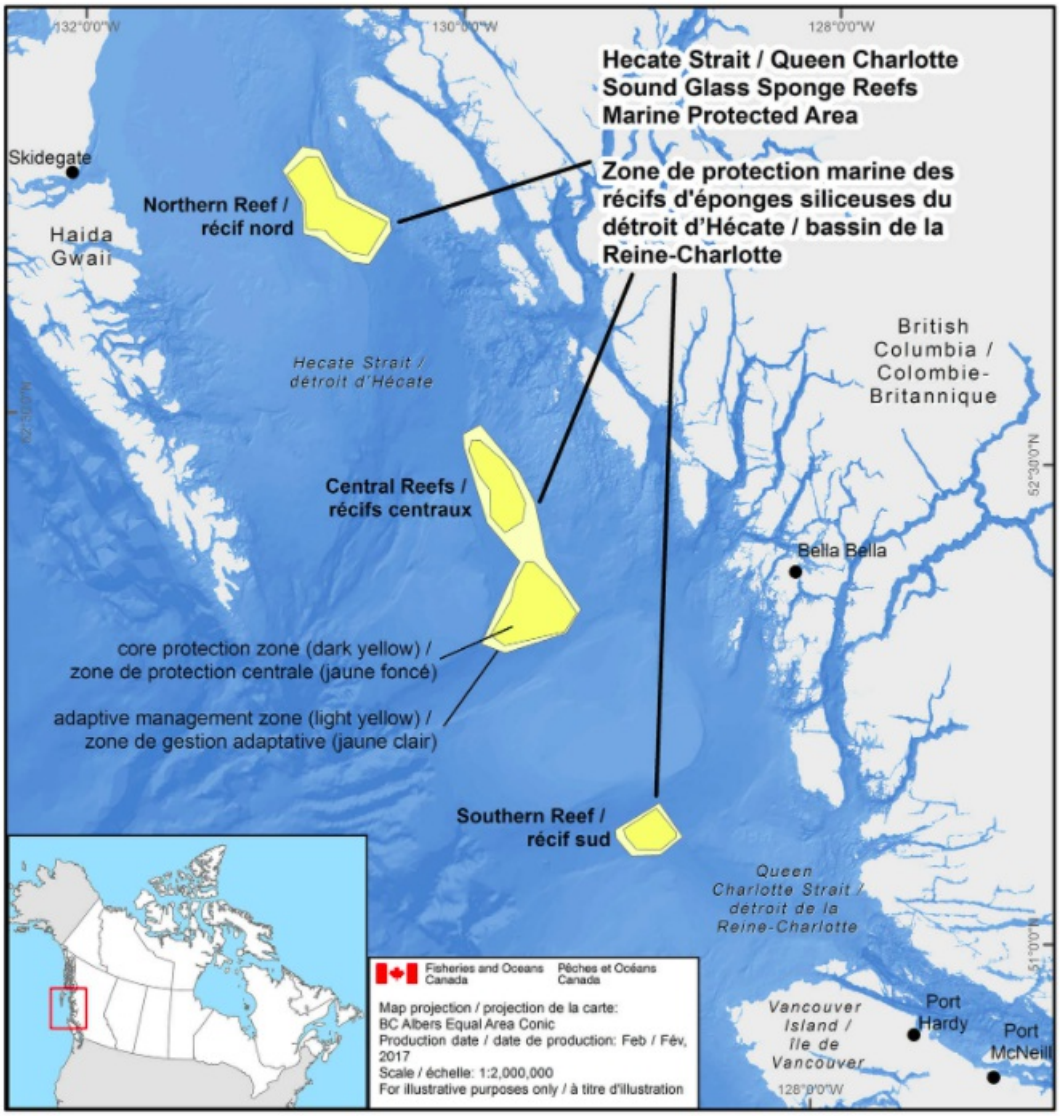


Figure 16: Hecate Strait and Queen Charlotte Sound Glass Sponge Reefs Marine Protected Area (MPA).

Eulachon

Factor 2.1 - Abundance

Northeast Pacific | Bottom trawls | Canada | British Columbia

High Concern
Eulachon have been reported to spawn in at least 40 rivers in British Columbia. The major river systems where eulachon return to spawn are the Fraser, Skeena, Nass, and Klinaklini. Due to dramatic declines in stock abundance since the mid-1990s, COSEWIC listed three designated units (DUs) in 2011: the Nass and Skeena river DU as "special concern" and the Central Pacific Coast and Fraser River DUs as "endangered" (Figure 18) {COSEWIC 2017}. Additionally, shrimp trawling in the West Vancouver Island Region may incidentally catch eulachon from the Columbia River subpopulation (Schweigert et al. 2012). Eulachon, therefore, receive a "high" concern score for stock status.
Justification:

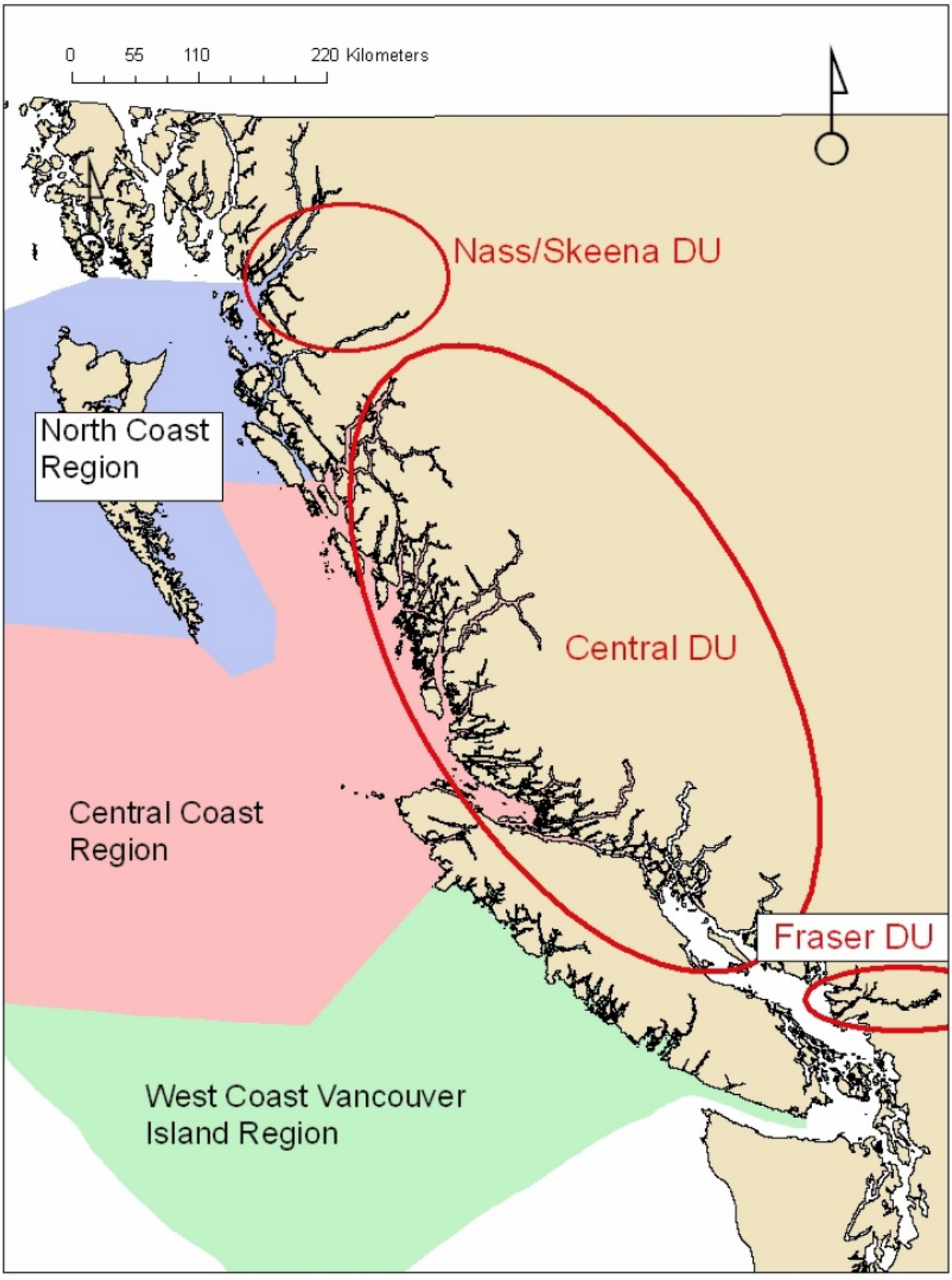


Figure 17: Delineation of the offshore area into regions relative to the eulachon DUs (Schweigert et al. 2012)

A recent genetic analysis identifies three large-scale groupings of euchalon: the Gulf of Alaska, southeast Alaska and northern BC, and southern Bc through the contiguous U.S. and those groups are further subdivided (Sutherland et al.

2020). The genetic structure observed in Sutherland et al. (2020) corresponds well with the three DUs within Canada. DFO analyses suggest that the decline in eulachon abundance can be best explained by the sequential historical impacts of directed in-river catch (prior to 1970), bycatch in the shrimp trawl fishery (1990 to 2000), and several consecutive years of anomalously low productivity (2002 to 2007 brood years) {Swchweigert et al. 2012}. Data confirm that spawning biomass declined dramatically in the Fraser and Central DUs from the late 1990s and early 2000s to 2012 (Figure 18), with a more gradual decline of the Nass/Skeena DU over the last century (Figure 20).

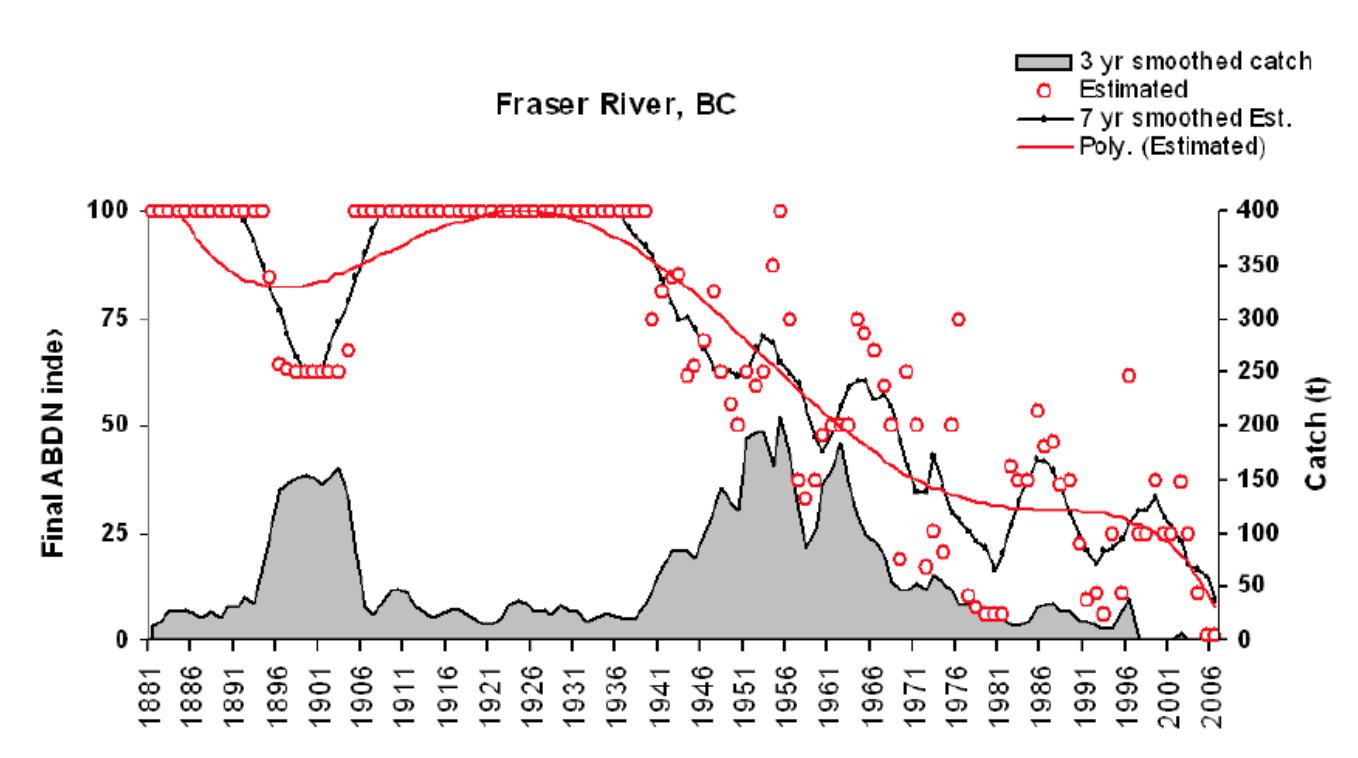


Figure 18: Fraser River, BC estimated eulachon abundance status (circles), 7 year smoothed abundance status estimations (black line), 3 yr. smoothed catch (grey fill) and a polynomial fitted trend line (red line)(Schweigert et al. 2012)

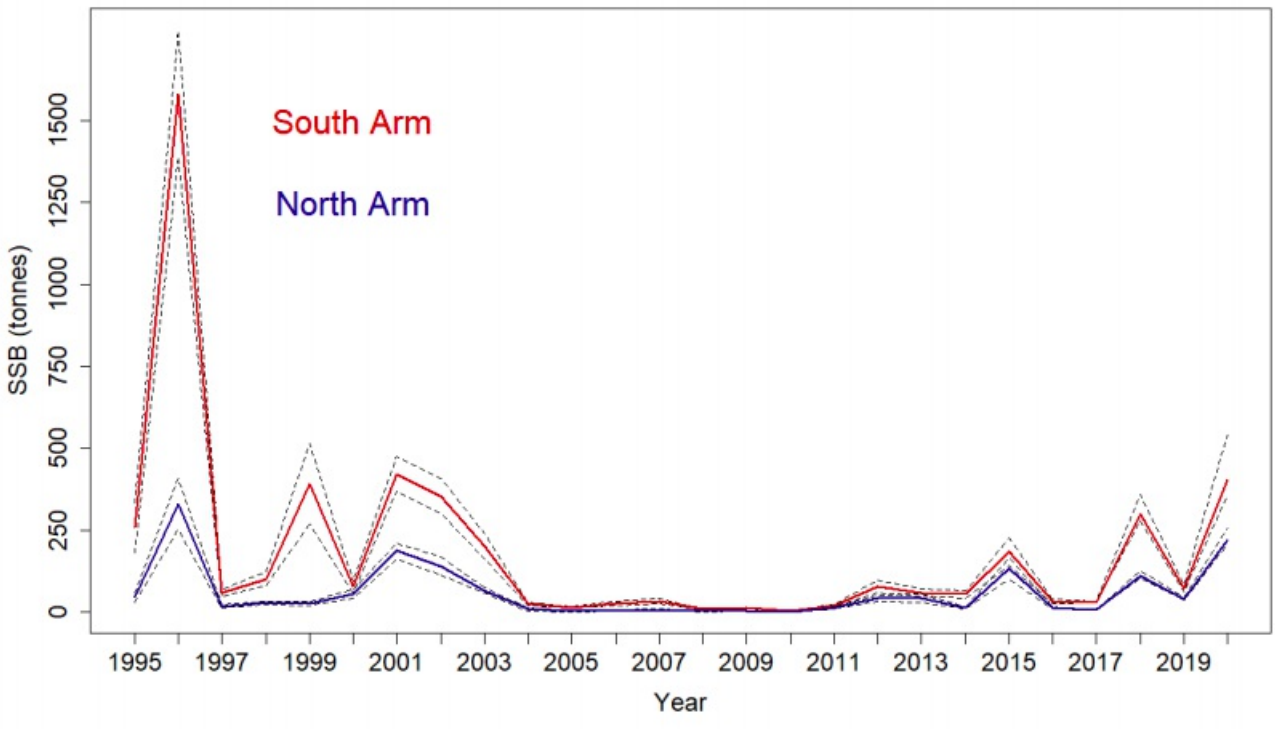


Figure 19: Spawning stock biomass (SSB) in tonnes for the South and North Arms of the Fraser River calculated from Fraser River Eulachon egg and larval survey data (1995-2020). Dashed lines are 95% credible intervals (DFO 2020f).

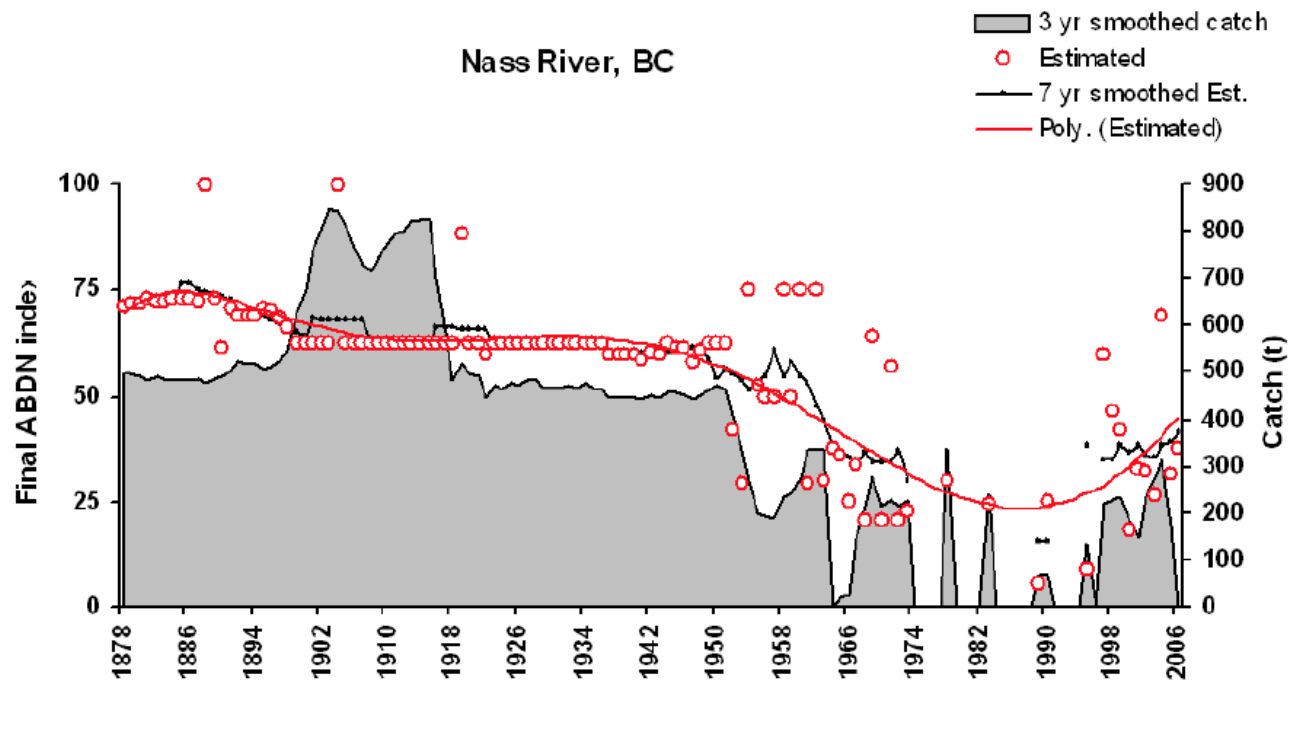


Figure 20: Nass River, BC (a) estimated eulachon abundance status (circles), 7 year smoothed abundance status estimations (black line), 3 yr. smoothed catch (grey fill) and a polynomial fitted trend line (red line) (Schweigert et al. 2012).

Factor 2.2 - Fishing Mortality

Northeast Pacific | Bottom trawls | Canada | British Columbia

Moderate Concern

Eulachon are caught in significant amounts in the groundfish and shrimp trawl fisheries, these fisheries are listed as threats to eulachon recovery in BC. Shrimp trawl fisheries are of particular concern because eulachon tend to associate with shrimp and are caught regularly in the fishery (Schweigert et al. 2012). The shrimp trawl fishery is a substantial contributor to eulachon bycatch, especially in high yield years like 2016 (DFO 2017f). Even if bycatch is not the leading cause of the eulachon decline, the mortality related to bycatch may impede potential recovery of this ecologically integral forage fish species {Gustafson et al. 2016} (Schweigert et al. 2012). Fraser river stock projections suggest a greater than 50% probability that the stock will exceed 20% of B_0 after approximately 6 generations (18 years) at catch removals under 30 t per year (trawl fishery Eulachon Action Levels or EALs are significantly below this catch removal level) {Schweigert et al. 2013}. Mortality rates below 0.1 would be consistent with population recovery for the Fraser River DU; however, because of insufficient monitoring, it is difficult to identify recovery targets for the Central Pacific Coast DU (Schweigert et al. 2012) and the effects of bycatch reduction on all subpopulations cannot yet be quantified (NMFS 2017).

Based on the conservative management approach taken by the DFO and updated projections suggesting eulachon's recovery potential (for the Fraser River DU), the shrimp trawl fishery receives a "moderate" concern for eulachon fishing mortality.

Justification:

Bycatch in shrimp trawls likely consists of eulachon from different stocks (DUs). Genetic analyses from research trawl surveys provide insight into the potential composition of eulachon from different fishing regions. Samples from surveys in the Central Coast region include roughly equal proportions from the three BC DUs and a lesser component (18%) from the Columbia River; samples from WCVI contain mostly eulachon from the Columbia River (56%) and the Fraser DU (39%) with minor contributions from the Central DU and Nass/SKeena DU (Schweigert et al. 2012). According to the ESA recovery plan for the Southern Distinct Population Segment (which includes subpopulations incidentally caught by BC shrimp trawls), although bycatch reduction efforts in the U.S. and Canada have been beneficial to eulachon, it is impossible to quantify this benefit without a "better understanding of bycatch as a proportion of eulachon in the marine environment, and its impact on recruitment" (NMFS 2017).

The commercial eulachon fishery was closed in 1997 due to the inability to control effort and participation and to ensure conservation objectives were met {COSEWIC 2017}. Limited First Nation harvests do occur in a few river systems, primarily in the Nass/Skeena DU (Schweigert et al. 2012). First Nation harvest rates for Fraser River Eulachon are set conservatively at 3.5% of the estimated SSB index; the maximum allowable harvest for 2021 is 7.02 t (DFO 2020f). Eulachon are currently being reviewed for listing under SARA. DFO has not formally developed reference points and harvest control rules for eulachon, but maintaining low levels of fishing mortality should increase the probability of rebuilding Fraser River stocks (DFO 2020f).

Limited observer data available for the shrimp trawl fishery {Rutherford 2013} indicate that eulachon constitutes 1.1% of the otter trawl catch and 0.4% of the beam trawl catch, representing 0.6% of the overall trawl catch. The DFO closely monitors the West Coast Vancouver Island (WCVI) SMAs for eulachon bycatch. DFO first addressed this issue in 1998 when they established EALs as 1% of the eulachon biomass index (to a maximum of 88,185 lb). Eulachon bycatch has decreased over time (Schweigert et al. 2012). Since then, EALs have been reduced to as low as 4 t in the 2017/2018 season; however, they are now set arbitrarily (i.e. no longer based off the offshore eulachon biomass index (pers. comm., Clark, DFO, 2017). The EALs have been reached in 2000, 2016, and 2019 and fishing was closed for the season in the affected areas (DFO 2020f). The Queen Charlotte Sound shrimp management area has been closed to fishing since 2000 because of concerns for eulachon from the Central Pacific Coast DU (DFO 2020f).

In 2000, mandatory bycatch reduction devices were required and a minimum spacing size of 1.75 in was instituted in

2009. Additionally, based on input from industry, the DFO is building on research conducted in the Oregon pink shrimp fishery that suggested the use of LED lights may further reduce eulachon bycatch (DFO 2017). Additional observer coverage is also proposed for future seasons. Although significant measures are being taken to reduce eulachon bycatch, it is possible that bycatch in shrimp trawl fishery could impede recovery of stressed eulachon stocks that are still well below historic levels.

Finfish

Factor 2.1 - Abundance

Northeast Pacific | Bottom trawls | Canada | British Columbia

Moderate Concern
Because there is no evidence that the finfish caught in this fishery are endangered, threatened or depleted, abundance of finfish is scored as "moderate" concern as described in the 2017 Seafood Watch Unknown Bycatch Matrix.

Factor 2.2 - Fishing Mortality

Northeast Pacific | Bottom trawls | Canada | British Columbia

High Concern
Observer coverage in the shrimp trawl fleet overall is extremely low at 0.5 to 3.4% (Rutherford et al. 2013), and BRDs are not 100% effective. In the absence of fleetwide bycatch estimates, Seafood Watch Unknown Bycatch Matrices are used. Finfish and forage fish are highly susceptible to interactions with shrimp trawl fishing gear per the 2017 Seafood Watch Criteria. This score of "high" concern was calculated using the Seafood Watch Unknown Bycatch Matrix.

Forage fish

Factor 2.1 - Abundance

Northeast Pacific | Bottom trawls | Canada | British Columbia

Moderate Concern
Because there is no evidence that forage fish (other than eulachon) caught in this fishery are endangered, threatened or depleted, abundance of forage fish is scored "moderate" concern as described in the 2017 Seafood Watch Unknown Bycatch Matrix.

Factor 2.2 - Fishing Mortality

Northeast Pacific | Bottom trawls | Canada | British Columbia

High Concern
Observer coverage in the shrimp trawl fleet overall is extremely low at 0.5 to 3.4% (Rutherford et al. 2013), and BRDs are not 100% effective. In the absence of fleetwide bycatch estimates, Seafood Watch Unknown Bycatch Matrices are used. Finfish and forage fish are highly susceptible to interactions with shrimp trawl fishing gear per the 2017 Seafood Watch Criteria. This score of "high" concern was calculated using the Seafood Watch Unknown Bycatch Matrix.

Humpback whale

Factor 2.1 - Abundance

Northeast Pacific | Traps (unspecified) | Canada | British Columbia

High Concern
DFO has not recently published information on humpback whales in BC waters. However, whales from three distinct population segments (DPSs) occur in waters that overlap with this fishery, and those DPSs have been listed under the U.S. Endangered Species Act (ESA) and stock assessments are provided by NMFS. Therefore, information from U.S. is used to score this factor.

The humpback whale has been listed as endangered under the U.S. Endangered Species Act (ESA) since 1970; however, in 2016, NMFS revised the humpback whale population designation by splitting it into 14 DPSs, three of which may interact with this fishery (Carretta et al. 2021). Stock identification between the ESA and the Marine Mammal Protection Act (MMPA) is complex. Humpback whales feeding in northern Washington and southern BC. are one of the two feeding groups in the California/Oregon/Washington stock recognized by NMFS (Carretta et al. 2021). Whales from three different DPSs (Central America, Mexico, and Hawaii) are included in the stock assessment, but whale stock delineation under the MMPA is currently under review (ibid). The most recent abundance estimate is 2,374 (CV=0.03) whales from the California and Oregon feeding group and 526 (CV=0.23) whales from the northern Washington and southern British Columbia feeding group (ibid). The minimum population estimate (taken from the lower 20^{th} percentile of the log-normal distribution) for this stock is 2,784 whales (ibid).

The California/Oregon/Washington humpback whale stock is listed as endangered and depleted for MMPA management purposes, the Central DPS is considered endangered under the ESA, and the Mexican DPS is threatened. Therefore, humpback whale is of “high” conservation concern.
Justification:
Due to historic declines in humpback whale numbers in Canada associated with historic commercial whaling, humpback whales were listed as a species of "Special Concern" by COSEWIC and under SARA in 2011 and 2017, respectively. BC humpback whales are protected under the Marine Mammals Regulations of the Fisheries Act (DFO 2013).

BC humpback whales demonstrated increasing trends in abundance over the last few decades, in line with the North Pacific population as a whole, which was estimated to be recovering at a rate of 4.9% to 6.8% annually (DFO 2013). Photo-identification data of humpbacks sighted in the Canadian Pacific from 1992 to 2006 suggests that the population utilizing BC waters, either as a migration corridor or for feeding, is estimated at approximately 2,145 animals (95% CI, 970 to 2,331) (Ford et al. 2009) (DFO 2013). More recent genetics and photo-identification research demonstrates two likely sub-populations, indicating distinct northern and southern BC feeding groups {Calambokidis et al. 2008} (Ford et al. 2009) (DFO 2013). However, there is currently insufficient evidence to delineate specific geographic boundaries of the distinct sub-populations, and SARA/DFO recognizes one North Pacific humpback whale stock (DFO 2013). It is important to note that humpback whales in BC likely represent an intermixing stock that may include members originating from endangered or threatened Distinct Population Segments under the Endangered Species Act of the United States (NMFS SAR 2016).

Factor 2.2 - Fishing Mortality

Northeast Pacific | Traps (unspecified) | Canada | British Columbia

Moderate Concern

Humpback whales from multiple distinct population segments (DPSs) migrate across national boundaries and mortality data varies according to jurisdiction. There is limited information on current humpback whale mortality rates in Pacific Canadian waters. Therefore, we have have broken down mortality information on this stock into two sections. The first includes historical estimates of Potential Biological Removal (PBR) in BC, along with media reports of entanglements in recent years. The second section contains fishing mortality information from U.S. waters only. Overall, updated evaluations on entanglements and BC humpback population trends region-wide are necessary to accurately assess fishing mortality concerns. Therefore, a score of "moderate" concern is given for fishing mortality.

Justification:

Fishing mortality in BC

The BC Marine Mammal Response Network reported 40 entangled humpback whales between 1987 and 2008, including four confirmed mortalities (Ford et al. 2009). These reports involved entanglements in various types of fishing gear including unknown gear (30%), gillnets (27.5%), traps (22.5%), herring pond (7.5%), aquaculture gear (5%), longline gear (2.5%), seine nets (2.5%) and anchor lines (2.5%) (Ford et al. 2009). Trap fishing gear was not responsible for any of the four known mortalities during the time period. Entanglement events with recreational prawn trap gear specifically occurred in 2015 and 2017 in BC waters (both individuals were disentangled successfully), suggesting there is also risk for entanglement in commercial prawn trap gear. Reported entanglements may represent as little as 10% of actual entanglement events (DFO 2013).

Ford et al. (2009) estimated a PBR of 21 humpbacks in BC annually; however, the DFO does not currently assess information against the PBR since not enough is known about the prevalence and severity of certain threats to draw conclusions at the population level (DFO 2013). Over 21 humpback entanglements were reported in 2016 alone (and at least two mortalities not associated with trap gear), in large part due to the increasing number of humpback whales using the BC area throughout the year (Vancouver Sun 2016). There were seven reported and confirmed humpback whale entanglements in trap gear in 2019, but the fisheries to which the gear belonged could not be identified (DFO 2020a). In July 2020, three humpback whales were seen ensnared in fishing gear in BC waters (National Observer 2020) and another was found dead and entangled in trap gear on a BC island in April (CBC News 2020). Based on published entanglement data from 1987 to 2002, the prawn trap fishery likely takes less than 50% of the unofficial BC humpback whale PBR as estimated by Ford et al. (2009).

More recent entanglement data suggest that the unofficial PBR, as estimated by Ford et al. (2009), could be exceeded should the uptick in entanglements continue. It is important to note, however, that the Ford et al. (2009) PBR is outdated. Overall, the spot prawn trap fishery may represent a relatively small component of overall fishing mortality for BC humpback whales (DFO 2013); however, the US west coast and BC humpback whale groupings represent intermixing stocks, which could include DPS' threatened or endangered under the Endangered Species Act.

Fishing mortality in the U.S.

Fishing gear that interacts with humpback whale includes gillnet, pot, and trap gear. Total cumulative annual mortality and serious injury of humpback whale (22.35 whales/yr from 2013-2017) from commercial fishing gear is greater than the stock's PBR of 16.7 whales in US waters (Carretta et al. 2021). The highest estimates of mean annual mortality and serious injury ($F_{2013\text{-}2017}$ ≥8.85/yr) is from unidentified fisheries (ibid). The stock assessment states that "it is likely that most cases involving 'unidentified fisheries' represent pot and/or trap gear (ibid). Total annual human-caused mortality (which includes vessel strikes, non-fishery entanglements, and entanglements in commercial, recreational, and tribal fisheries) from 2013-2017 is estimated at 42.1 humpback whales; this exceeds the range-wide PBR estimate of 33.4 whales (ibid).

Quillback rockfish

Factor 2.1 - Abundance

Northeast Pacific | Traps (unspecified) | Canada | British Columbia

High Concern

Quillback rockfish were designated as "threatened" by COSEWIC in 2009. No overall estimate of decline is possible; however, all survey indices have declined, some by 50 to 75% since the mid-1980s (Figures 23, 24). Commercial trawl and longline fisheries and recreational fisheries are the principal threats to quillback recovery (Figure 25). Due to the COSEWIC "threatened" status of quillback rockfish in BC, quillback rockfish receive a "high" concern score for abundance.

Justification:

Commercial fishing pressure has been reduced as a result of strengthened rockfish conservation efforts established in the mid-1990s, including introduction of closed areas and decrease in commercial harvest quotas (COSEWIC 2009). Juvenile rockfish are encountered in the shrimp trap fishery; however, landings of quillback rockfish in the shrimp trap fishery are negligible in comparison to trawl and longline commercial and recreational landings (Favaro et al. 2010) (Rutherford et al. 2010).

In the most recent stock assessment (2011), estimates of inside and outside quillback rockfish B2011: B_{MSY} ratios were less than the Upper Stock Reference Point (USRP), but greater than the Limit Reference Point (LRP), and both inside and outside quillback units fell in the "cautious zone" based on the DFO's Precautionary Approach (Figure 26). The outside quillback unit's B_{2011}: B_{MSY} ratio was 0.736 (CV 0.57), and the inside quillback unit's B_{2011}: B_{MSY} ratio was 0.493 (CV 0.41) {Yamanaka et al. 2011}.

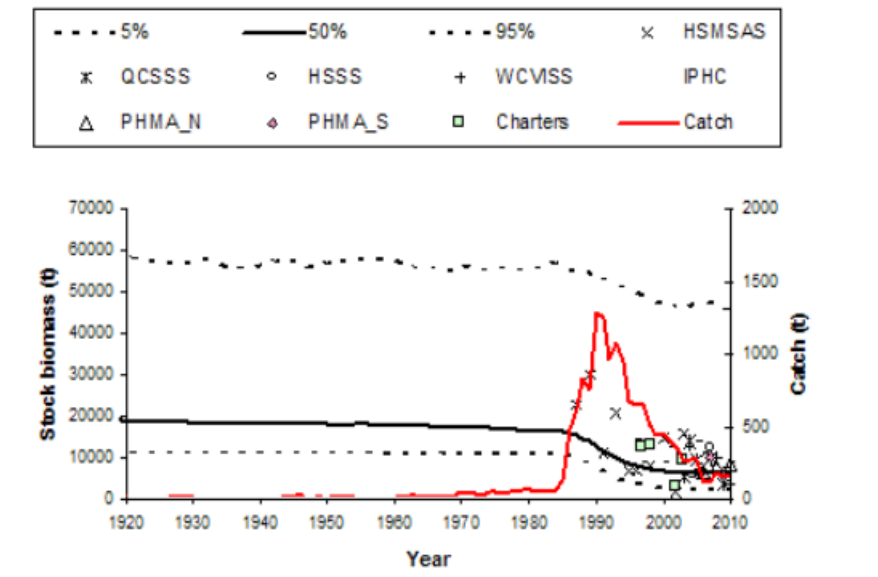


Figure 21: Catch, and posterior median and 90% probability interval for stock biomass (t) of Quillback Rockfish - inside management unit, and the observed stock trend indices divided by their posterior median value for the catchability coefficient for years 1918 to 2010. Results are shown for the reference case. Symbols show survey indices and include the Johnstone Strait Jig Survey (NIjig), Dogfish longline survey (dogfish), Rockfish longline (RLL) survey in PFMA 12 to 16, 18 and 28, submersible survey (sub), and the Strait of Georgia jig survey (SOG,jig).

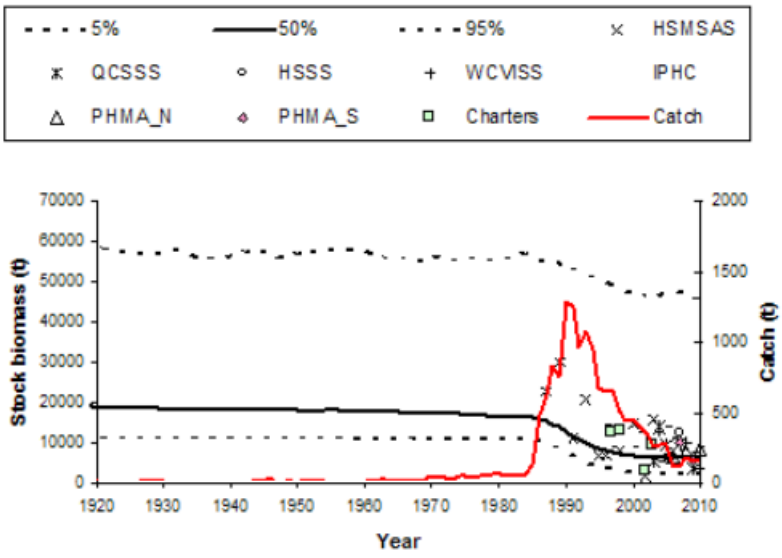


Figure 22: Catch, and posterior median and 90% probability interval for stock biomass (t) of Quillback Rockfish - outside management unit, and the observed stock trend indices divided by their posterior median value for the catchability coefficient for years 1918 to 2010. Results are shown for the reference case. Symbols show survey indices and include the Hecate Strait Multispecies Assemblage Survey (HSMSAS), Queen Charlotte Sound Synoptic Trawl Survey (QCSSS), Hecate Strait Synoptic Trawl Survey (HSSS), West Coast Vancouver Island Synoptic Trawl Survey (WCVISS), International Pacific Halibut commission Standardized Stock Assessment Longline Survey (IPHC), Pacific Halibut Management Association Longline (PHMA) Survey in Northern B.C. waters (PHMA_N), PHMA Survey in Southern B.C. waters (PHMA_S), and ZN Industry charter longline surveys (Charters) {Yamanaka et al. 2011}

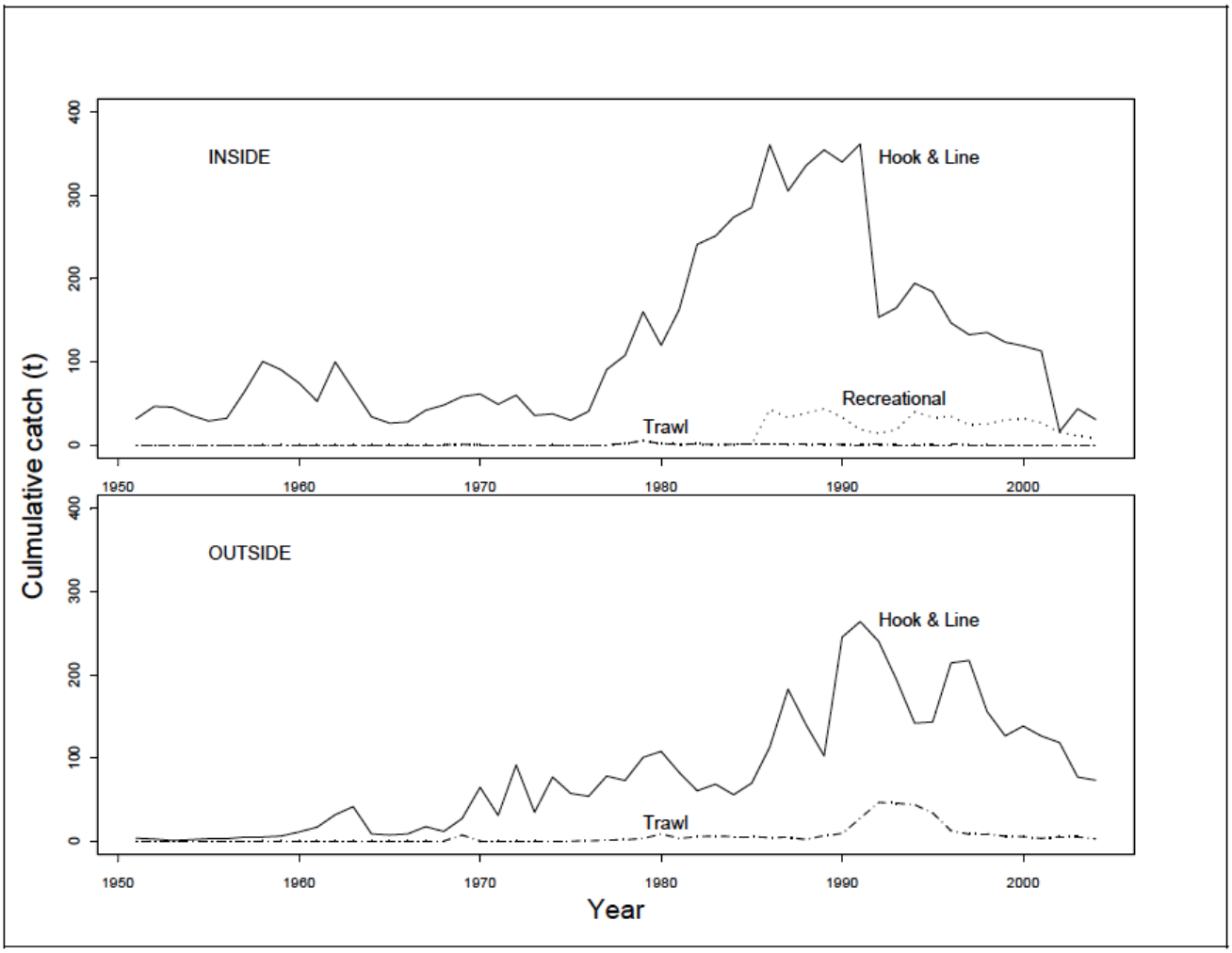


Figure 23: Quillback Rockfish landings for the inside (top) and the outside (bottom) by fishery, commercial hook and line and trawl fisheries and the recreational fishery. The solid line represents the hook and line fishery,dash-dot is trawl, light dots are recreational (COSEWIC 2009).

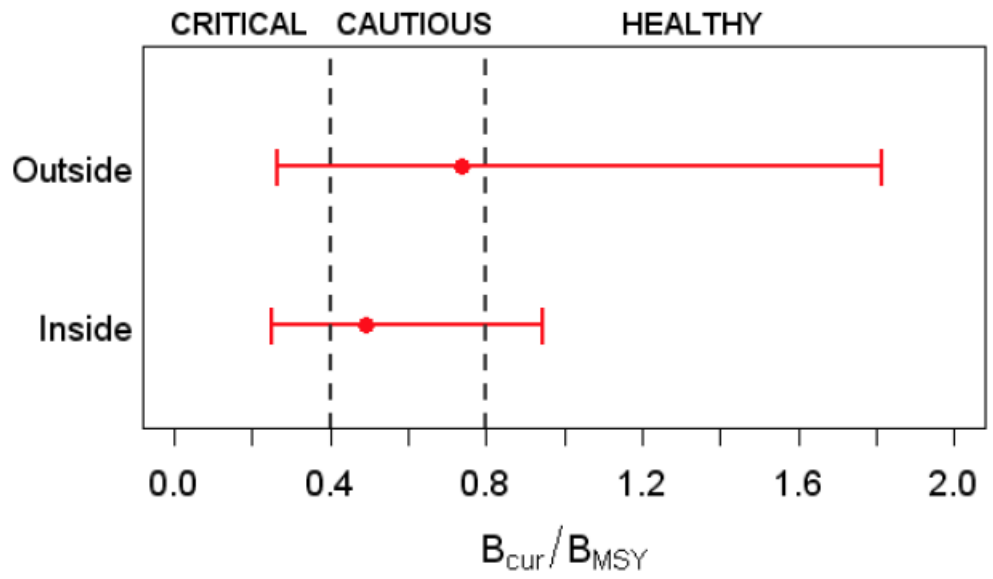


Figure 24: Quillback Rockfish stock status for the outside and inside management units in B.C. Consistent with DFO's Precautionary Approach and Fisheries Reference Points stock status is presented as the median biomass in 2011 over the biomass at MSY with 90% confidence intervals.

Factor 2.2 - Fishing Mortality

Northeast Pacific | Traps (unspecified) | Canada | British Columbia

Low Concern

In 2010, the catches of outside and inside quillback rockfish in all commercial and recreational groundfish fisheries were 158.6 and 33.9 t, respectively. Total fishing mortality, if kept constant, is similar to values projected to allow for gradual rebuilding of the stock; Tables 5 & 6 (DFO 2012a). Quillback catch in the spot prawn trap fishery could not be estimated due to small sample size and low encounter rates (Rutherford et al. 2010). Therefore, the spot prawn fishery's contribution to overall fishing mortality is very low relative to commercial groundfish fisheries. Fishing mortality from all sources is evaluated here. F_{2011}/F_{MSY} <=1 for the commercial quillback fishery in both management areas, which should allow rebuilding over time in conjunction with overall fishing mortality caps (DFO 2012a). The spot prawn trap fishery is not a substantial contributor to F; its contribution to F is expected to be low enough to not adversely affect the population. The fishery, therefore, receives a score of "low" concern for quillback fishing mortality.

Justification:

Quillback rockfish are listed as COSEWIC "threatened," and are caught occasionally in the spot prawn trap fishery. Landings of both inside and outside quillback began to decline after the mid-1990s, and mortality rates have recently dropped below the units' respective F_{MSY} estimates. F_{2011}/F_{MSY} was equal to 1 and 0.6 for the outside and inside management units, respectively.

Commercial groundfish fishery landings of both outside and inside quillback rockfish increased during the 1980s and early 1990s. During the late 1980s and early 1990s, estimates of fishing mortality were more than 3 and 6 times the estimates of F_{MSY} for outside and inside quillback rockfish, respectively (DFO 2012a).

Squat lobster

Factor 2.1 - Abundance

Northeast Pacific | Traps (unspecified) | Canada | British Columbia

Moderate Concern

Squat lobsters are not a highly vulnerable species (see the PSA below), and squat lobster abundance is unknown relative to reference points. Because there is no evidence that squat lobsters caught in this fishery are endangered, threatened or depleted, and because squat lobsters are not highly vulnerable, squat lobster is scored as a "moderate" concern for abundance.

Justification:

1. Squat lobster, Canada spot prawn trap

Productivity	Value	Score (1=low risk, 2=medium risk, 6=high risk)	Reference		Susceptibility Attribute	Information	Score (1=low risk, 2=medium risk, 6=high risk)	Reference
Average age at maturity (years)	2	1	Poore et al. 2011		Areal overlap	Default. Data limited.	3	
Average maximum age (years)	5	1	aquariumofpacific.org		Vertical overlap	Default. Data limited.	3	
Fecundity (eggs/yr)	5,000	2	Tapella et al. 2002, Poore et al. 2011		Selectivity of fishery	Default. Data limited.	2	
Reproductive strategy	Demersal egg layer or brooder	2	Tapella et al. 2002, Poore et al. 2011		Post-capture mortality		3	
Trophic level	3.1	2	seaaroundus.org		Susceptibility Subscore	2.325		
Density dependence (invertebrates only)	Compensatory	1	Poore et al. 2011					
Quality of Habitat	Robust	1	Poore et al. 2011		Productivity-Susceptibility Score	2.73		
Productivity Subscore	1.428571				Vulnerability Rating (high, medium, low)	MEDIUM		

Factor 2.2 - Fishing Mortality

Northeast Pacific | Traps (unspecified) | Canada | British Columbia

Moderate Concern
There is no target fishery for squat lobsters in BC (pers. comm., Convey, DFO 2017). Removals of squat lobsters in the Canada spot prawn trap fishery are unknown due to limited observer coverage and landings data (they are required to be returned immediately to the water). One study that investigated spot prawn trap bycatch from 2000 to 2008 over 17,210 research traps (slightly different from commercial traps) found that the ratio of squat lobsters (discarded) to spot prawns (landed) was approximately 0.08/1 (Favaro et al. 2010). Squat lobsters are not highly vulnerable species (see PSA above), and there are no reference points available for fishing mortality. Squat lobsters therefore receive a "moderate" concern for fishing mortality.

Factor 2.3 - Discard Rate/Landings

Northeast Pacific | Bottom trawls | Canada | British Columbia

< 100%
There is insufficient observer coverage coastwide (0.5% to 3.4%) to estimate overall discards in the shrimp trawl fishery in BC (Rutherford et al. 2013) (pers. comm., Clark, DFO 2017). Discard and bycatch rates from the adjacent Washington trawl fishery (as estimated from the West Coast Groundfish Observer Program) can serve as reasonable proxy for discard estimates in BC. The fisheries share similar target species and gear requirements (pers. comm., Wargo, WDFW 2017) (DFO 2017). From 2010 to 2015, the average discard : landings ratio for Washington trawl fishery was 0.07:1 (Somers et al. 2016). Even if this is a conservative estimate, the BC shrimp trawl fishery likely falls well below the 100% cutoff for this criterion.

Northeast Pacific | Traps (unspecified) | Canada | British Columbia

< 100%
Data on bycatch in the BC trap fishery was collected via a fishery independent study conducted 1999 to 2008, where 17,210 traps were monitored. The total bycatch/landings (spot prawn) ratio was approximately 18% (Favaro et al. 2010). However, invertebrates composed a majority of the bycatch (>95%). The post-capture morality rate for invertebrates is conservatively assumed to be 50% based on research from the Alaska Fisheries Science Center and additional studies suggesting discard mortality rates are relatively low for invertebrates caught in trap gear (AFSC 2017) (Suuronen 2005). Therefore, the dead discards to landings ratio is <0.1/1. Bait use in trap fisheries can be significant and includes pellets, cat food, small fish, etc. (pers. comm., Ayres, WDFW 2017). Exact bait use amounts for this fishery are unknown but the bait use to landings ratio is likely to be well under 0.5/1. Bait use data are limited, however, it is safe to assume the ratio of (discards + bait) / landings is well under 1.

Criterion 3: Management Effectiveness

Five factors are evaluated in Criterion 3: Management Strategy and Implementation, Bycatch Strategy, Scientific Research/Monitoring, Enforcement of Regulations, and Inclusion of Stakeholders. Each is scored as either 'highly effective', 'moderately effective', 'ineffective,' or 'critical'. The final Criterion 3 score is determined as follows:

- *5 (Very Low Concern) — Meets the standards of 'highly effective' for all five factors considered.*
- *4 (Low Concern) — Meets the standards of 'highly effective' for 'management strategy and implementation' and at least 'moderately effective' for all other factors.*
- *3 (Moderate Concern) — Meets the standards for at least 'moderately effective' for all five factors.*
- *2 (High Concern) — At a minimum, meets standards for 'moderately effective' for Management Strategy and Implementation and Bycatch Strategy, but at least one other factor is rated 'ineffective.'*
- *1 (Very High Concern) — Management Strategy and Implementation and/or Bycatch Management are 'ineffective.'*
- *0 (Critical) — Management Strategy and Implementation is 'critical'.*

The Criterion 3 rating is determined as follows:

- ***Score >3.2=Green or Low Concern***
- ***Score >2.2 and ≤3.2=Yellow or Moderate Concern***
- ***Score ≤2.2 = Red or High Concern***

Rating is Critical if Management Strategy and Implementation is Critical.

Guiding principle

- The fishery is managed to sustain the long-term productivity of all impacted species.

Five factors are evaluated in Criterion 3: Management Strategy and Implementation, Bycatch Strategy, Scientific Research/Monitoring, Enforcement of Regulations, and Inclusion of Stakeholders. Each is scored as either 'highly effective', 'moderately effective', 'ineffective,' or 'critical'. The final Criterion 3 score is determined as follows:

Criterion 3 Summary

FISHERY	MANAGEMENT STRATEGY	BYCATCH STRATEGY	RESEARCH AND MONITORING	ENFORCEMENT	INCLUSION	SCORE
Northeast Pacific | Bottom trawls | Canada | British Columbia	Highly effective	Moderately Effective	Highly effective	Highly effective	Highly effective	**Green (4.000)**
Northeast Pacific | Traps (unspecified) | Canada | British Columbia	Highly effective	Moderately Effective	Highly effective	Highly effective	Highly effective	**Green (4.000)**

Criterion 3 Assessment

SCORING GUIDELINES

Factor 3.1 - Management Strategy and Implementation
Considerations: What type of management measures are in place? Are there appropriate management goals, and is there evidence that management goals are being met? Do manages follow scientific advice? To achieve a highly effective rating, there must be appropriately defined management goals, precautionary policies that are based on scientific advice, and evidence that the measures in place have been successful at maintaining/rebuilding species.

Factor 3.2 - Bycatch Strategy

Considerations: What type of management strategy/measures are in place to reduce the impacts of the fishery on bycatch species and when applicable, to minimize ghost fishing? How successful are these management measures? To achieve a Highly Effective rating, the fishery must have no or low bycatch, or if there are bycatch or ghost fishing concerns, there must be effective measures in place to minimize impacts.

Factor 3.3 - Scientific Research and Monitoring

Considerations: How much and what types of data are collected to evaluate the fishery's impact on the species? Is there adequate monitoring of bycatch? To achieve a Highly Effective rating, regular, robust population assessments must be conducted for target or retained species, and an adequate bycatch data collection program must be in place to ensure bycatch management goals are met.

Factor 3.4 - Enforcement of Management Regulations

Considerations: Do fishermen comply with regulations, and how is this monitored? To achieve a Highly Effective rating, there must be regular enforcement of regulations and verification of compliance.

Factor 3.5 - Stakeholder Inclusion

Considerations: Are stakeholders involved/included in the decision-making process? Stakeholders are individuals/groups/organizations that have an interest in the fishery or that may be affected by the management of the fishery (e.g., fishermen, conservation groups, etc.). A Highly Effective rating is given if the management process is transparent, if high participation by all stakeholders is encouraged, and if there a mechanism to effectively address user conflicts.

Factor 3.1 - Management Strategy And Implementation

Northeast Pacific | Bottom trawls | Canada | British Columbia

Highly effective

The Canadian shrimp trawl fishery is managed by the Minister of Fisheries and Oceans and Department of Fisheries and Oceans at the national level, primarily under legislation associated with the Fisheries Act (R.S., 1985, c. F-14) and the Integrated Fishery Management Plan (IFMP). Additionally, the Shrimp Trawl Sectoral Committee (STSC) is a primary management advisory process for the shrimp trawl fishery (DFO 2017). A number of management measures are in place to sustainably manage the shrimp trawl fishery including limited entry, annual stock assessments and biomass estimates, logbooks, independent dockside monitoring and partial at-sea observer coverage, bycatch reduction measures, and gear restrictions to ensure a clean target fishery. Species retained in addition to smooth pink and sidestripe shrimp include incidental prawns, squid, and octopus (retained in small quantities per regulations for squid and prawns). Specific seasons, catch limits, and area closures apply to each retained species. Therefore, the fishery receives a "highly effective" score based on the overall harvest management strategy.

Justification:

The trawl fishery occurs in 34 of 36 SMAs, with trends in biomass monitored over time in most areas. SMA-specific reference points (estimated B_{PROX}) are set based on annual stock assessments and fishery independent surveys. These reference points are designed to conservatively prevent overfishing and identify if a stock is at risk of overfishing. If an SMA TAC is exceeded or if the stock falls below a critical level, the fishery will be closed in-season.

It is important to note that the BC shrimp trawl industry essentially split into two different groups during the 2016/2017 fishing season: smaller vessels that harvest modest volumes and larger otter trawl vessels that harvest more significant volumes. This split was largely in response to high abundance levels of shrimp during the 2015/16 season that fostered increased participation during high yield years and exacerbated issues associated with non-target species catches (DFO 2017).

Northeast Pacific | Traps (unspecified) | Canada | British Columbia

Highly effective

The Canadian shrimp trap fishery is managed by the Minister of Fisheries and Oceans and Department of Fisheries and Oceans (DFO). The commercial fishery is limited entry, with seasonal closures, in-season area closures, gear limits, gear and buoy marking requirements (tags), trap mesh size requirements, minimum size limits, daily fishing time restrictions, and a daily single haul limit (DFO 2017a). Moderately stable landings data from the early 1990s to the present suggest the precautionary, assessment-based management approach used by the DFO can sustainably manage the spot prawn stock, while incorporating uncertainty and environmental variability. The spot prawn fishery receives a score of "highly effective" for management strategy and implementation.

Justification:

A fixed escapement model is used to assess and manage the harvest in-season using standardized CPUE data. The model indicates the minimum number of female spawners required during the hatch period to meet target reference points by management subarea. When the minimum monthly index is reached in a subarea, the fishery is closed {DFO 2017a). Implementation of this fixed escapement strategy is carried out through an in-season, industry-funded monitoring program. At-sea observers sample commercial catches, and these data are used to estimate female spawner abundance indices as well as sex and cohort composition of the commercial catch {Boutillier and Bond 2000}.

Factor 3.2 - Bycatch Strategy

Northeast Pacific | Bottom trawls | Canada | British Columbia

Moderately Effective

Minimizing bycatch is described as one of the leading goals in the shrimp trawl IFMP for the BC area. The shrimp trawl fishery employs a number of management measures to reduce bycatch including mandatory bycatch reduction devices, bycatch action levels, and time and area closures. The percentage of bycatch relative to shrimp landings in the commercial fishery is unknown since the partial observer coverage (0.5% to 3.4% coastwide) is insufficient to estimate fleetwide bycatch (Rutherford et al. 2013). Observer efforts have largely focused on tracking eulachon bycatch, a species of concern that is regularly caught in this fishery (DFO 2017). In May 2019, DFO allowed the use of LED lights in the shrimp trawl fishery as a means to reduce Eulachon bycatch, but the use of LED lights is new and effectiveness in BC is unknown and DFO is working with license holders to establish best practices (DFO 2020c)(DFO 2020f). DFO also recently required 100% at-sea observer coverage for all shrimp trawl fishing in PFMA 124 and 125 (DFO 2020f). Overall, a number of bycatch reduction measures are in place; however, the efficacy of these measures is unknown due to data limitations, and the shrimp trawl fishery receives a score of "moderately effective" for bycatch strategy.

Justification:

A number of gear requirements in the shrimp trawl fishery are designed to reduce bycatch levels. Specifically, trawl nets must include a rigid grid or grate along with an escape hole. And based on industry recommendations, as of 2016/17 the spacing between the bars of the grate must be no greater than 1.25 inches apart. The netting directly above the grid must also have an escape hole, and the sides of the opening must be reinforced so that the opening remains unobstructed and maintains its shape while the net is being towed through the water (DFO 2017).

Eulachon (listed as endangered in some regions by COSEWIC) are regularly caught in the shrimp trawl fishery, and the shrimp trawl fishery was listed as one of the main threats to eulachon recovery in the region (Schweigert et al. 2012). In order to reduce the negative impacts of the shrimp trawl fishery on eulachon stocks, eulachon bycatch action levels (EALs) were established in the WCVI SMA (4 tonnes (MT) annually). If the estimate of eulachon bycatch in a given WCVI SMA reaches the EAL, the commercial fishery will likely close; the fishery closed early in 2000, 2016, and 2019 after the EAL was reached (DFO 2020f). Additional area closures exist to avoid eulachon bycatch in the Queen Charlotte Sound area (DFO 2017) and to avoid rockfish in rockfish conservation areas (DFO 2017).

It is important to note that the eulachon EAL was reached in two SMAs during 2016 when shrimp abundance was high and the fishery was closed in these areas. In response, the fishery subsequently split into two different groups: larger otter trawl vessels and smaller vessels with more modest landings. The larger vessel group recently proposed increasing observer coverage in the fishery when shrimp biomass is high, and if this management recommendation is implemented, more data may be available on bycatch in the fleet in the future (pers. comm., Wallace 2017). Managers are also considering individual vessel eulachon bycatch limits in specific SMAs, which could be implemented in-season in the future (DFO 2017).

Northeast Pacific | Traps (unspecified) | Canada | British Columbia

Moderately Effective

Bycatch in the spot prawn trap fishery is presumed to be low with minimal diversity (generally less than 6%) {Favaro 2010}(Rutherford et al. 2010) (Figure 27). The majority of species caught are invertebrates that are easily sorted and returned to the water with presumed low mortality (DFO 2017a). Both the commercial and recreational fishery require rot cord to release bycatch if traps are lost (DFO 2017a). Entanglement of humpback whales (Special Concern under COSEWIC and SARA) remains a potential issue for the prawn trap fishery, and no actions are specifically required to minimize these interactions outside of standard gear labeling. Canada has signed the Global Ghost Gear Initiative; in 2019 DFO began requiring all commercial fisheries to report lost and found gear (DFO 2020a). Gear requirements to reduce the risk of ghost fishing in conjunction with monitoring of rockfish bycatch associated with Rockfish

Conservation Areas, low catch rates of threatened quillback rockfish, and risk of humpback whale entanglements result in a "moderately effective" rating for bycatch strategy.

Justification:

Concerns about rockfish sustainability in the region led to the implementation of formal rockfish conservation measures in 2002. These measures included catch restrictions, fishery monitoring, assessment programs and establishment of areas closed to certain fishing activities. Rockfish encounters in the commercial prawn and shrimp trap fishery are a rare event (0.000 to 0.045 rockfish/trap) and the prawn and shrimp trap fisheries were allowed to continue in the Rockfish Conservation Areas with the collection of bycatch information. The sampling program estimates total rockfish bycatch in the commercial fishery (Rutherford et al. 2010).

The most frequently encountered rockfish in the trap fishery are quillback rockfish, which have been assessed as "threatened" by the COSEWIC (DFO 2017b). Yet, a recent study of bycatch rates in the trap fishery found that bycatch rates of rockfish were so low that total rockfish bycatch by species could not be estimated by management region or coastwide owing to the low number of rockfish encountered (Rutherford et al. 2010).

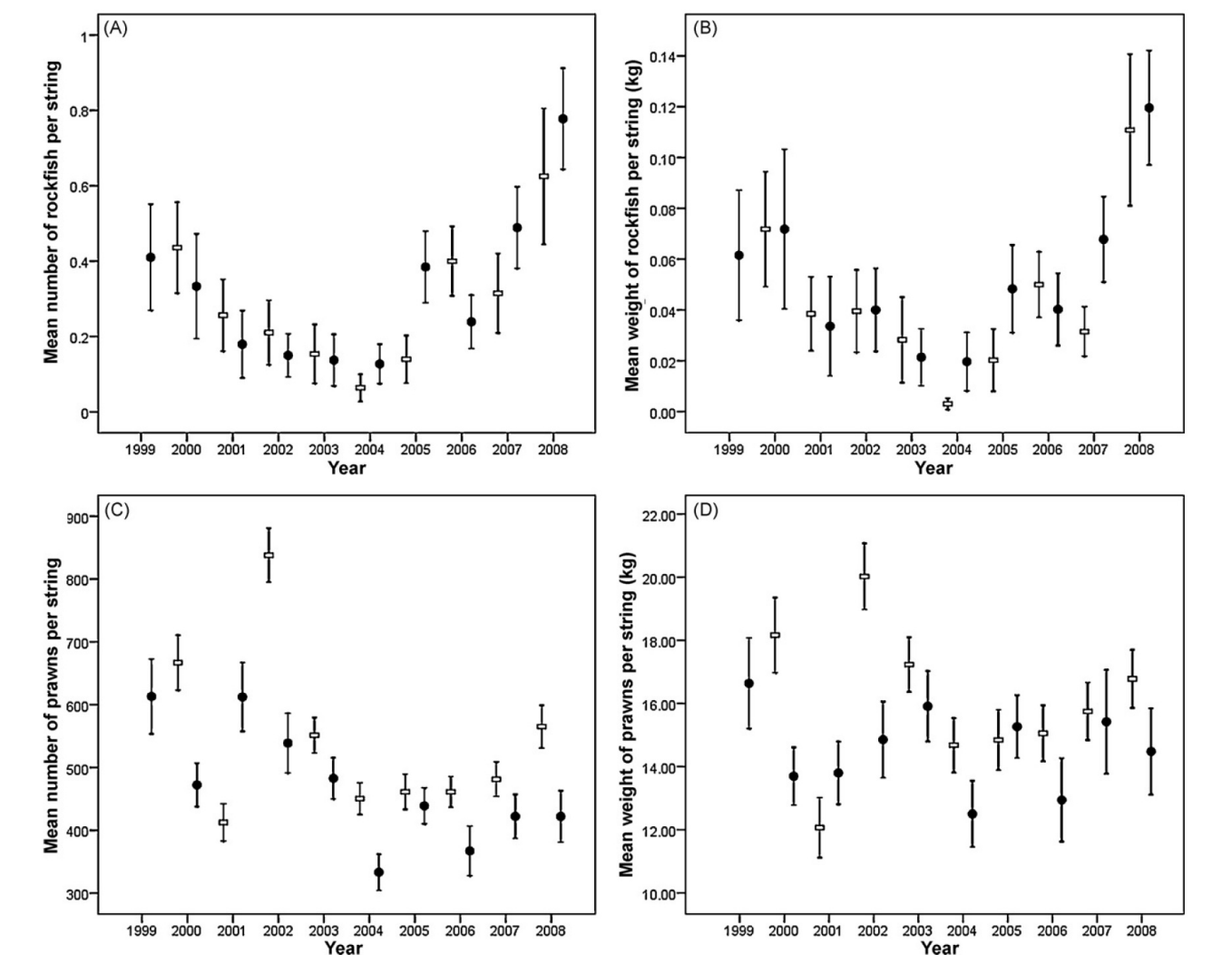


Figure 25: Catch of rockfish (A: by count; B: by weight) and spot prawns (C: by count; D: by weight) in a spot prawn trap research survey in Howe Sound, British Columbia. Means are shown (±1 SE) per 20-trap string. The number of strings deployed per sampling period is given in Table 2. Black circles represent fall sampling, and white rectangles represent spring sampling {Favaro 2010}.

Factor 3.3 - Scientific Research And Monitoring

Northeast Pacific | Bottom trawls | Canada | British Columbia

Highly effective

The trawl fishery is managed via a current stock assessment informed by fishery dependent and fishery independent data sources. Shrimp trawl research is robust and peer-reviewed through committees like the Center for Science Advice Pacific (CSAP) and/or the Canadian Science Advisory Secretariat (CSAS), and shrimp abundance and bycatch of eulachon is relatively well-monitored. Therefore, the trawl shrimp fishery receives a score of "highly effective" for scientific research and monitoring.

Justification:

Fishing effort and landings are tracked using required logbooks in conjunction with required real-time fishing and landing hails (notifications) (DFO 2017). Pre-season stock forecasts are used to set the TACs each year, with in-season assessments providing feedback to adjust the TACs accordingly. Swept-area fishery independent surveys are carried out annually in individual SMAs, and results are used to index and monitor shrimp abundance over time. This forms the basis for the harvest control rules from which TACs are set (DFO 2017). There is limited observer coverage (0.5% to 3.4% coastwide) in the shrimp trawl fleet (Rutherford et al. 2013). Observer coverage is primarily carried out in the WCVI SMAs to monitor eulachon bycatch rates, with other areas prioritized as specific issues arise. Industry recently supported a study to evaluate the efficacy of LED lights in reducing eulachon bycatch, with promising early results (DFO 2017).

Northeast Pacific | Traps (unspecified) | Canada | British Columbia

Highly effective

Life history parameters, bycatch, lost fishing gear, and catch data are tracked through a number of fishery dependent and fishery independent sources; therefore, the shrimp trap fishery receives a score of "highly effective" for scientific research and monitoring.

Justification:

Life history parameters related to growth and fishing mortality are derived from semi-annual independent fishery surveys. Fisheries-dependent data are also collected in season by on-board and on-ground observers to monitor stock status relative to the established SI reference points and to monitor rockfish bycatch fleetwide (DFO 2017a). A number of peer-reviewed studies have evaluated the efficacy of the current escapement-based model as a fishery management tool (Smith 2008) and examined bycatch in shrimp trap fisheries in the region (Rutherford et al. 2010), {Favaro 2010}. Overall stock abundance is determined by annual commercial landings and is considered a reasonable proxy (DFO 2017a). All traps are required to have tags, and the number of replacement tags issued is tracked by managers as a proxy to assess lost or ghost-fishing gear.

Factor 3.4 - Enforcement Of Management Regulations

Northeast Pacific | Bottom trawls | Canada | British Columbia

Highly effective

General enforcement is carried out by Fishery Officers who conduct regular patrols by land, sea and air (DFO 2017d). Fishery Officers conduct at-sea and dockside inspections as part of regular patrols to ensure compliance with fishery regulations (DFO 2017). Inspections focus on fishing vessels at-sea and at landing ports to inspect catch on board, bycatch gear in nets, hails, landing records, and harvest logs. Closed time and area patrols may also be conducted by Canadian Coast Guard (CCG) patrol vessels, program vessels, or by air in conjunction with other patrols (DFO 2017). There is sufficient capacity to ensure compliance and enforcement based on the capacity of the fishery; therefore, the shrimp trawl fishery receives a score of "highly effective" for enforcement of management regulations.

Justification:

Regular fishery reviews must be conducted against the IFMP's objectives. Also, self-diagnostic tools like the Fishery Checklist (a tool for internal use) can help the DFO monitor improvements that support sustainable fisheries, and identify areas of weakness that require further work. Compliance and enforcement are reviewed annually as part of the checklist (DFO 2017c). Fishery Notice distribution is used to ensure that management measures are transparent and shared in-season with fishery participants and the public.

Northeast Pacific | Traps (unspecified) | Canada | British Columbia

Highly effective

General enforcement is carried out by Fishery Officers who conduct regular patrols by land, sea and air (DFO 2017d). Violations encountered by Fishery Officers in 2016 include but are not limited to the following: illegal gear, illegal selling, and area/time violations (DFO 2017a). At-sea enforcement personnel provide additional fleet monitoring, which in 2016 included 181 fishing gear and catch inspections specifically for trap mesh size, trap tags, and product size. In all, 86% of the fleet was checked for general compliance by at-sea enforcement personnel during the 2016 season (DFO 2017a). Appropriate management and observation measures are regularly enforced and verified and there is sufficient capacity to manage and enforce the shrimp trap fishery; therefore, it receives a "highly effective" score for compliance.

Justification:

As specified in the shrimp trap fishery IFMP, regular fishery reviews must be conducted against the IFMP's objectives. In addition, self-diagnostic tools like the Fishery Checklist (a tool for internal use) can help the Department monitor improvements that support sustainable fisheries, and identify areas of weakness that require further work. Compliance and enforcement are reviewed annually as part of the checklist (DFO 2017c). Fishery notice distribution is used to ensure that management measures are transparent and shared in-season with fishery participants and the public.

Factor 3.5 - Stakeholder Inclusion

Northeast Pacific | Bottom trawls | Canada | British Columbia

Highly effective
The Shrimp Trawl Sectoral Committee (STSC) meets annually and provides a forum for the exchange of information and views between the people involved with the industry and the DFO on issues important to the management and sustainability of the fishery. There is some concern as the current STSC does not include a seat for conservation organizations; however, this may be changed in 2017 {DFO 2017, Appendix 12}. Overall, the management process is relatively transparent, with notifications and invitations to the public to participate in year-round meetings, allowing for dispute resolution and inclusion in the management process; therefore, the fishery receives a score of "highly effective" for stakeholder inclusion.

Northeast Pacific | Traps (unspecified) | Canada | British Columbia

Highly effective
Similar to the STSC for the shrimp trawl fishery, a prawn advisory board exists to include various stakeholders in the prawn management process (DFO 2017). Overall, the management process is transparent, with notifications and invitations to the public to participate in year-round meetings, allowing for dispute resolution and inclusion in the management process. Additionally, industry representatives are involved in the establishment and funding of a number of fishery-dependent stock monitoring and compliance measures (DFO 2017a). The fishery receives a score of "highly effective" for stakeholder inclusion.

Criterion 4: Impacts on the Habitat and Ecosystem

This Criterion assesses the impact of the fishery on seafloor habitats, and increases that base score if there are measures in place to mitigate any impacts. The fishery's overall impact on the ecosystem and food web and the use of ecosystem-based fisheries management (EBFM) principles is also evaluated. Ecosystem Based Fisheries Management aims to consider the interconnections among species and all natural and human stressors on the environment. The final score is the geometric mean of the impact of fishing gear on habitat score (factor 4.1 + factor 4.2) and the Ecosystem Based Fishery Management score. The Criterion 4 rating is determined as follows:

- ***Score >3.2=Green or Low Concern***
- ***Score >2.2 and ≤3.2=Yellow or Moderate Concern***
- ***Score ≤2.2 = Red or High Concern***

Guiding principles

- Avoid negative impacts on the structure, function or associated biota of marine habitats where fishing occurs.
- Maintain the trophic role of all aquatic life.
- Do not result in harmful ecological changes such as reduction of dependent predator populations, trophic cascades, or phase shifts.
- Ensure that any enhancement activities and fishing activities on enhanced stocks do not negatively affect the diversity, abundance, productivity, or genetic integrity of wild stocks.
- Follow the principles of ecosystem-based fisheries management.

Rating cannot be Critical for Criterion 4.

Criterion 4 Summary

FISHERY	FISHING GEAR ON THE SUBSTRATE	MITIGATION OF GEAR IMPACTS	ECOSYSTEM-BASED FISHERIES MGMT	SCORE
Northeast Pacific | Bottom trawls | Canada | British Columbia	2	+.5	Low Concern	**Yellow (3.162)**
Northeast Pacific | Traps (unspecified) | Canada | British Columbia	2	+.5	Low Concern	**Yellow (3.162)**

Criterion 4 Assessment

SCORING GUIDELINES

Factor 4.1 - Physical Impact of Fishing Gear on the Habitat/Substrate
Goal: The fishery does not adversely impact the physical structure of the ocean habitat, seafloor or associated biological communities.

- *5 - Fishing gear does not contact the bottom*
- *4 - Vertical line gear*
- *3 - Gears that contacts the bottom, but is not dragged along the bottom (e.g. gillnet, bottom longline, trap) and is not fished on sensitive habitats. Or bottom seine on resilient mud/sand habitats. Or midwater trawl that is known to contact bottom occasionally. Or purse seine known to commonly contact the bottom.*
- *2 - Bottom dragging gears (dredge, trawl) fished on resilient mud/sand habitats. Or gillnet, trap, or bottom longline fished on sensitive boulder or coral reef habitat. Or bottom seine except on mud/sand. Or there is known trampling of coral reef habitat.*
- *1 - Hydraulic clam dredge. Or dredge or trawl gear fished on moderately sensitive habitats (e.g., cobble or boulder)*
- *0 - Dredge or trawl fished on biogenic habitat, (e.g., deep-sea corals, eelgrass and maerl)*

Note: When multiple habitat types are commonly encountered, and/or the habitat classification is uncertain, the score will be based on the most sensitive, plausible habitat type.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts
Goal: Damage to the seafloor is mitigated through protection of sensitive or vulnerable seafloor habitats, and limits on the spatial footprint of fishing on fishing effort.

- *+1 —>50% of the habitat is protected from fishing with the gear type. Or fishing intensity is very low/limited and for trawled fisheries, expansion of fishery's footprint is prohibited. Or gear is specifically modified to reduce damage to seafloor and modifications have been shown to be effective at reducing damage. Or there is an effective combination of 'moderate' mitigation measures.*
- *+0.5 —At least 20% of all representative habitats are protected from fishing with the gear type and for trawl fisheries, expansion of the fishery's footprint is prohibited. Or gear modification measures or other measures are in place to limit fishing effort, fishing intensity, and spatial footprint of damage caused from fishing that are expected to be effective.*
- *0 —No effective measures are in place to limit gear impacts on habitats or not applicable because gear used is benign and received a score of 5 in factor 4.1*

Factor 4.3 - Ecosystem-Based Fisheries Management
Goal: All stocks are maintained at levels that allow them to fulfill their ecological role and to maintain a functioning ecosystem and food web. Fishing activities should not seriously reduce ecosystem services provided by any retained species or result in harmful changes such as trophic cascades, phase shifts or reduction of genetic diversity. Even non-native species should be considered with respect to ecosystem impacts. If a fishery is managed in order to eradicate a non-native, the potential impacts of that strategy on native species in the ecosystem should be considered and rated below.

- *5 — Policies that have been shown to be effective are in place to protect species' ecological roles and ecosystem functioning (e.g. catch limits that ensure species' abundance is maintained at sufficient levels to provide food to predators) and effective spatial management is used to protect spawning and foraging areas, and prevent localized depletion. Or it has been scientifically demonstrated that fishing practices do not have negative ecological effects.*
- *4 — Policies are in place to protect species' ecological roles and ecosystem functioning but have not proven to be effective and at least some spatial management is used.*
- *3 — Policies are not in place to protect species' ecological roles and ecosystem functioning but detrimental food web impacts are not likely or policies in place may not be sufficient to protect species' ecological roles and ecosystem functioning.*
- *2 — Policies are not in place to protect species' ecological roles and ecosystem functioning and the likelihood of detrimental food impacts are likely (e.g. trophic cascades, alternate stable states, etc.), but conclusive scientific evidence is not available for this fishery.*
- *1 — Scientifically demonstrated trophic cascades, alternate stable states or other detrimental food web impact are resulting from this fishery.*

Factor 4.1 - Impact of Fishing Gear on the Habitat/Substrate

Northeast Pacific | Bottom trawls | Canada | British Columbia

2

The shrimp trawl fishery employs beam trawl gear (net held open by a neutrally buoyant beam) or otter trawl gear (net held open with doors). The shrimp trawl fishery off the coast of BC tends to fish in high energy, soft bottom environments that are more robust to benthic alteration by trawl gear than complex, high-structure substrate (DFO 2017). Although shrimp trawl gear generally fishes slightly off the seafloor, there is documentation of some deleterious effects of the fishing gear on the benthic habitat and biota (Hannah et al. 2010) (DFO 2017e). The fishery receives a score of 2 for the physical impact of fishing gear on the seafloor based on 2017 Seafood Watch Criteria.

Northeast Pacific | Traps (unspecified) | Canada | British Columbia

2

The spot prawn trap fishery occurs in nearshore areas over rocky or hard bottoms that can include glass-sponge reefs or coral beds (DFO 2017a). The fishery receives a score of 2 for the physical impact of fishing gear on the seafloor based on 2017 Seafood Watch Criteria.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

Northeast Pacific | Bottom trawls | Canada | British Columbia

+.5
The shrimp trawl IFMP addresses the spatial footprint of shrimp trawl effort. Four sponge reef areas in eastern Queen Charlotte Sound and Hecate Straight were protected as "sensitive benthic areas" and were closed to shrimp trawling officially in 2002 (DFO 2017). More recently, in accordance with the Sensitive Benthic Areas Policy and its Ecological Risk Assessment Framework (ERAF) for Cold-water Corals and Sponge Dominated Communities, restrictions on bottom contact fishing activities were implemented in 2015 on nine glass sponge reef areas in the Strait of Georgia, and these areas are now closed to fishing by shrimp trawl (Figure A). Within SMAs, there are areas closed to shrimp trawling, which include rockfish conservation areas, two marine protected areas, ecological reserves, and national marine conservation Areas (DFO 2017). A complete list, detailed descriptions and maps of protected areas can be found the updated FMP (DFO 2020c). In summary, the shrimp trawl fishery prohibits expansion of the fishery's footprint, and vulnerable habitats are protected through area closures; therefore, it receives +0.5 for mitigation rating.

Northeast Pacific | Traps (unspecified) | Canada | British Columbia

+.5
The shrimp trap fishery is closed in a number of regions with known vulnerable habitats, and expansion of the fishery into new zones is prohibited through enforceable regulations. Therefore, it scores +0.5 for mitigation of gear impacts.
Justification:
Existing measures, such as license limitation, trap limitation, and a daily single haul provision have reduced fishing effort, intensity, and the fishery's spatial footprint. The number of licenses has declined since the mid-1990s, and the fishing season also has decreased dramatically to approximately 40 days since 2012; the overall footprint of the fishery on benthic habitat has been mitigated in recent years (DFO 2017a).

Area closures are also in place to protect vulnerable habitat. The Hecate Strait and Queen Charlotte Sound Glass Sponge Reefs Marine Protected Area was established under the *Oceans Act* in February 2017 to conserve the biological diversity, structural habitat, and ecosystem function of glass sponge reefs, and prawn and shrimp trap fishing is prohibited (DFO 2017a). Additionally, all bottom contact fishing for shrimp (including traps) is prohibited in nine glass sponge reef areas in the Strait of Georgia to protect these areas in accordance with the Sensitive Benthic Areas Policy and its Ecological Risk Assessment Framework for cold-water corals and sponge dominated communities (DFO 2017a).

Factor 4.3 - Ecosystem-based Fisheries Management

Northeast Pacific | Bottom trawls | Canada | British Columbia
Northeast Pacific | Traps (unspecified) | Canada | British Columbia

Low Concern
DFO recognizes pandalid shrimp as an important forage fish species because shrimp larvae are a critical source of food for a number of marine organisms. As adults, shrimp are a food source for a number of pelagic fish species such as hake, turbot, spiny dogfish, cod, rockfish, and skate (DFO 2017). As part of an ecosystem-based fishery management (EBFM) approach, DFO emphasizes bycatch reduction (focusing on vulnerable species like rockfish and eulachon), sensitive habitat closures, marine reserves and protected areas that preserve ecosystem function, and management measures designed to preserve the viability of shrimp ecology (e.g., seasonal closures or delays to protect reproductive females) (DFO 2017a). A number of policies are in place that protect ecosystem function using spatial and temporal management, and that account for the ecological role of shrimp; therefore, the trawl fishery receives a score of "low" concern for EBFM.

Acknowledgements

Scientific review does not constitute an endorsement of the Seafood Watch® program, or its seafood recommendations, on the part of the reviewing scientists. Seafood Watch® is solely responsible for the conclusions reached in this report.

Seafood Watch would like to thank the consulting researcher and author of this report, Megan Peterson, as well as several anonymous reviewers for graciously reviewing this report for scientific accuracy.

References

2014. NOAA. Current fishery statistics no. 2014-2- Imports and exports of fishery products annual summary, 2014 revised.
AFSC. 2017. AFSC/RACE/SAP/Urban: Snow Crab Handling Mortality.
Agbayani, S., Picco, C.M., and Alidina, H.M. Cumulative impact of bottom fisheries on benthic habitats: A quantitative spatial assessment in British Columbia, Canada. Ocean and Coastal Management 116: 423-434
Anderson, P.J. and Piatt, J.F., 1999. Community reorganization in the Gulf of Alaska following ocean climate regime shift. Marine Ecology Progress Series, pp.117-123.
Aquarium of the Pacific. 2017. Squat lobster.
Boutillier, J.A. and Bond, J.A., 2000. Using a fixed escapement strategy to control recruitment overfishing in the shrimp trap fishery in British Columbia. Journal of Northwest Atlantic Fishery Science, 27, pp.261-272.
Butler, T. 1980. Shrimps of the Pacific Coast of Canada. Canadian Bulletin of Fisheries and Aquatic Sciences. Bulletin 202. 26 pp.
Butler, T.H., 1964. Growth, reproduction, and distribution of pandalid shrimps in British Columbia. Journal of the Fisheries Board of Canada, 21(6), pp.1403-1452.
Cadrin, S.X., Boutillier, J.A. and Idoine, J.S., 2004. A hierarchical approach to determining reference points for Pandalid shrimp. Canadian Journal of Fisheries and Aquatic Sciences, 61(8), pp.1373-139
Carretta, J.V., Erin M. Oleson, Karin. A. Forney, Marcia M. Muto, David W. Weller, Aimee R. Lang, Jason Baker, Brad Hanson, Anthony J. Orr, Jay Barlow, Jeffrey E. Moore, and Robert L. Brownell Jr. 2021. U.S. Pacific Marine Mammal Stock Assessments: 2020, U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-646.

CBC News, Lindsey, B. 2017. 'Just a fantastic feeling': Entangled humpback rescued off B.C. coast.
CBC News. 2015. Humpback whale caught in prawn traps rescued near Powell River, B.C.
CBC News. Oudshoorn, K. 2020. Entangled humpback whale found dead on remote B.C. island.

Collier, P., Hannah, R., Frimodig, A. 2006. Pacific ocean shrimp. CDFW Review of the Fishery. 9 pp.
COSEWIC. 2009. COSEWIC assessment and status report on the Quillback Rockfish Sebastes maliger in Canada. Committee on the Status of Endangered Wildlife in Canada. 71 pp.
Department of Fisheries and Oceans. 2008. Proceedings of the Precautionary Approach Workshop on Canadian Shrimp and Prawn Stocks and Fisheries; November 26-27, 2008. 168 pp.
Department of Fisheries and Oceans. 2009. Proceedings of the Precautionary Approach Workshop on Shrimp and Prawn Stocks and Fisheries; November 26-27, 2008. DFO Can. Sci. Advis. Sec. Proceed Ser. 2008/031.
Department of Fisheries and Oceans. 2012. Assessment of inshore shrimp stocks along the coast of British Columbia, 2011. Canadian Science Advisory Secretariat Science Advisory Report 2011/085. 12 pp.
Department of Fisheries and Oceans. 2013. Recovery Strategy for the North Pacific Humpback Whale (Megaptera novaeangliae) in Canada. Species at Risk Act Recovery Strategy Series. Fisheriesand Oceans Canada, Ottawa. 67 pp.
Department of Fisheries and Oceans. 2016. Pacific region Integrated Fisheries Shrimp Trawl Management Plan, April 1, 2016 to March 31, 2017. 169 pp.
Department of Fisheries and Oceans. 2017. Compliance and enforcement.
Department of Fisheries and Oceans. 2017. Pacific Region DRAFT Integrated Fishery Management Plan January 1 - December 31 2018. Eulachon Fraser River Plan. 54 pp.
Department of Fisheries and Oceans. 2017. Pacific region Integrated Fisheries Prawn and Shrimp Trap Management Plan, May 1, 2017 to April 30, 2018. 141 pp.
Department of Fisheries and Oceans. 2017. Pacific region Integrated Fisheries Shrimp Trawl Management Plan, April 1, 2017 to March 31, 2018. 194 pp.
Department of Fisheries and Oceans. 2017. Species At Risk Act Species profiles.
Department of Fisheries and Oceans. 2017. Sustainable Fisheries Framework.
Department of Fisheries and Oceans. 2020a. Pacific region Integrated Fisheries Prawn and Shrimp Trap Management Plan, May 1, 2020 to April 30, 2021. 146 pp.

Department of Fisheries and Oceans. 2020c. Pacific region Integrated Fisheries Prawn and Shrimp Trawl Management Plan,

April 1, 2020 to March 31, 2021. 208 pp.

Department of Fisheries and Oceans. 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. 16 pp.
DFO. 2018a. Results of the Shrimp Management Area 18 and 19 Shrimp Surveys, June 16 – 20, 2018. Shrimp Survey Bulletin 18-03 September 2018.

DFO. 2018b. Glass sponge aggregations in Howe Sound: locations, reef status, and ecological significance assessment. Canadian Science Advisory Secretariat Science Response 2018/032.

DFO. 2019a. Results of the West Coast of Vancouver Island Shrimp Survey, May 1 – 14, 2019. Shrimp Survey Bulletin 19-01 August 2019.

DFO. 2019b. Results of the Shrimp Management Area 16 Shrimp Survey, June 16 – 17, 2019. Shrimp Survey Bulletin 19-04 August 2019.

DFO. 2019c. Results of the Shrimp Management Area 12IN Shrimp Survey. Shrimp Survey Bulletin 19-06 November 2019.

DFO. 2019d. Results of the Shrimp Management Area 14 Shrimp Survey, June 17 – 23, 2019. Shrimp Survey Bulletin 19-03 August 2019.

DFO. 2019e. Results of the Shrimp Management Area Fraser River Shrimp Survey. Shrimp Survey Bulletin 19-02 August 2019.

DFO. 2020b. Results of the Shrimp Management Area PRD Shrimp Survey. September 10 – 21, 2020. Shrimp Survey Bulletin 20-01 October 2020.

DFO. 2020f. Eulachon Fraser River Integrated Fisheries Management Plan January 1 - December 31, 2021.

DFO. 2021a. Results of the Shrimp Management Area GSTE Shrimp Survey, January 12 to 16, 2021. Shrimp Survey Bulletin 20-02 February 2021 Draft for Review.

DFO. Ecological Risk Assessment Framework (ERAF) for Coldwater Corals and Sponge Dominated Communities
Favaro, B., Rutherford, D.T., Duff, S.D. and Côté, I.M., 2010. Bycatch of rockfish and other species in British Columbia spot prawn traps: Preliminary assessment using research traps. Fisheries Research, 102(1), pp.199-206.
Ford J.K.B., A.L. Rambeau, R.M. Abernethy, M.D. Boogaards, L.M. Nichol, and L.D. Spaven. 2009. An Assessment of the Potential for Recovery of Humpback Whales off the Pacific Coast of Canada. DFO Can. Sci. Advis. Sec. Res. Doc. 2009/015. 33 p.
Grant N, Matveev E, Kahn AS, Archer SK and others. 2019. Effect of suspended sediments on the pumping rates of three species of glass sponge *in situ*. Mar Ecol Prog Ser 615:79-100.

Hannah, R.W., 2011. Variation in the distribution of ocean shrimp (Pandalus jordani) recruits: links with coastal upwelling and climate change. Fisheries Oceanography, 20(4), pp.305-313.
Hannah, R.W., Jones, S.A., Miller, W. and Knight, J.S., 2010. Effects of trawling for ocean shrimp (Pandalus jordani) on macroinvertebrate abundance and diversity at four sites near Nehalem Bank, Oregon. Fishery Bulletin, 108(1), pp.30-39.
Martell, S., Boutillier, J., Nguyen, H., Walters, C. 2000. Reconstructing the offshore Pandalus jordani fishery off the West Coast of Vancouver Island and simulating alternative management policies. Canadian Science Advisory Secretariat Science Advisory Report 2011/085. 40 pp.
Miller A, Chapman J, Dearden A, Ross P (Editor). 2020. Ocean Watch Átl'ka7tsem/Txwnéwu7ts/Howe Sound Edition 2020. Ocean Wise Research Institute, Ocean Wise Conservation Association, Vancouver, B.C., Canada. 388 pp. ISBN: 978-1-7772408-2-0 Available from: http://oceanwatch.ca

Ministry of Agriculture. 2016. Fast Stats 2015. British Columbia's Agrifood and Seafood Sector. 48 pp.
Ministry of Agriculture. 2017. British Columbia Seafood Industry. 2015 Year in Review. 20 pp.
National Marine Fisheries Service. September (NMFS). 2017. Recovery Plan for the Southern Distinct Population Segment of Eulachon (Thaleichthys pacificus). National Marine Fisheries Service, West Coast Region, Protected Resources Division, Portland, OR, 97232.

National Observer. Baker, R. 2020. Rescue team scrambling to find three distressed humpback whales on B.C. coast.

NMFS Stock Assessment Report (SAR). 2016. Humpback whale. (Megaptera novaeangliae): California/Oregon/Washington Stock. NOAA Fisheries. 7 pp.
NMFS. 2016. Fisheries of the United States 2015. 135 pp.
Owens, B. 2006. Ridgeback prawn. CDFW Review of the Fishery. 7 pp.
Poore, G., Ahyong, S. and Taylor, J. eds., 2011. The biology of squat lobsters (Vol. 20). CSIRO Publishing. 363 pp.
Rutherford, D., Barton, L., Clark, D. and Fong, K. 2013. Catch Composition Data from the British Columbia Commercial Shrimp Trawl Bycatch Monitoring Program, 2002-2011. Canadian Data Report of Fisheries and Aquatic Sciences 1246. Fisheries and Oceans Canada, Nanaimo BC. 120 pp.
Rutherford, D.T., Fong, K., and Nguyen, H. 2010. Rockfish Bycatch in the British Columbia Commercial Prawn Trap Fishery. DFO Can. Sci. Advis. Sec. Res. Doc.2009/109. iii, 25 pp.
Schweigert, J. Wood, C., Hay, D. et al. 2012. Recovery Potential Assessment of Eulachon (Thaleichthys pacificus) in Canada. DFO Research Document 2012/098. 212 pp.
Sea Around Us. 2017. Squat lobster.
Smith, M. 2008, Trapped by Uncertainty? A Decision Framework for Evaluating Escapement-Based Management Procedures for the Spot Prawn (Pandalus Platyceros) Fishery in Howe Sound, BC. Project 543. Simon Fraser University Master's Thesis. 86 pp.
Smith, Q., Gray, D., Woods, G. 2014. 2015 Annual Management Report for Southeast Alaska and Yakutat Shrimp Fisheries. Fishery Management Report No. 14-47. Alaska Department of Fish and Game. Division of Sport Fish and Commercial Fisheries. Juneau, AK. 85 pp.
Somers, K.A., Y.-W. Lee, J.E. Jannot, & J. McVeigh. 2016. Catch tables by sector: Pink shrimp trawl, 2004-2015. Last updated: 1 August 2016. NOAA Fisheries, NWFSC Observer Program, 2725 Montlake Blvd E., Seattle, WA 98112.
Sutherland, B.J.G., Candy, J., Mohns, K., Cornies, O., Jonsen, K., Le, K., Gustafson, R.G., Nichols, K.M., and Beacham, T.D. 2020. Population structure of eulachon *Thaleichthys pacificus* from Northern California to Alaska using single nucleotide polymorphisms from direct amplicon sequencing. *Canadian Journal of Fisheries and Aquatic Sciences* doi: 10.1139/cjfas-2020-0200.

Suuronen, P., 2005. Mortality of fish escaping trawl gears (No. 478). Food & Agriculture Org.
Tapella, F., Lovrich, G.A., Romero, M.C. and Thatje, S., 2002. Reproductive biology of the crab Munida subrugosa (Decapoda: Anomura: Galatheidae) in the Beagle Channel, Argentina. Journal of the Marine Biological Association of the United Kingdom, 82(4), pp.589-595.
Vancouver Sun. Pynn, L. 2016. Increase in humpback whales in B.C. waters results in record number of entanglements in fishing gear.

Appendix

Appendix A

Updates to the Canada Pacific Shrimp Report :
Updates to the March 5, 2018 BC Coldwater Shrimp report were made on October 6, 2021:

Overall Recommendations for coldwater shrimp caught by traps and bottom trawls in British Columbia remain unchanged, but individual criterion updates are outlined below.

C2.2 Corals and other biogenic habitats upgraded from "High" Concern to "Moderate" Concern because the sustainability of fishing mortality is unknown, but the fishery is managed in a way that reduces impact.