Monterey Bay Aquarium
Seafood Watch®

Pink shrimp, Sidestripe shrimp, Spot prawn

Pandalus jordani, Pandalopsis dispar, *Pandalus platyceros*

Image © Monterey Bay Aquarium

British Columbia

Bottom Trawl, Trap

March 5, 2014
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About Seafood Watch®

The Monterey Bay Aquarium Seafood Watch® program evaluates the ecological sustainability of wild-caught and farmed seafood commonly found in the North American 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. The program's mission is to engage and empower consumers and businesses to purchase environmentally responsible seafood fished or farmed in ways that minimize their impact on the environment or are in a credible improvement project with the same goal.

Each sustainability recommendation is supported by a seafood report. Each report synthesizes and analyzes the most current ecological, fisheries and ecosystem science on a species, then evaluates this information against the program's sustainability criteria to arrive at a recommendation of "Best Choice," "Good Alternative," or "Avoid." In producing the seafood reports, Seafood Watch utilizes 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 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 seafood reports will be updated to reflect these changes. Both the detailed evaluation methodology and the scientific reports, are available on seafoodwatch.org.

For more information about Seafood Watch and seafood reports, please contact the Seafood Watch program at Monterey Bay Aquarium by calling 1-877-229-9990 or visit online at seafoodwatch.org.

Seafood Watch and seafood reports are made possible through a grant from the David and Lucile Packard Foundation.

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 capture fisheries must possess to be considered sustainable by the Seafood Watch program:

- *Stocks are healthy and abundant.*
- *Fishing mortality does not threaten populations or impede the ecological role of any marine life.*
- *The fishery minimizes bycatch.*
- *The fishery is managed to sustain long-term productivity of all impacted species.*
- *The fishery is conducted such that impacts on the seafloor are minimized and the ecological and functional roles of seafloor habitats are maintained.*
- *Fishing activities should not seriously reduce ecosystem services provided by any fished species or result in harmful changes such as trophic cascades, phase shifts, or reduction of genetic diversity.*

Based on these guiding principles, Seafood Watch has developed a set of four sustainability **criteria** to evaluate capture fisheries for the purpose of developing a seafood recommendation for consumers and businesses. These criteria are:

1. Impacts on the species under assessment
2. Impacts on other species
3. Effectiveness of management
4. Habitat and ecosystem impacts

Each criterion includes:

- Factors to evaluate and score
- Evaluation guidelines to synthesize these factors and to produce a numerical score
- A resulting numerical score and **rating** for that criterion

Once a score and rating has been assigned to each criterion, an overall seafood recommendation is developed on additional evaluation guidelines. Criteria ratings and the overall recommendation are color-coded to correspond to the categories on the Seafood Watch pocket guide:

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

Best Choice/Green: Are well managed and caught or farmed in ways that cause little harm to habitats or other wildlife.

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

Avoid/Red: Take a pass on these for now. These items are overfished or caught or farmed in ways that harm other marine life or the environment.

Summary

This report focuses on the commercial coldwater shrimp fisheries of British Columbia. The following species of shrimp are reviewed: trap caught spot prawn (*Pandalus platyceros*), bottom trawl caught pink shrimp (*Pandalus jordani*), and bottom trawl caught sidestripe shrimp (*Pandalopsis dispar*). Northern shrimp (*P. borealis*), caught in the pink shrimp trawl fishery is sold as pink shrimp, so is not assessed. Coldwater shrimp from New England, and the US West Coast (including California, Washington and Alaska) are assessed in separate reports.

Spot prawns caught by trap are a **Best Choice**, while pink shrimp and sidestripe shrimp caught in trawls are all **Good Alternatives**.

All shrimp species assessed score as 'green' for Criteria 1: Impacts on the stock. For Criteria 2: Impacts on other species, trawl caught pink and sidestripe shrimp score as 'red', while trap caught spot prawn score as 'yellow'. Although shrimp comprise greater than 85 percent of the multi-species shrimp trawl catch, bycatch mortality of Pacific eulachon (*Thaleichthys pacificus*), classified as an endangered species according to the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), may hamper the species' recovery. While several species of rockfish are caught as bycatch in the prawn trap fishery, including the threatened quillback rockfish, this bycatch mortality is of very low concern due to the comparatively high mortality of this species in the directed groundfish fishery. Criteria 3: Management Effectiveness, scores as "green" for all assessed species due to moderately and highly effective scores for harvest and bycatch management strategy categories. Criteria 4: Impacts on the Habitat and Ecosystem, scores as "yellow" across all assessed species. Both trap and trawls are set over moderately sensitive habitats, but the Department of Fisheries and Oceans (DFO) limits fishing in highly sensitive areas.

Table of Conservation Concerns and Overall Recommendations

Stock	Fishery	Impacts on the Stock Rank (Score)	Impacts on other Species Lowest scoring species Rank*, Subscore, Score	Manage-ment Rank Score	Habitat and Ecosystem Rank Score	Overall Recommendation Score
Pink shrimp	British Columbia Trawl	Green 5	Eulachon Red, 1.53,1.53	Green 4.47	Yellow 2.74	**GOOD ALTERNATIVE 3.11**
Sidestripe shrimp	British Columbia Trawl	Green 5	Eulachon Red, 1.53,1.53	Green 4.47	Yellow 2.74	**GOOD ALTERNATIVE 3.11**
Spot prawn	British Columbia Trap	Green 5	Quillback rockfish Yellow, 2.24,2.12	Green 4.47	Yellow 2.74	**BEST CHOICE 3.37**

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, **and** neither Harvest Strategy (Factor 3.1) nor Bycatch Management Strategy (Factor 3.2) are Very High Concern[2], **and** no more than one Red Criterion, **and** no Critical scores, **and** does not meet the criteria for Best Choice (above)
- **Avoid/Red** = Final Score <=2.2, **or** either Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern [2], **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).

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Introduction

Scope of the analysis and ensuing recommendation

This report focuses on the commercial coldwater shrimp fisheries of British Columbia, Canada. Three species of shrimp are reviewed: spot prawn (*Pandalus platyceros*) caught by trap, pink shrimp (*Pandalus jordani*) caught by bottom trawl and sidestripe shrimp (*Pandalopsis dispar*) caught by bottom trawl. Northern shrimp (*Pandalus borealis* also known as *Pandalus borealis eous* and *Pandalus eous*) is caught in the pink shrimp trawl fishery and sold as pink shrimp, so is assessed collectively with pink shrimp in this report.

Production statistics and importance to the US/North American market

Shrimp is the most popular seafood item in the US, exceeding that of even tuna and salmon. Americans consume more shrimp than any other country (4 pounds per person annually), far more than is harvested from within US borders. The US is the world's top shrimp importer.

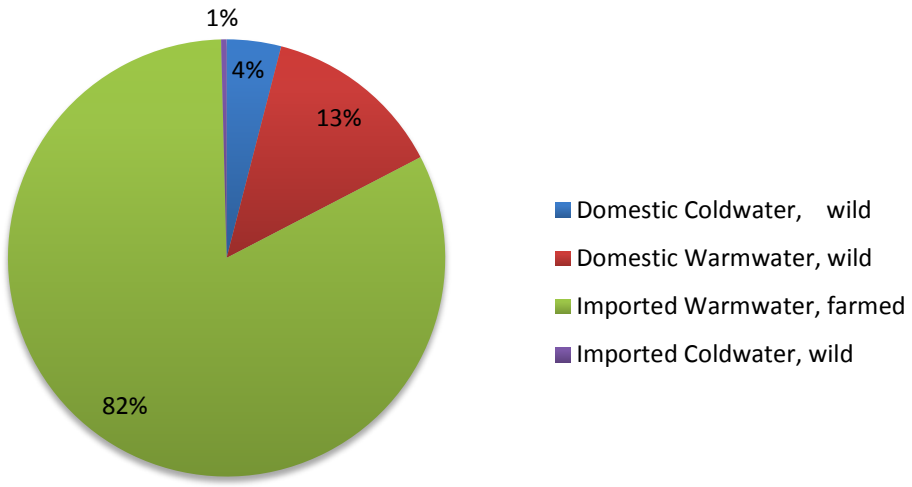

Figure 1. Domestic coldwater shrimp are harvested from the Atlantic and Pacific Oceans. Warm water shrimp are harvested from the Gulf of Mexico and South Atlantic Ocean. Nearly all imports are of warm water shrimp (which are primarily farmed); the small amount of coldwater shrimp imports comes from Canada (NOAA Fisheries 2011).

Coldwater shrimp constitute a small percentage of the total US shrimp supply (Figure 1). All coldwater shrimp are wild caught. Canada, Argentina and Denmark are the highest volume importers of coldwater shrimp to the US (the majority is from Canada), with lesser volumes imported by Chile, Greenland, Japan, Germany, the Netherlands, Spain and New Zealand. North American coldwater shrimpers face market competition from imported farmed shrimp (warm water), largely from Asia. The impact of the globalization of shrimp, coupled with insatiable

American demand, has had profound effects. The market value, quality and sources of supply have dramatically changed, with implications for American fishermen, consumers and US trade.

Within the North American coldwater shrimp market, Eastern Canada is the largest producer (Figures 2 and 3). Industrial factory freezer trawls operate year-round, providing a constant supply of shrimp to the processors, allowing them to undersell competitors. Major setbacks around the turn of the century have been two-fold: 1) an overall decrease in the size of shrimp landed, and 2) explosive growth in the aquaculture industry (warm water shrimp). The effect was dramatic—the price of shrimp halved, forcing fishermen to make up the price difference by attempting to sell even more product. Consequently, shrimp has moved from a luxury food item, to a premium product, to a lower-priced commodity where it remains today (DFO 2010a).

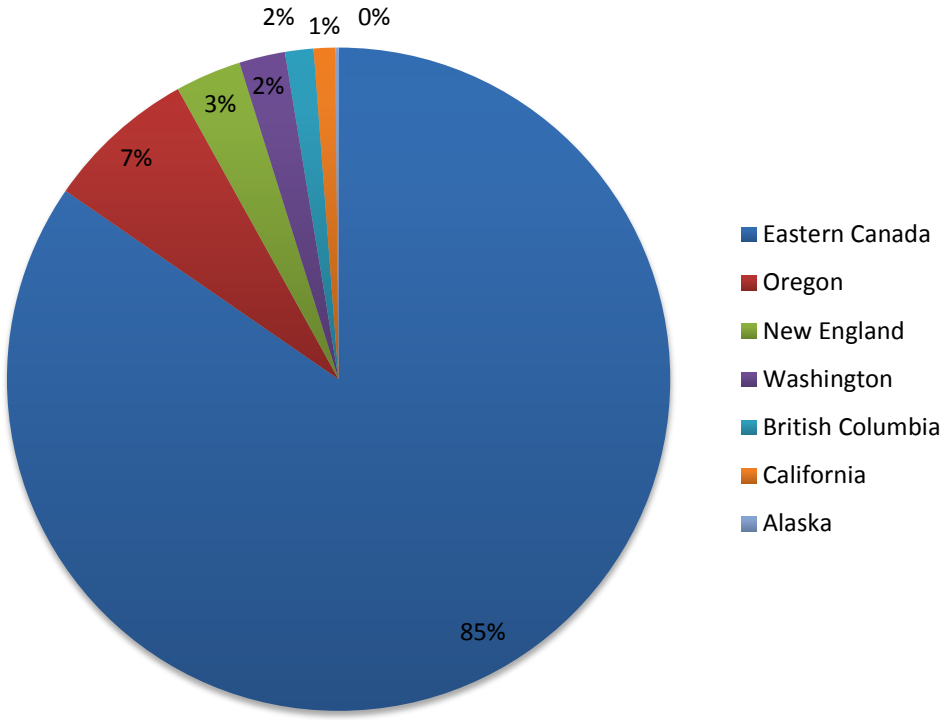

Figure 2. 2010 US and Canadian landings include all species of coldwater shrimp combined (NOAA Fisheries 2011).

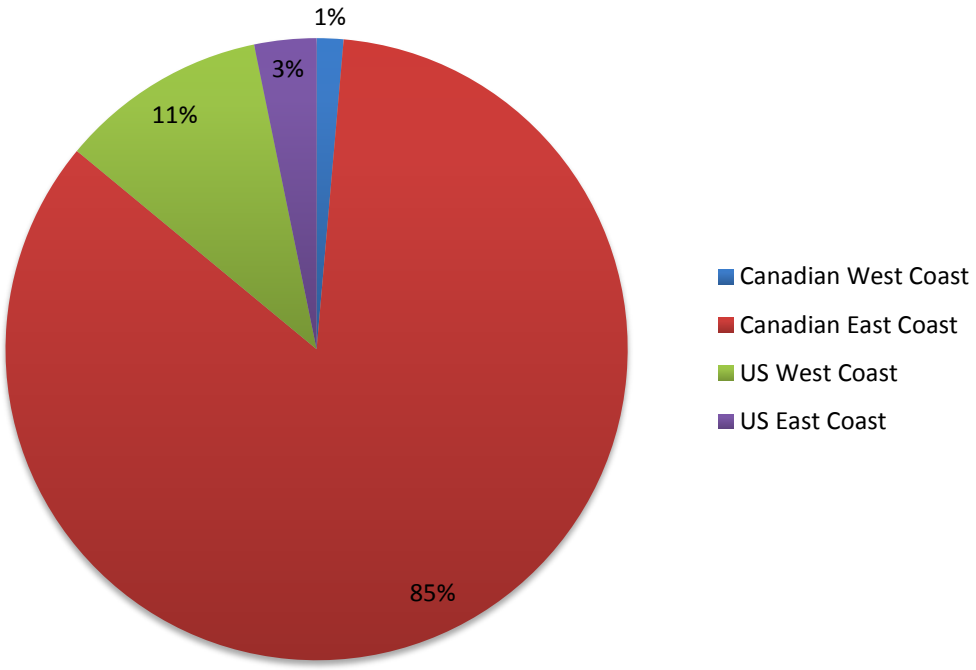

Figure 3. 2010 coldwater shrimp landings by coastal region: Eastern Canada and the Western US are the most productive shrimp regions in North America (NOAA Fisheries 2011).

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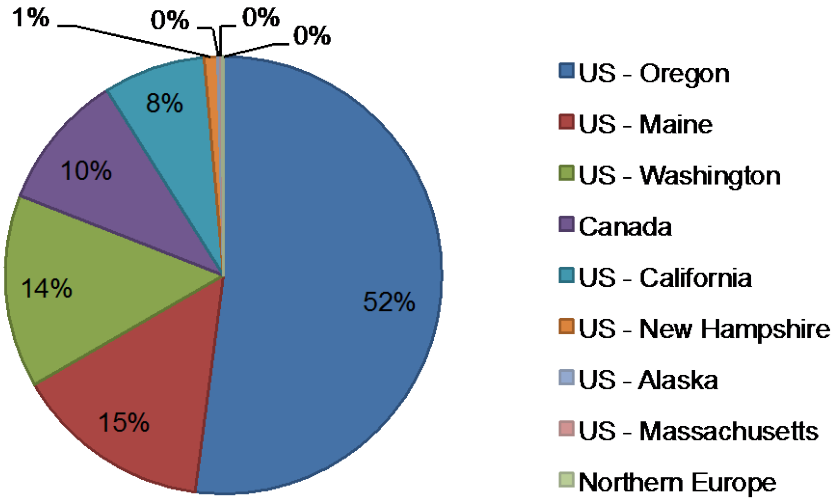

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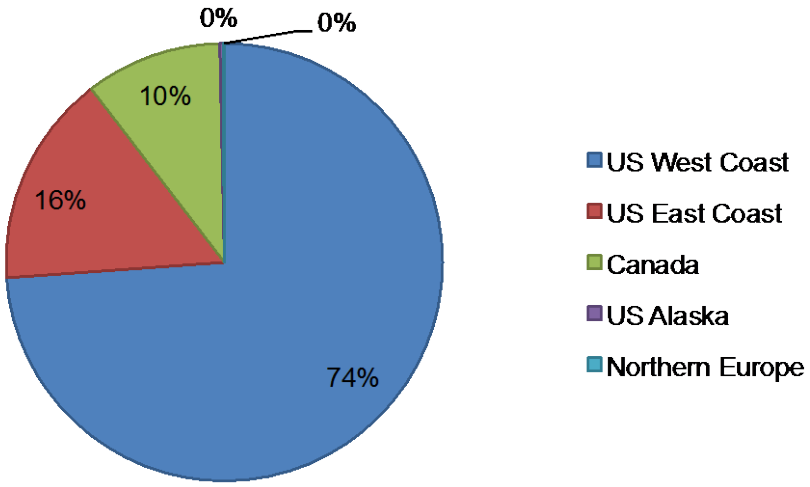
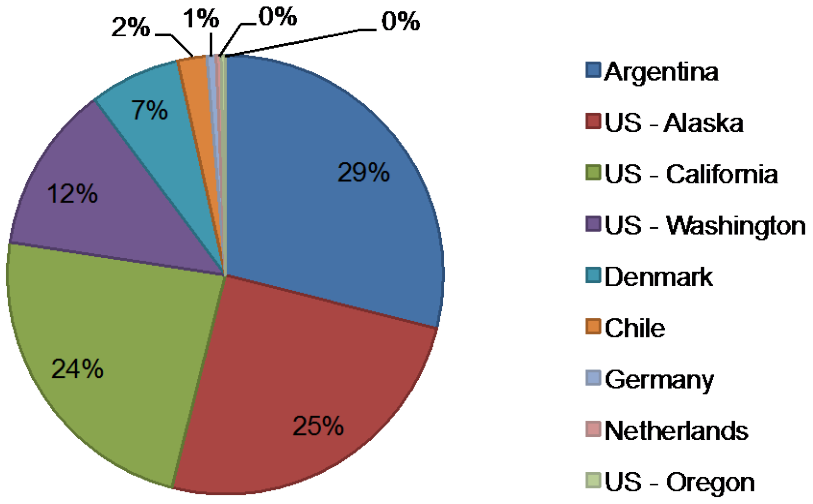


Figures 4a and 4b. Origin of lower-priced coldwater shrimp (including northern, pink and striped shrimp) available on the US market (based on data from 2009-2011) by a) state/country, b) region (NMFS 2013e, CDFG 2013c, ODFW 2011, Q. Smith ADFW). Note: Canadian shrimp are primarily of East Coast origin.

5a)



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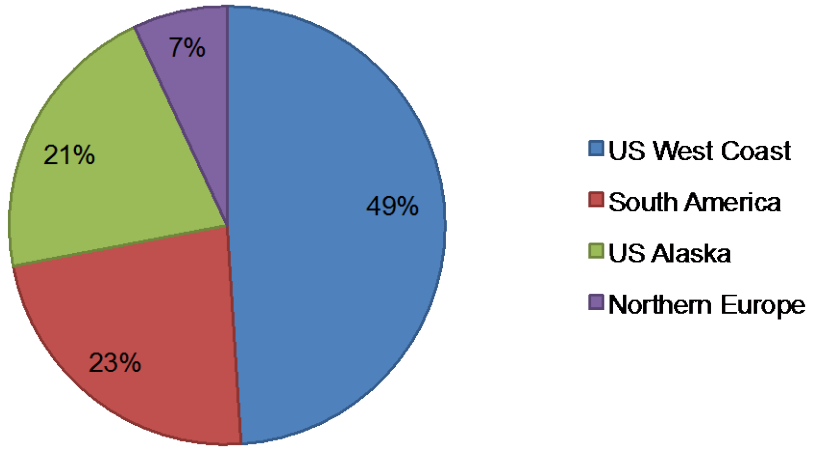

Figures 5a and 5b. Origin of higher-priced coldwater shrimp (including dock/coonstripe, sidestripe and coonstripe shrimp and spot and ridgeback prawns from the US, Argentine red shrimp from South America, and brown shrimp from the North Sea) available on the US Market (based on data from 2009-2011) by a) U.S. state/country, b)region (NMFS 2013e, CDFG 2013c, ODFW 2011, Q. Smith ADFW).

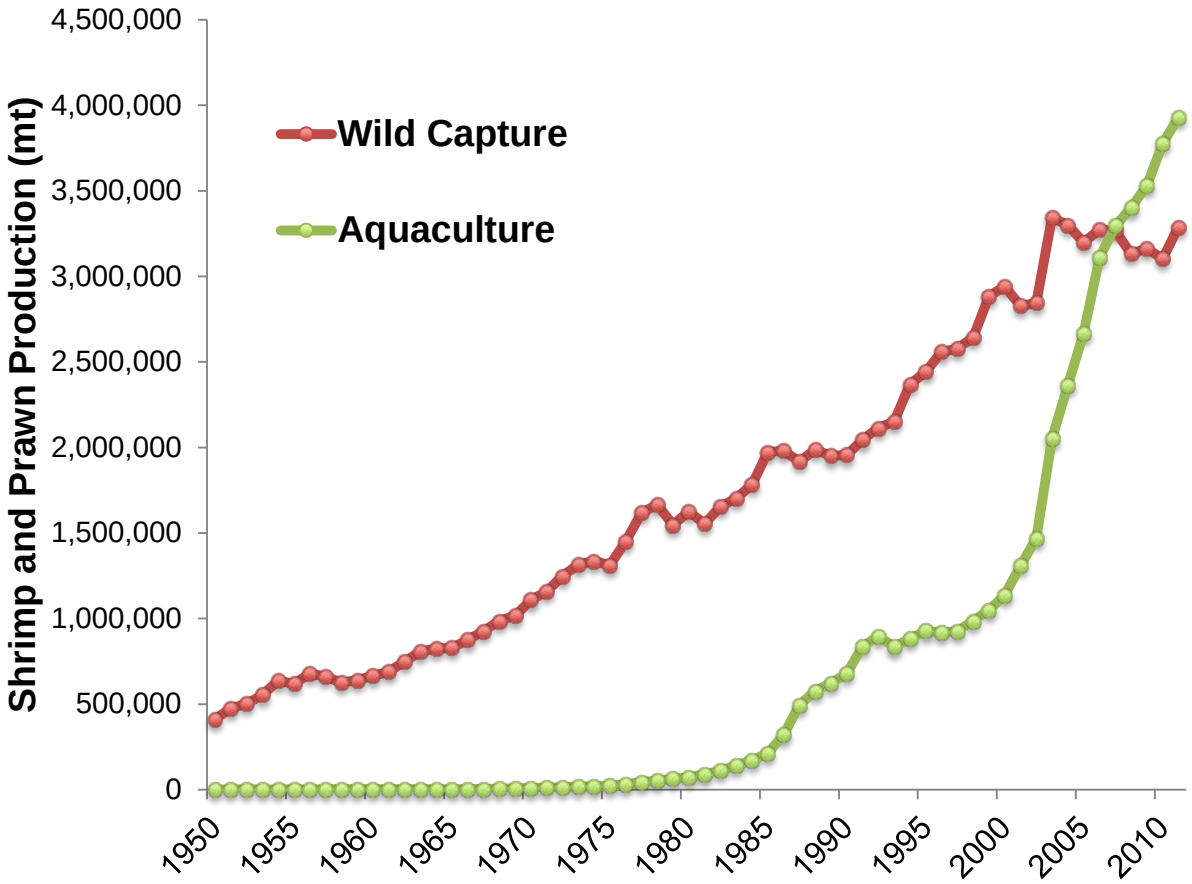

Figure 6. Global shrimp production, all species, wild captured and farmed 1950-2011. Based on data sourced from the FishStat database (FAO 2013a, FAO 2013b).

This state of affairs has effectively put many fishermen out of business. British Columbia, whose trawl fleet is comprised of small vessels fishing only part of the year, cannot compete. In 2011, only 45 of 243 fishing licenses were active and the last processor is no longer active. One advantage that remains is their final products are of higher quality. Shrimp are hand-peeled (due to a lack of processors) and thus better preserved. They also land species, like sidestripe shrimp, that are naturally larger. Although these products sell for more money than those from Eastern Canada and Oregon, there doesn't seem to be enough demand (D. Clark, DFO, pers. comm.).

The trap fishery, by contrast, is much more lucrative because it is a higher quality product. Traps inflict no physical damage to the shrimp during harvesting, unlike trawls, and are hand-peeled and can even be retained live. The most commonly landed species are spot prawns, which are also the largest coldwater species commercially available. Their current market value is approximately USD$5.50 - $10.79/ lb., many times more than trawl harvested shrimp (DFO 2012b, Reilly, CDFG, pers.com.).

Common and market names

Common names vary by region, but this report will adhere to the nomenclature listed here (Table 1). Market names for most seafood items including shrimp can vary wildly.

Primary product forms are either raw or cooked and include the following options, depending on the species and its size:

- Frozen block whole, Frozen block peeled (machine or hand), Frozen IQF (individual quick frozen), Fresh, Live

Overview of the species and management bodies

More than 3,000 species of shrimp exist worldwide, of which approximately 40 species are harvested for commercial purposes. In the United States, coldwater shrimp are harvested both in areas closer to land (within state jurisdiction) and further offshore (within federal jurisdiction) (see Table 1). Typically, species are managed by either the state or the federal government depending upon their harvest location. In the case of coldwater shrimp, the states have sole management responsibility. However, observer programs for the pink shrimp fishery are managed federally. This report reviews management of the various coldwater shrimp species landed state-by-state.

Table 1. Coldwater and U.S. West 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 U.S./Canada	Scientific name	Range	U.S./Canadian fishery location	Sources
Atlantic				
Northern shrimp, pink shrimp, great northern prawn, salad shrimp, Pacific pink shrimp (P. *eous*)	*Pandalus borealis*	Gulf of Maine to North Sea	Baffin Bay to Gulf of Maine	Bergstrom 2000, DFO 2003
Striped shrimp	*P. montagui* (*P. tridens*)	Gulf of Maine to North Sea and 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)	N/A	
Argentinean shrimp	*Pleoticus muelleri*	Southwest Atlantic.		
Pacific				
***Northern shrimp**, pink shrimp, great northern shrimp, salad shrimp, Pacific pink shrimp (*P. eous*)	*P. eous, or P. borealis eous* also referred to as *P. borealis* (Pacific version of *P. borealis*)	Washington to Russia, patchy distribution off California and Japan	Davis straight off Labrador to the Gulf of Maine	Bergstrom 2000, CDFG 2001, Hannah and Jones 2003
***Pink shrimp,** ocean shrimp, smooth pink shrimp, ocean pink shrimp, Oregon pink shrimp	*P. jordani*	Aleutian Islands to Baja California	Vancouver Island, B.C. to Point Arguello, California	
***Spot prawn**, spot shrimp, spot, prawn	*P. platyceros*	Gulf of Alaska to Baja California, and off Japan	Alaska to southern California	
Pacific ridgeback prawn	*Sicyonia ingentis*	Monterey to Baja California	Santa Barbara area	
Coonstripe shrimp, humpback shrimp, king shrimp	*P. hypsinotus*	Washington to Japan	Primarily incidental in other shrimp fisheries.	
Striped shrimp	*P. montagui* (*P. tridens*)	California to Japan		
Rough patch shrimp	*P. stenolepsis*	Alaska to Washington.		
Humpy shrimp	*P. goniurus*	Washington to Northern Japan		
Dock shrimp (Oregon, Alaska, Canada), coonstripe shrimp (California)	*P. danae*	British Columbia to Baja California		
***Sidestripe shrimp**	*P. dispar*	North America west coast nearshore		
Generally not for human consumption				
Bay shrimp, Pacific bay shrimp, California bay shrimp, grass	*Crangon franciscorum*	Alaska to Southern California	San Francisco area	CDFG 2001, and

shrimp	(primarily)			online sources
Red rock shrimp	*Lysmata californica*	Santa Barbara to Baja California		
Blue mud shrimp, crawfish, mud prawn, ghost shrimp, and mud shrimp	*Upogebia pugettensis*	Alaska to Baja California.		
Ghost shrimp, Pacific intertidal shrimp, crawfish, mud prawn, burrowing shrimp, red ghost shrimp, and orange mud shrimp	*Callianassa californiensis*	Alaska to Baja California.		
Brine shrimp, sea monkey, fairy shrimp	*Artemia salina*, *A. franciscana*	Salty lakes in Utah and West Coast states		

Overview of the species and management bodies

The British Columbia shrimp trawl fishery takes place in both inshore and offshore regions of British Columbia and Vancouver Island and is managed by the Department of Fisheries and Oceans (DFO). The primary species landed include pink, northern, and sidestripe shrimp. Historical records indicate shrimp was harvested by trawl beginning in the late 19th Century, but this fishery did not really develop until the 1960s, when the salmon and halibut fisheries plummeted. Landings peaked in 1995/96, again at a time of further reduction in the salmon and groundfish fisheries (DFO 2012d).

The DFO in British Columbia manages the commercial shrimp trawl fishery via 36 different Shrimp Management Areas (SMAs), each of which is assessed and managed separately (Figure 7). This multispecies fishery is dominated by pink shrimp but other species such as northern shrimp are also caught depending on the SMA. These species are assessed separately, but managed under one Total Allowable Catch (TAC) and sold together, all under the common name of pink shrimp (D. Clark, DFO, pers. comm.). Consequently, this report shall refer to these species as pink shrimp, with the understanding that this may include additional species beyond *P. jordani*. Sidestripe shrimp are assessed separately and sold separately, so this report will assess sidestripe shrimp as well.

The current fleet is greatly reduced in size, with only about 19% of licensed vessels actively fishing. Effort is concentrated in southern waters, closest to shore. Most vessels are beam trawls, less than 100 ft. in length (DFO 2012d).

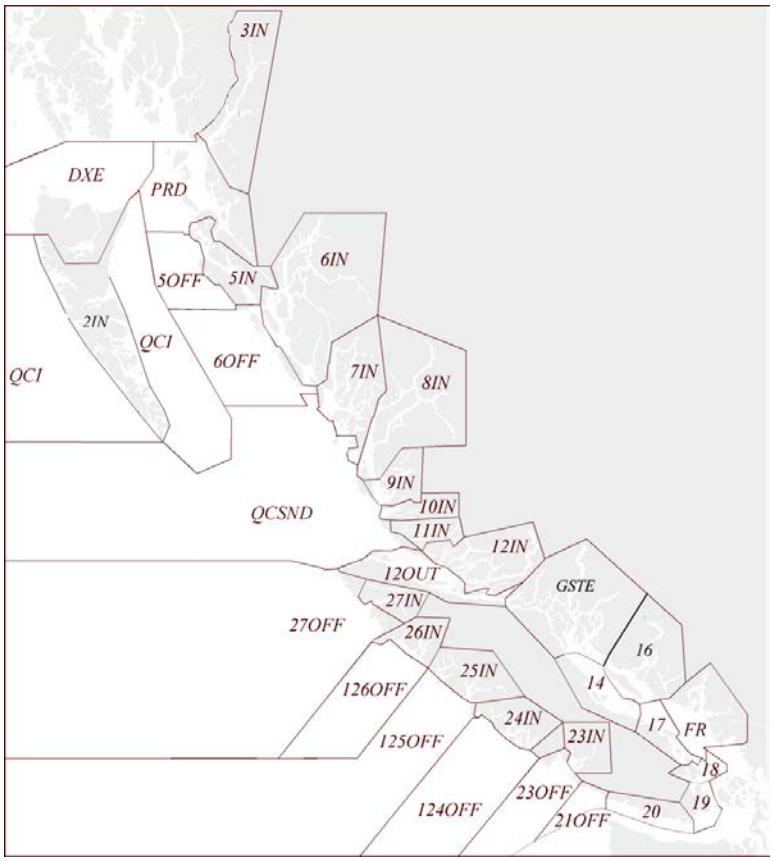

Figure 7. Shrimp Management Areas (SMAs) defined for the shrimp trawl fishery (DFO 2012d).

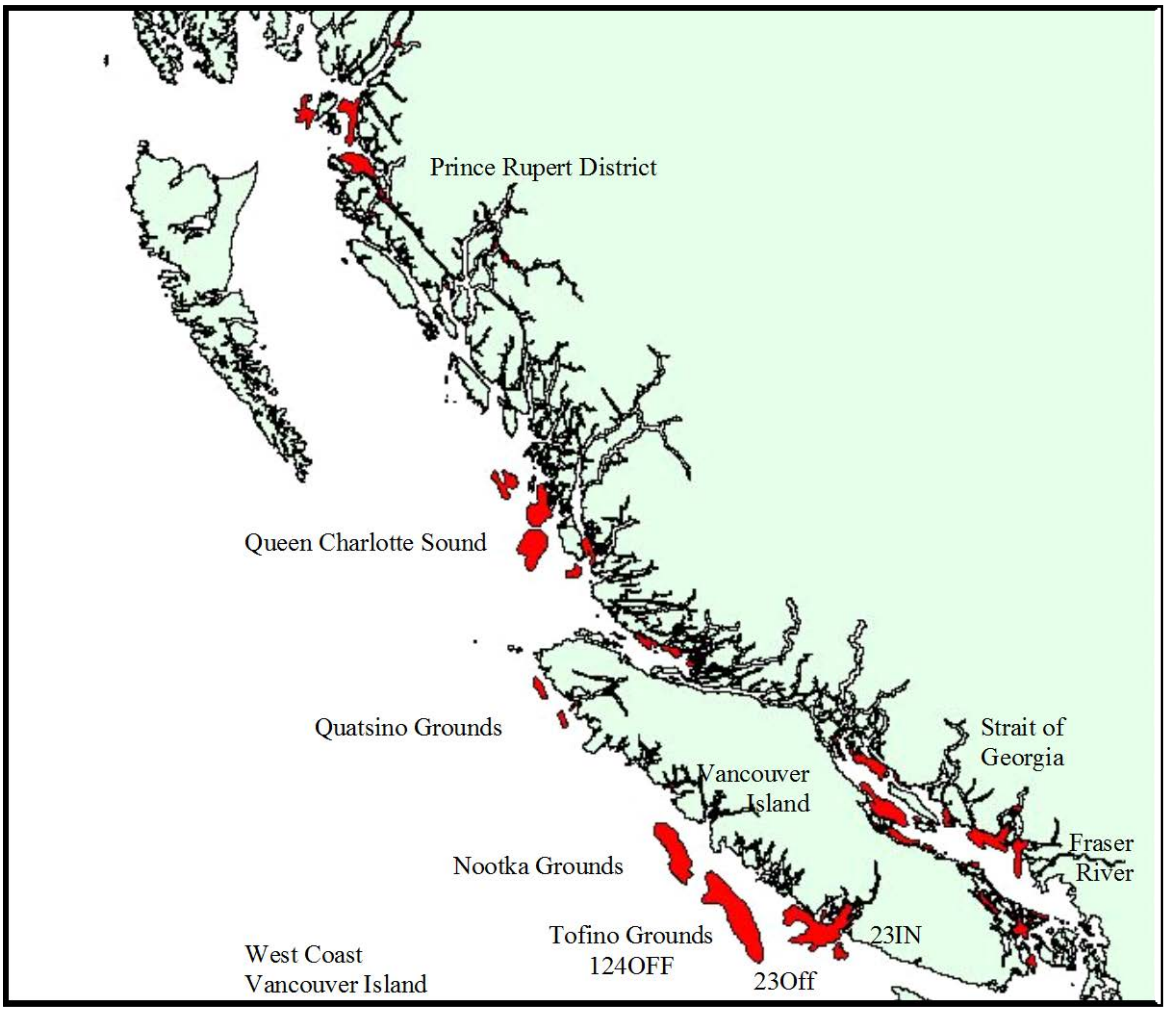

Figure 8: Areas of highest production for pink and sidestripe shrimp (from DFO 2013b)

The trap fishery, which is managed on a Pacific Fishery Management Area (PFMA) sub-area level (Figure 9), is also a multispecies fishery, whereby up to four different species of shrimp may be retained if caught. However, more than 90% of the landings in the trap fishery come from spot prawns (*Pandalus platyceros*) (DFO 2012e). Therefore this will be the only species assessed.

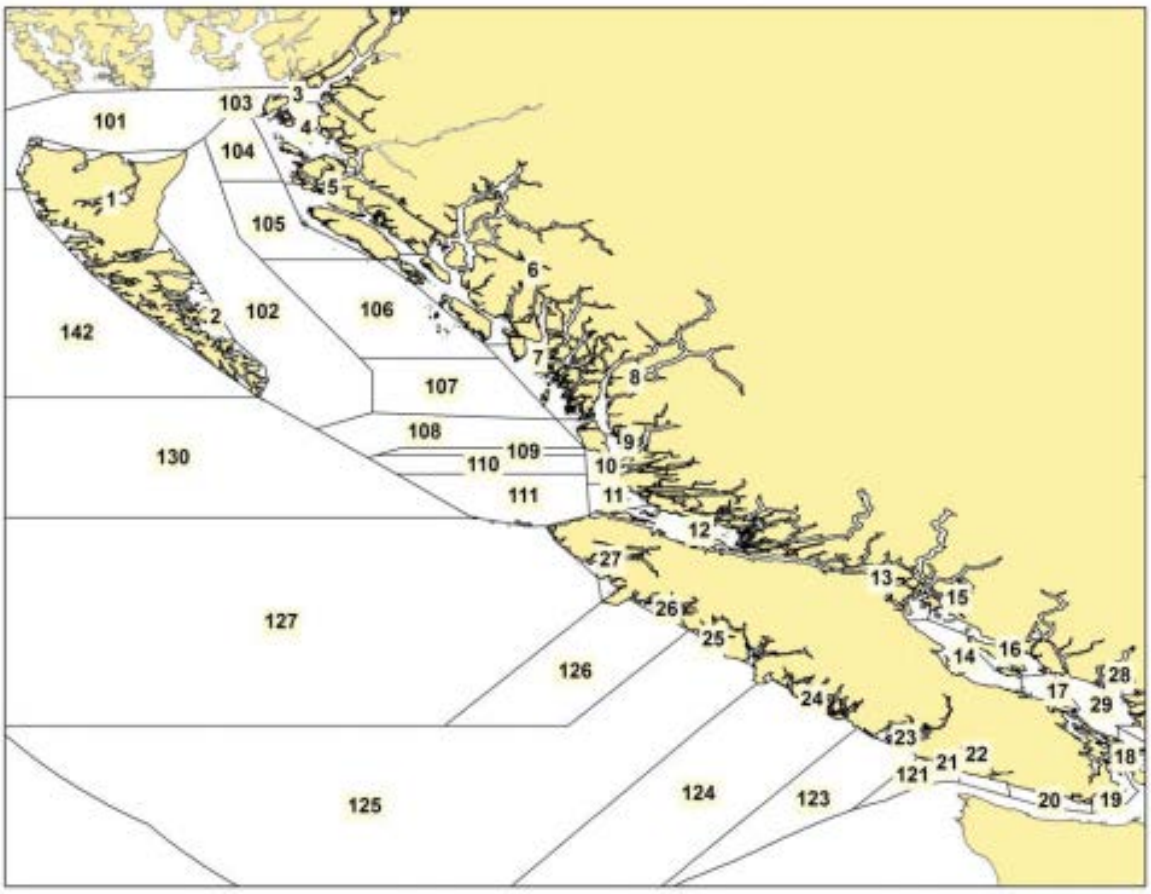

Figure 9: Map of fishing areas (Pacific Fishery Management Areas) (DFO 2013b).

Assessment

Scoring Guide

- All scores result in a zero to five final score for the criterion and the overall final rank. A zero score indicates poor performance, while a score of five indicates high performance.
- The full Seafood Watch Fisheries Criteria that the following scores relate to are available on our website at http://www.seafoodwatch.org

Criterion 1: Impacts on the Species under Assessment

This criterion evaluates the impact of fishing mortality on the species, given its current abundance. The inherent vulnerability to fishing rating influences how abundance is scored, when abundance is unknown. 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.

Criterion 1 Summary

Stock	Fishery	Inherent Vulnerability Score	Stock Status Score	Fishing Mortality Score	Criterion 1 Score
Pink shrimp	British Columbia Trawl	Low	Very Low Concern (5)	Low Concern (3.67)	Green
Sidestripe shrimp	British Columbia Trawl	Low	Very Low Concern (5)	Low Concern (3.67)	Green
Spot prawns	British Columbia Trap	Low	Very Low Concern (5)	Very Low Concern (5)	Green

Criterion 1 Assessment

Factor 1.1 — Inherent Vulnerability

Scoring guidelines

- *Low—The FishBase vulnerability score for species is 0-35, OR species exhibits life history characteristics that make it resilient to fishing, (e.g., early maturing (<5 years), short lived (< 10 years), small maximum size, and low on food chain).*

- *Medium—The FishBase vulnerability score for species is 36-55, OR species exhibits life history characteristics that make it neither particularly vulnerable nor resilient to fishing, (e.g., moderate age at sexual maturity (5-15 years), moderate maximum age (10-25 years), moderate maximum size, and middle of food chain).*

  High—The FishBase vulnerability score for species is 56-100, OR species exhibits life history characteristics that make is particularly vulnerable to fishing, (e.g., long-lived (>25 years), late maturing (>15 years), low reproduction rate, large body size, and top-predator).

  Note: The FishBase vulnerability scores is an index of the inherent vulnerability of marine fishes to fishing based on life history parameters: maximum length, age at first maturity, longevity, growth rate, natural mortality rate, fecundity, spatial behaviors (e.g., schooling, aggregating for breeding, or consistently returning to the same sites for feeding or reproduction) and geographic range.

Factor 1.2 — Abundance

Scoring guidelines

- *5 (Very Low Concern)—Strong evidence exists that the population is above target abundance level (e.g., biomass at maximum sustainable yield, BMSY) or near virgin biomass.*

- *4 (Low Concern)—Population may be below target abundance level, but it is considered not overfished*

- *3 (Moderate Concern) —Abundance level is unknown and the species has a low or medium inherent vulnerability to fishing.*

- *2 (High Concern)—Population is overfished, depleted, or a species of concern, OR abundance is unknown and the species has a high inherent vulnerability to fishing.*

- *1 (Very High Concern)—Population is listed as threatened or endangered.*

Factor 1.3 - Fishing Mortality

Scoring guidelines

- *5 (Very Low Concern)—Highly likely that fishing mortality is below a sustainable level (e.g., below fishing mortality at maximum sustainable yield, FMSY), OR fishery does not target species and its*

contribution to the mortality of species is negligible (≤ 5% of a sustainable level of fishing mortality).

- *3.67 (Low Concern)—Probable (>50%) chance that fishing mortality is at or below a sustainable level, but some uncertainty exists, OR fishery does not target species and does not adversely affect species, but its contribution to mortality is not negligible, OR fishing mortality is unknown, but the population is healthy and the species has a low susceptibility to the fishery (low chance of being caught).*
- *2.33 (Moderate Concern)—Fishing mortality is fluctuating around sustainable levels, OR fishing mortality is unknown and species has a moderate-high susceptibility to the fishery and, if species is depleted, reasonable management is in place.*
- *1 (High Concern)—Overfishing is occurring, but management is in place to curtail overfishing, OR fishing mortality is unknown, species is depleted, and no management is in place.*
- *0 (Critical)—Overfishing is known to be occurring and no reasonable management is in place to curtail overfishing.*

Pink Shrimp and Sidestripe Shrimp

Factor 1.1 Inherent Vulnerability score**: Low**
All coldwater shrimp species are considered to have low inherent vulnerability.

Rationale:

Factor	All Coldwater Shrimp	Score	Source
Average age at maturity	< 5 yrs.	3	(Bergstrom 2000) (Cadrin 2004)
Average maximum age	< 10 yrs.	3	
Reproductive strategy	Broadcast spawner	3	
Density dependence	Compensatory dynamics at low population sizes demonstrated or likely	3	
Score (mean of factor scores)		3	

Factor 1.2 Abundance score: **Low Conservation Concern**
Stock assessments are performed annually and estimates of total biomass are based on fishery independent surveys of pink and sidestripe shrimp. Results indicating biomass and abundance trends are published in-season in Shrimp Survey Bulletins. Assessments determine whether shrimp within an SMA are in the healthy zone, cautious zone, or critical zone (Fig 10). These zones are defined by an upper stock reference (USR) point and a limit reference point (LRP). Stocks that are above the USR are considered healthy, those that fall between the USR and LRP

are considered cautious, and stocks that fall below the LRP are deemed critical and immediately closed. SMAs are not reopened until assessments determine the stock is out of the critical zone.

The most recently published assessment found that the majority of the SMAs assessed were in the healthy zone (9 healthy, 3 cautious, and 1 critical) (DF0 2011b). This is indicative of the biomass estimate generally being above an appropriate target reference point. Although not all of the SMAs are healthy, given that most are and that the critical SMA was immediately closed (i.e. critical populations are not fished), a score of Low Conservation Concern is appropriate.

Factor 1.3 Fishing mortality: **Very Low Conservation Concern**
Provisional harvest control rules (PHCRs) that incorporate the precautionary approach were developed using an upper stock reference point (80% B_{msy}) and a limit reference point (40% B_{msy}) (see Table 2). The PHCR is currently set at 35% of the estimated total biomass, thus protecting a large portion of the stock.

The Total Allowable Catch (TAC) is defined and set annually based on the results of the stock assessments, which form the biological basis for these catch ceilings. If a TAC for any species is reached during the fishing season, the fishery is closed, making it likely that fishing mortality is at or below a sustainable level. In 2010, only two of the 36 SMAs were assessed as below the limit reference point and were closed to fishing (DFO 2011b).

Overall, fishing effort in the trawl fishery across SMAs has dramatically declined over time and is currently only 12% of 2005 effort (Schweigert 2012) and is well below the TAC.

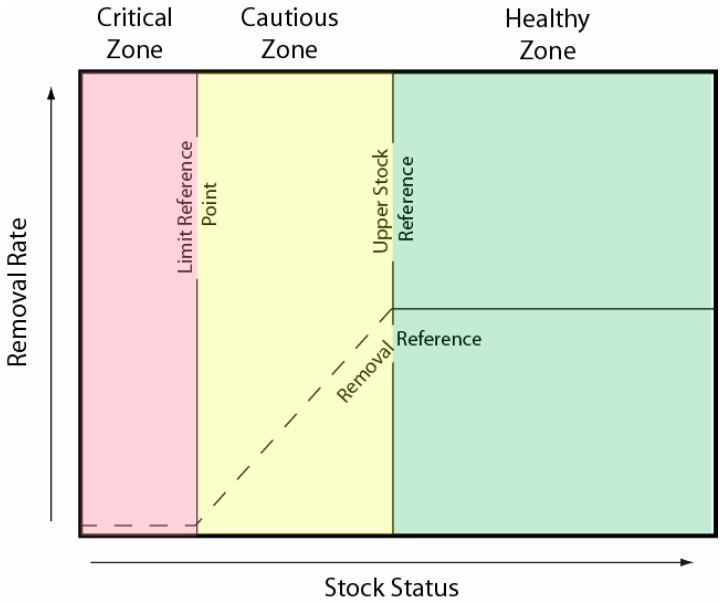

Figure 10. Adjustments to Removal Rate (harvest rate) when Stock Status is in Critical (zero), Cautious (0 to 35%) or Healthy Zone (35%). Healthy and Cautious zone is delineated by Upper stock reference point. Cautious and Critical zone delineated by Limit Reference Point (DFO 2012d).

Table 2. The estimated total biomass (B_{prox}), limit reference point (LRP) and upper stock reference point (USR) for pink and sidestripe shrimp within various SMAs. (DFO 2012d).

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*)

Spot Prawn

Factor 1.1 Inherent Vulnerability score: **Low**

All coldwater shrimp species are considered to have low inherent vulnerability.

Rationale:

Factor	All Coldwater Shrimp	Score	Source
Average age at maturity	< 5 yrs.	3	(Bergstrom 2000) (Cadrin 2004)
Average maximum age	< 10 yrs.	3	
Reproductive strategy	Broadcast spawner	3	
Density dependence	Compensatory dynamics at low population sizes demonstrated or likely	3	
Score (mean of factor scores)		3	

Factor 1.2 Abundance score: **Very Low Conservation Concern**
Spot prawns are assessed with an escapement-based model to ensure adequate spawning takes place each year (Boutillier 2000). Growth and mortality parameters for the model are determined each year from both fishery dependent and independent data. It is a standardized catch per unit effort (CPUE) model based on ensuring a minimum number of female spawners are available at time of egg hatch, which normally occurs around the end of March (DFO 2013a). Annual commercial landings are considered a reasonable proxy of total abundance. Overall landings have generally increased since 1990 (DFO 2012e), and current biomass is estimated to be above the target reference point.

Factor 1.3 Fishing mortality score: **Very Low Conservation Concern**
As discussed above, target reference points are generated each year. In-season monitoring of catch per unit of effort allows managers to determine when this point is reached and close the fishery to protect spawning females, making it highly likely that fishing mortality is at or below a level that does not hinder recovery (DFO 2012e). Once the fishery is closed for the season (based on when the spawner index level is reached), the area remains closed to commercial fishing to the end of the spawning cycle and the opening date of the commercial season the following year (DFO 2013a).

Criterion 2: Impacts on Other Species

All main retained and bycatch species in the fishery are evaluated in the same way as the species under assessment were evaluated in Criterion 1. 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.

To determine the final Criterion 2 score, the score for the lowest scoring retained/bycatch species is multiplied by the discard rate score (ranges from 0-1), which evaluates the amount of non-retained catch (discards) and bait use relative to the retained catch. The Criterion 2 rating is determined as follows:

- *Subscore >3.2=Green or Low Concern*
- *Subscore >2.2 and <=3.2=Yellow or Moderate Concern*
- *Subscore <=2.2=Red or High Concern*

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

Criterion 2 Summary

Only the lowest scoring main species is/are listed in the table and text in this Criterion 2 section; a full list and assessment of the main species can be found in Appendix B.

Trawl

Stock	**Inherent Vulnerability** Rank	**Stock Status** Rank (Score)	**Fishing Mortality** Rank (Score)	**Subscore**	**Score** (subscore*discard modifier)	**Rank** (based on subscore)
Eulachon	Low	Very High Concern (1)	Moderate Concern (2.33)	1.53	1.53	Red
Pink shrimp	Low	Very Low Concern (5)	Very Low Concern (5)	5.00	5.00	Green
Sidestripe shrimp	Low	Very Low Concern (5)	Very Low Concern (5)	5.00	5.00	Green

Trap

Stock	**Inherent Vulnerability** Rank	**Stock Status** Rank (Score)	**Fishing Mortality** Rank (Score)	**Subscore**	**Score** (subscore*discard modifier)	**Rank** (based on subscore)
Quillback rockfish	High	High Concern (2)	Low Concern (3.67)	2.71	2.57	Yellow
Spot prawns	Low	Very Low Concern (5)	Very Low Concern (5)	5.00	5.00	Green

Criterion 2 Assessment

Trawl fishery

While there is an observer program for the otter and beam shrimp trawl fishery, coverage is very limited in many years and/or SMAs. Rutherford (2013) sums the data from the program across the years 2002-2011, but cautions that the data need evaluation as to their suitability for estimating total, species specific, catch of non-target species for each SMA. These data do present the only information available, however, and so will be used as the basis for this assessment. Summing available observed catch composition data across years (2002-2011) and SMAs, shrimp make up the vast majority (>85%) of the catch in both beam and otter trawls (Rutherford 2013). According to the Integrated Fisheries Management Plan (IMFP), 6 species may be retained. In addition to the 3 we cover in this report for the trawl fishery (pink, sidestripe and northern shrimp), spot prawns (*Pandalus platyceros*), coonstripe (*Pandalus danae*), and humpback (*Pandalus hypsinotus*) may also be retained (although these 3 are never targeted). Actual catch composition is highly variable across SMA, years, and gear types (beam trawl vs otter trawl), both for the composition of the shrimp catch and the catch of other species. Summed data indicate over 200 species or species groups are caught in the shrimp trawl fishery across the SMAs and years observed (Appendix I). Given the categories used and the very low observer coverage in many years and SMAs (Olsen 2000, Rutherford 2013), the total number of species caught is unknown, but is clearly in the hundreds. This includes many species of groundfish, but in lieu of better data this assessment assumes that the majority of fishing mortality of those species is in the region's groundfish fisheries and that the species most likely to be affected as bycatch in the fishery is the Pacific eulachon (*Thaleichthys pacificus*), an anadromous smelt that occurs from Northern California to the Bering Sea.

Factor 2.1 Inherent Vulnerability score: **Low**
Eulachon have a low vulnerability score of 33 on FishBase.

Factor 2.2 Abundance status score: **Very High Conservation Concern**
Eulachon's stock status is currently under review for the Species at Risk Act (SARA) listings. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) has identified two

populations or DUs as 'Endangered', (Fraser River and Central Pacific Coast DUs) and a third population as 'Special Concern' (Nass/Skeena Rivers DU) (COSEWIC 2013). The SARA listings under consideration are also by these three DUs (Fraser R., Central Pacific Coast and Nass/Skeena R.), with the same statuses as the current COSEWIC listings.

Rationale:

Approximately 15 of the likely 20 spawning populations are in BC (Rutherford 2013). In the mid 2000's eulachon populations declined throughout the species' range. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) listed two designated units (DUs) of eulachon populations in BC as endangered (Fraser River, Central Pacific Coast) and a third as a special concern (Nass/Skeena River). This finding has prompted consideration for listing under the federal Species At Risk Act (SARA).

Eulachon no longer supports significant commercial BC fisheries (Figure 11), recreational fishing is prohibited, but does support several First Nation in-river food fisheries, the largest on the Nass River averaging 200 t per year over the last 60 years with no temporal trend (Figure 12) (Moody & Pitcher 2010, COSEWIC 2013). However, according to COSEWIC, while eulachon population the Nass/Skeena DU has been stable, central and southern BC populations are in decline, and it for in these central and southern BC populations that bycatch in the shrimp trawl fishery may be a concern. However, we note that the 2011 COSEWIC report states that eulachon biomass is small relative to eulachon biomass estimates in the sea (COSEWIC 2011).

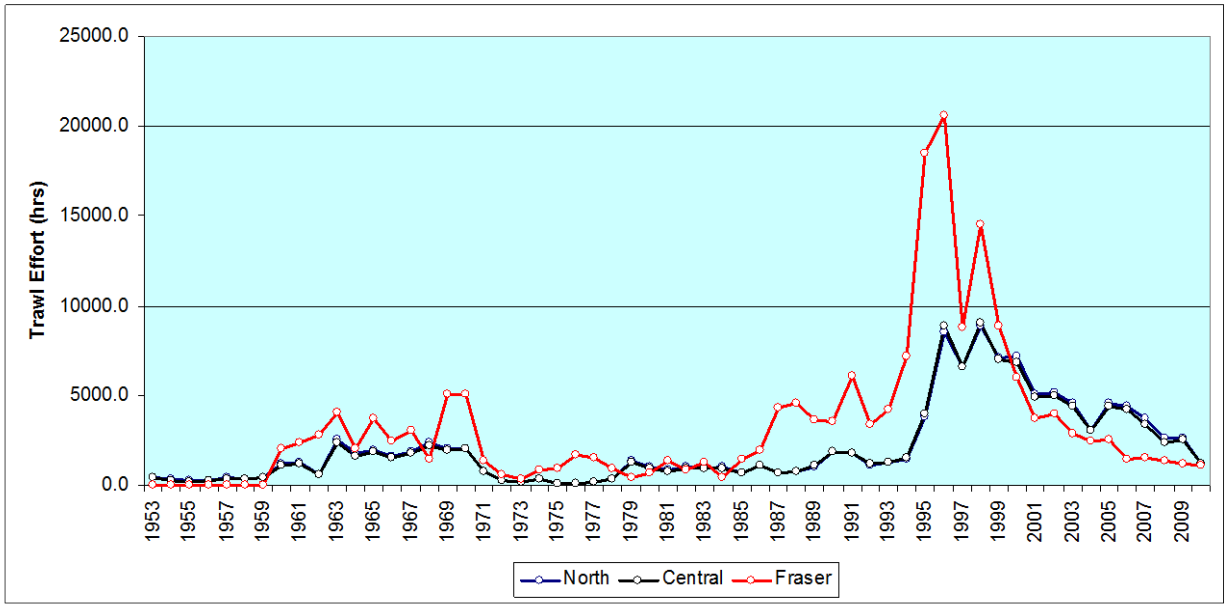

Figure 11: Estimated commercial shrimp trawl fishery effort (0-500m depth range) for each DU based on the proportion of eulachon by DU from the genetic samples. The North DU corresponds to the Nass/Skeena Rivers DU. Note that the lines for the North and Central DU largely overlap (Schweigert et al. 2012).

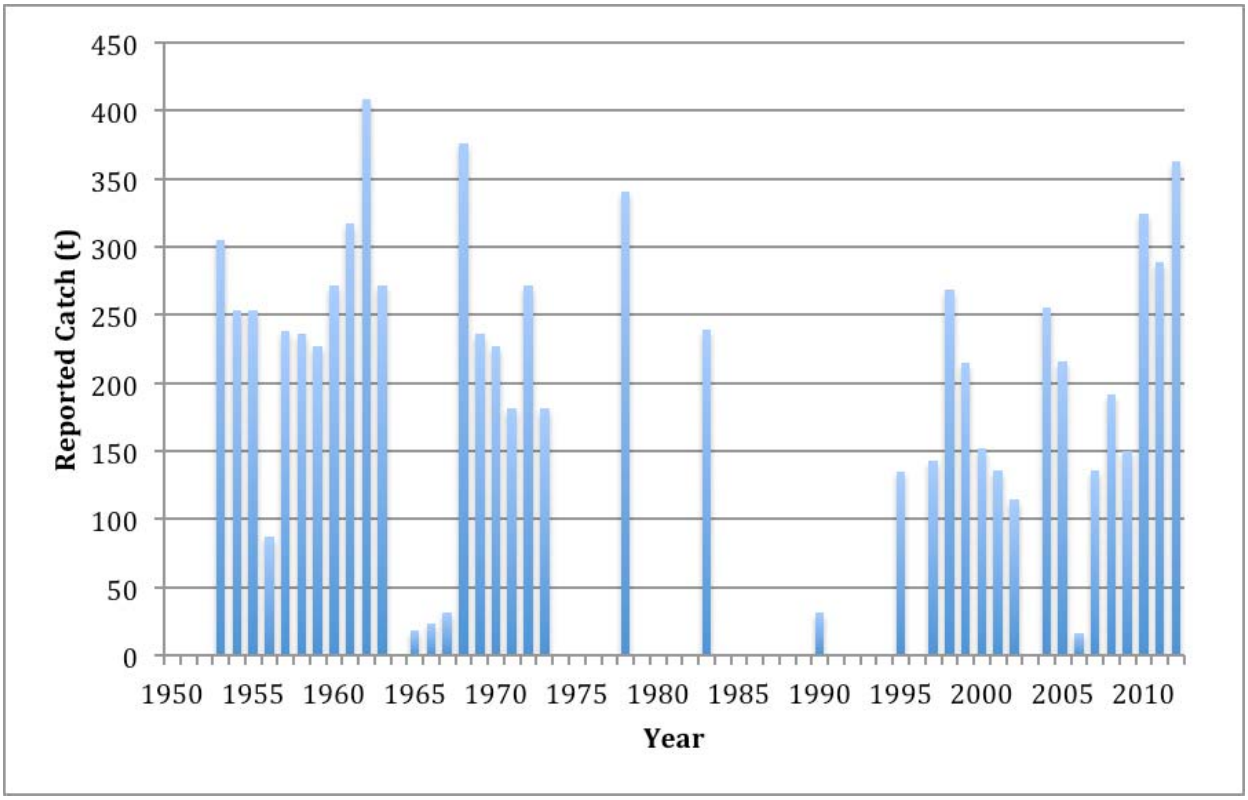

Figure 12: First Nations catch (t) of Eulachon in the Nass River, 1953-2012. Catch data were not available for years with missing bars. Data from 1953-1996 were taken from Moody (2008), and data for 1997 – 2012 were provided by LGL Limited. (COSEWIC 2013)

Factor 2.3 Fishing mortality score**: Moderate Conservation Concern**

Due to a First Nation in-river directed fishery, eulachon's fishing mortality in BC is highest in the Nass/Skeena River population, a DU rated as 'Special Concern' under COSEWIC and assessed as stable in May 2013 (COSEWIC 2013). Eulachon is not fished directly in significant amounts in either 'Endangered' populations in the Fraser River and Central Pacific Coast DUs. Eulachon caught as bycatch in the shrimp trawl fishery, particularly in the WCVI SMAs (estimated as 0.3 mt for the 2011/2012 season (DFO 2013b)) may be a significant source of fishing mortality for the 'endangered' DUs. The recent eulachon recovery potential estimate study found that whether or not the trawl fishery is the cause of the decline of eulachon, the mortality related to bycatch may impede eulachon's potential recovery (Schweigert 2012).

Rationale:

The primary sources of fishing mortality (this does not include other sources of mortality) to the endangered eulachon populations (Fraser River and Central Pacific Coast DUs) are the shrimp trawl and groundfish trawl fisheries because directed commercial fisheries nor do significant First Nations fisheries for eulachon exist in these DUs. Limited observer data available for the shrimp trawl fishery (Rutherford 2013) indicates 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,

estimating that 0.3 mt were caught as bycatch in the 2011/2012 fishing season, with an average of 3.2 mt caught as bycatch between 2001 and 2012 and an average of 0.2 mt caught each year between 2008 and 2012(DFO 2013b).

Eulachon bycatch has decreased in the shrimp trawl fishery over time, and its further reduction is a primary focus for the fishery. DFO first addressed this issue in 1998 when they established Eulachon Action Levels (EALs) as 1% of the eulachon biomass index (to a maximum of 88,185 pounds). In 2000, mandatory bycatch reduction devices were required and a minimum spacing size of 1.75 inches was instituted in 2009. The EALs have only been reached once, in 2000, and fishing was closed in the affected areas. Since then, in-season bycatch estimates of eulachon have decreased over time, dropping from 22,406 pounds in 2001 to 8,818 pounds in 2005 and have been less than 2,205 pounds since 2006 (D. Clark, DFO, pers. comm.). In season bycatch estimates are derived by applying the eulachon to shrimp ratio from at sea observations to the total estimated shrimp catch (DFO 2012d). Fishing effort has also dramatically declined over time and is currently only 12% of 2005 effort. Only about 7% of the shrimp TAC was reached in 2011 for the two closest to shore WCVI SMAs. Fishing has also been closed since 1999 Queen Charlotte Sound, an area where eulachon were caught as bycatch. This may indicate that more than just shrimp trawls are impacting their population (Schweigert 2012). It would appear that, like Alaska, the reduction of fishing effort has played a large role in the reduction of bycatch. Therefore if effort increases in the future, this criterion may need to be re-evaluated.

Regardless of when or if eulachon are listed under SARA, additional regulatory changes to further reduce eulachon bycatch are likely in the foreseeable future (D. Clark, DFO, pers. comm.). The DFO has been diligent about keeping track of eulachon bycatch, continually adjusting EALs and monitoring bycatch (DFO 2013b). A recent DFO assessment of eulachon's recovery potential in British Columbia acknowledges that while the precise cause of its endangered status in the two DUs remains unknown, the impact of the shrimp trawl fishery is of concern. Research surveys indicate that eulachon are often closely associated with shrimp and are a common bycatch species in the trawl fishery. Therefore, whether or not the trawl fishery is the cause of the decline of eulachon, the mortality related to bycatch may impede eulachon's potential recovery (Schweigert 2012). DFO also monitors eulachon biomass in SMAs in conjunction with its shrimp trawl surveys (DFO 2012g, DFO 2012h). While eulachon biomass increased from 2011 to 2012 (see figures 13 and 14), its biomass remains low (DFO 2012g, DFO 2012h).

Figure 13: Trend in eulachon biomass index as determined from shrimp trawl surveys conducted in SMA QCSND, from 1998 to 2012 (from DFO 2012g). This SMA has been closed to shrimp trawling from 1999 to present.

Figure 14: Trend in eulachon biomass index as determined from shrimp trawl surveys conducted in WCVI SMAs, from 1973 to 2012 (from DFO 2012h).

Factor 2.4 Overall discard rate: **0-20%**

Results of 10 years of limited observer data indicate an average eulachon bycatch rate of 0.4% for beam trawls and 1.1% for otter trawls. However, the actual rate varies widely from year to year and is dependent upon the SMA involved. This is likely because only a small percentage of the total trawl effort was actually observed—coverage ranged from less than 1% to 3.4%

(Rutherford 2013). Based on information in Schweigert 2012, Rutherford et. al.'s estimate is not representative of the trawl fishery as a whole.

Trap fishery

In the trap fishery observers do not collect bycatch data for species other than rockfish, rather they sample spot shrimp to create the spawner index (L. Convey, DFO, pers. comm.). However, DFO is in the process of developing a bycatch monitoring program for all species (D. Rutherford, DFO, pers. comm.). Therefore, the only source of published information presently available about bycatch comes from research surveys conducted by DFO that document the catch of all species. While these surveys may not be scientifically valid when extrapolated across the entire fishery, they nonetheless represent the only data available today. These surveys reveal that numerous species are caught (Table 3) (Favaro 2010). Of these, squat lobster was the only species that comprised a substantial part of the catch (>5%). No information is provided in the study on the mortality of squat lobster. In lieu of fishery specific data or other evidence of greater survival (e.g. through the application of better handling practices), Seafood Watch assumes a conservative 50% mortality rate for invertebrates in pot fisheries (Kruse 1994, Stevens 1996, He 2001, DiNardo et al 2002, Warrenchuk and Shirley 2002, Grant 2003, Purves et al 2003, Tallack 2007, Gilbert and Lopez 2008, Rudershausen et al 2008, Stewart 2008, Stoner et al 2008, Stoner 2012). Squat lobsters therefore comprise less than 5% of the catch mortality (Figure 11). For this reason, in addition to the relatively small size of the fishery and the catch of other species with greater conservation concern (rockfish), the fishery's impact on squat lobster stocks is not assessed further.

Rockfish are also caught in the fishery, and mortality is typically high in these species because of barotrauma (Favaro 2010, Rutherford 2010). A rockfish bycatch monitoring program conducted from 2002 to 2008 found that juvenile quillback rockfish (*Sebastes maliger*) are the most frequent rockfish species caught, comprising 62% of all rockfish caught during this time period. Quillback rockfish were designated threatened in November 2009 by COSEWIC and are currently being considered for listing under SARA. Mean annual quillback bycatch estimates range from 13,867 to 19,996 fish, or up to 2.9mt using 0.233kg as the per fish mass (Rutherford 2010) (we use this estimate with caution due to a combination of low encounter rates and the small area in which monitoring was conducted). Across all fisheries, mortality for quillback rockfish is 192.5 mt (DFO 2012i), so bycatch in the prawn trap fishery is approximately 1.5% of the total quillback rockfish fishing mortality. This exceeds 1%, meeting the criteria for being considered a 'main species' (because quillback is a threatened species).

Table 3: Catch composition of research spot prawn traps, 1999-2008 (data from Favaro 2010).

Common name	Scientific name	Total catch (kg)	Assumed discard mortality	Catch mortality (kg)	% of Total Catch mortality
Spot prawn	*Pandalus platyceros*	13020.4	100	13020.4	91
Squat lobster	*Munida quadrispina*	1022.38	50	511.19	4
Giant Pacific octopus	*Enteroctopus dofleini*	410.54	50	205.27	1
Sunflower seastar	*Pycnopodia helianthoides*	316.32	50	158.16	1
Humpback shrimp	*Pandalus hypsinotus*	122.79	50	61.395	0
Pink shrimp (smooth)	*Pandalus jordani*	119.76	50	59.88	0
Dungeness crab	*Cancer magister*	110.48	50	55.24	0
Pink shrimp	*Pandalus eous*	92.1	50	46.05	0
Red rock crab	*Cancer productus*	88.85	50	44.425	0
Fish-eating seastar	*Stylasterias forreri*	47.88	50	23.94	0
Pacific red octopus	*Octopus rubescens*	43.28	50	21.64	0
Quillback rockfish	*Sebastes maliger*	35.61	100	35.61	0
Total		15430.39		14243.2	

Factor 2.1 Inherent Vulnerability score**: High**
Quillback rockfish have a high vulnerability score of 64 on FishBase.

Factor 2.2 Abundance score: **High Conservation Concern**
Stock status is currently under review for the SARA listing. COSEWIC identifies the entire BC quillback rockfish population as one DU (with two management units), and lists quillback rockfish as 'Threatened' (COSEWIC 2009). This determination is based on data through 2004/2005. In a recent stock assessment, inside and outside quillback rockfish B_{2010}:B_{MSY} ratios were less than the Upper Stock Reference Point (USR), but greater than the Limit Reference Point (LRP) (the outside unit's B_{2011}:B_{MSY} ratio was 0.736 (95% confidence intervals = 0.266-1.814), and the inside unit's B_{2011}:B_{MSY} ratio was 0.493 (0.252-0.945)) (DFO 2012i). Although between LRP and USR, the high levels of uncertainty in the B_{2010}:B_{MSY} estimates, lead to the score of high conservation concern for this factor.

Factor 2.3 Fishing mortality: **Low Conservation Concern**
Quillback rockfish fishing mortality is currently under review for the SARA listing, but a COSEWIC assessment and status report identifies directed fishing as the principal threat. Quillbacks can still be legally landed in all fisheries. The commercial groundfish fishery has a combined TAC which includes quillback and other rockfish species (Copper - *Sebastes maliger*, China - *S. nebulosus* and Tiger - *S. nigrocinctus*), while the recreational fishery has a combined bag limit for the 6 species of inshore rockfish (DFO 2012i). According to the stock assessment, the current levels of fishing mortality for quillback rockfish may allow recovery of this species

although there are high levels of uncertainty associated with these estimates (F_{2011}/F_{MSY} for the outside unit was 1.0 ± 0.91 and 0.6 ± 0.4 for the inside unit) (DFO 2012i). The Bayesian population model shows that the outside and inside populations have leveled off their decline in recent years. Based on population trajectories and the F_{2011}/F_{MSY} ratios, the estimated level of quillback fishing mortality caused by the prawn trap fishery (approximately 1.5% of the total fishing mortality) may have a negligible impact on the overall fishing mortality of this species, leading to a score of low conservation concern for this factor.

Factor 2.4 Overall discard rate: **20-40%**

Spot prawns comprise roughly 84% of the catch (Favaro 2010). Assuming all of these are retained, discards (incorporating estimated mortality) comprise approximately 10% of the catch (Figure 11). Bait use in the trap fishery is likely to contribute to the discard rate. Pellet bait is used (pers. com. L. Convey), but DFO has no information on how much bait is used per pot or on what species are used to make the pellets. This assessment assumes that the weight of bait is around 20% of landings, thus increasing the discards+bait/landings rate by 20% to approximately 30%.

Criterion 3: Management effectiveness

Management is separated into management of retained species (harvest strategy) and management of non-retained species (bycatch strategy).

The final score for this criterion is the geometric mean of the two scores. 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 or either the Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern = Red or High Concern.*

Rating is Critical if either or both of Harvest Strategy (Factor 3.1) and Bycatch Management Strategy (Factor 3.2) ratings are Critical.

Criterion 3 Summary

Fishery	**Management: Retained Species** Rank (Score)	**Management: Non-retained species** Rank (Score)	**Criterion 3** Rank Score
British Columbia Trap	Very Low Concern (5)	Low Concern (4)	Green 4.47
British Columbia Trawl	Very Low Concern (5)	Low Concern (4)	Green 4.47

Factor 3.1 Harvest Strategy score– Very Low Conservation Concern

Fishery	**Critical?**	Mgmt. strategy and implement.	Recovery of stocks of concern	Scientific research and monitoring	Scientific advice	Enforce.	Track record	Stakeholder inclusion	**Harvest Strategy** **Rank (Score)**
British Columbia Trap	No	Highly Effective	N/A	Highly Effective	Highly Effective	Highly Effective	Highly Effective	Highly Effective	Very Low Concern (5)
British Columbia Trawl	No	Highly Effective	N/A	Highly Effective	Highly Effective	Highly Effective	Highly Effective	Highly Effective	Very Low Concern (5)

Scoring

Factor 3.1: Management of Fishing Impacts on Retained Species
Seven subfactors are evaluated: Management Strategy, Recovery of Species of Concern, Scientific Research/Monitoring, Following of Scientific Advice, Enforcement of Regulations, Management Track Record, and Inclusion of Stakeholders. Each is rated as 'ineffective', 'moderately effective', or 'highly effective'.

- 5 (Very Low Concern) = Rated as 'highly effective' for all seven subfactors considered
- 4 (Low Concern) = Management Strategy and Recovery of Species of Concern rated 'highly effective' and all other subfactors rated at least 'moderately effective'.
- 3 (Moderate Concern) = All subfactors rated at least 'moderately effective'.
- 2 (High Concern) = At minimum meets standards for 'moderately effective' for Management Strategy and Recovery of Species of Concern, but at least one other subfactor rated 'ineffective'.
- 1 (Very High Concern) = Management exists, but Management Strategy and/or Recovery of Species of Concern rated 'ineffective'
- 0 (Critical) = No management exists when a clear need for management exists (i.e., fishery catches threatened, endangered, or high concern species) OR there is a high level of Illegal, Unregulated, and Unreported Fishing occurring.

Trawl fishery

Overall, this fishery is managed with a highly effective harvest strategy. Managers could further strengthen their program by increasing the number of observer days required in order to generate more data.

Rationale:

Management Strategy and Implementation – Highly Effective
The current strategy uses the precautionary approach. The trawl fishery occurs in 34 of the 36 SMAs, with biomass within SMAs monitored over time. Reference points, based on results from annual stock assessments, are designed to prevent overfishing and identify if a stock is overfished. If a TAC is exceeded or if a stock's biomass has fallen into the critical zone, the SMA is closed to fishing (DFO 2009). Although not every SMA is assessed each year, current assessments indicate this approach is successful as the vast majority of SMAs that are assessed remain free from emergency closures and stay open throughout the season. Assessing individual SMAs allows managers to fine tune regulatory decisions throughout the fishing season. Additional harvest management strategies in the trawl fishery include fishing seasons, area closures, limitations on the number of fishing vessels allowed in the fishery, logbooks, independent dockside monitoring, net mesh size restrictions as well as bycatch reduction strategies which are described below in 3.2.1 (DFO 2013b). Based on the overall harvest management strategy, this subfactor is deemed 'Highly Effective.'

Scientific Research and Monitoring – Highly Effective
Pre-season forecasts are used to set the TACs each year, with in-season assessments providing feedback to adjust the TACs accordingly if needed. Swept-area fishery independent surveys are carried out 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 2012d). Observer coverage funding comes from active vessels, and in 2011, only 45 out of 227 licensed vessels were active in the fishery. Observer coverage is primarily carried out in the WCVI SMAs to monitor eulachon bycatch rates, with other areas prioritized as specific issues arise. The observer coverage in WCVI since 1997 has averaged 3.4%. In 2010 the program target was moved to Prince Rupert District and averaged 6.6%. Coast wide the observer coverage averages about 1% of effort (tow hours) and 2% of catch.

Scientific Advice – Highly Effective
Managers receive science advice through peer-reviewed reports from the DFO's Canadian Science Advisory Secretariat (CSAS). In-season stock status advice is communicated via shrimp bulletins (DFO 2012d). In general, managers follow scientific advice and use it as a basis for recommendations.

Enforcement – Highly Effective
Regulations are regularly enforced. Compliance priorities include: closed areas/ times; retention rules; gear configurations; and inspections of catch on board, bycatch gear in nets, hails, landing records, and harvest logs both at sea and at landing ports. Inspections will 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 be conducted by Canadian Coast Guard patrol vessels, program vessels, or by air, in conjunction with other patrols. (DFO 2012d).

Track Record – Highly Effective
Shrimp landings peaked in 1995/96 and have been declining ever since. However, this is primarily an effect of the globalization of the shrimp market. Combined with inexpensive farm-raised shrimp from Asia, supply has outstripped demand, thus removing the economic incentive to continue fishing for British Columbian shrimpers (D. Clark, DFO, pers. comm.). The low landings of shrimp today are due to the low participation resulting from the market value of shrimp, not because of mismanagement.

Stakeholder inclusion – Highly Effective
The management process is transparent, with notifications and invitations to the public to participate year-round in meetings (D. Clark, DFO, pers. comm.).

Trap fishery

Overall, this fishery is managed in an excellent manner. Long-term stock productivity and abundance is evident, as landings have generally increased over time. Managers initiated a lengthy sampling program to estimate rockfish bycatch, despite its non-protected status.

Rationale:

Management Strategy and Implementation – Highly Effective
The current strategy is based on the precautionary approach. A fixed escapement model, the Spawner Index Model, is used to assess and manage the harvest in-season. Using catch per unit effort data, the model indicates the minimum number of female spawners required during the hatch period and harvest reference points are set. When the minimum monthly index is reached in a particular PFMA sub-area, the fishery is immediately closed. In recent years, the fishing season for spot prawns has been about 60 days. Since 2000, the fisheries have been managed more conservatively, with closures occurring when the number of spawning females falls to 10% above the spawner index, which provides a buffer to ensure spawner indexes are met (DFO 2013a). Landings data indicate a general, but steady, increase over time (DFO 2012e). Additional management measures to manage effort in the trap fishery include a limitation on license number, limitations on numbers of traps allowed per license, harvest log requirements, restrictions on mesh size and trap volume, single haul per day limits, and vessel length restrictions (DFO 2013a).

Scientific Research and Monitoring – Highly Effective
Parameters related to growth and fishing mortality are derived from semi-annual independent fishery surveys. Fisheries dependent data is also collected in-season by observers to monitor stock status relative to the established reference points. Overall stock abundance is determined by annual commercial landings and is considered a reasonable proxy. As this is not a year-round fishery, robust monitoring efforts to aid in-season management decisions are integral (DFO 2012e).

Scientific Advice – Highly Effective
Management does follow scientific advice and does not have a track record of disregarding it. DFO is currently reviewing the 2013 season and results indicate that scientific advice was nearly always followed. Over 80% of the in-season fisheries management decisions were based on area-specific scientific advice relative to the adopted (science peer-reviewed) reference points (i.e., fishery closures). The remainder, i.e., <20% of in-season decisions made by fisheries managers, were based on scientific advice in an adjacent area. In the latter, the management action was always precautionary to implement fishing closures based on scientific advice from the adjacent area (L. Convey, DFO, pers. comm.).

Enforcement – Highly Effective
DFO regularly conducts self-diagnostic tools like the Fishery Checklist (a tool for internal use) to help monitor improvements that support sustainable fisheries, and identify areas of weakness

that require further work. Compliance and enforcement are reviewed annually as part of this Checklist (L. Convey, DFO, pers. comm.).

The post-season review for 2011 indicated that 90% of the fleet was checked for general compliance on board during the season. A compliance priority is enforcement of the single haul management program coast wide. Funding for this program is provided to DFO by industry and covers surveillance, vehicle and vessel maintenance, and prosecution of cases. Additional priorities include monitoring infractions related to time and area closures, inadequate reporting of haul time in logbooks, and illegal sales (DFO 2012e). Overall, regulations are regularly enforced and independently verified, including logbook reports, dedicated enforcement, and independent verification by Fisheries Act certified Observers (DFO 2013a).

Track Record – Highly Effective
Over the last 20 years, and within the backdrop of fluctuations that are typical for forage species, landings have generally increased. License limitations began in 1990 and landings have risen from about 1.6M pounds to 4.8M pounds in 2010. Over this same time period, management has been consistent and became precautionary in 2000. This is evidence of long-term maintenance of stock abundance and productivity, and ecosystem integrity (DFO 2012e).

Stakeholder inclusion – Highly Effective
The management process is transparent, with notifications and invitations to the public to participate year-round in meetings (DFO 2012e).

Factor 3.2: Bycatch Management Strategy score – Low Conservation Concern

Fishery	**All Species Retained?**	**Critical?**	Mgmt. strategy and implement.	Scientific research and monitoring	Scientific advice	Enforce.	**Management of bycatch species** **Rank (Score)**
British Columbia Trap	No	No	Highly Effective	Moderately Effective	Highly Effective	Highly Effective	Low Concern (4)
British Columbia Trawl	No	No	Highly Effective	Moderately Effective	Highly Effective	Highly Effective	Low Concern (4)

Scoring

Factor 3.2: Management of Fishing Impacts on Bycatch Species
Four subfactors are evaluated: Management Strategy, Scientific Research/Monitoring, Following of Scientific Advice, and Enforcement of Regulations. Each is rated as 'ineffective', 'moderately effective', or 'highly effective'. Unless reason exists to rank Scientific

Research/Monitoring, Following of Scientific Advice, and Enforcement of Regulations differently, these ranks are the same as in 3.1.

- 5 (Very Low Concern) = Rated as 'highly effective' for all four subfactors considered
- 4 (Low Concern) = Management Strategy rated 'highly effective' and all other subfactors rated at least 'moderately effective'.
- 3 (Moderate Concern) = All subfactors rates at least 'moderately effective'.
- 2 (High Concern) = At minimum meets standards for 'moderately effective' for Management Strategy but some other factors rated 'ineffective'.
- 1 (Very High Concern) = Management exists, but Management Strategy rated 'ineffective'
- 0 (Critical) = No bycatch management even when overfished, depleted, endangered or threatened species are known to be regular components of bycatch and are substantially impacted by the fishery.

Trawl fishery

There has been a proactive and self-funded approach by the industry to curb total bycatch. Bycatch monitoring results indicate that overall bycatch has decreased as a result (Rutherford 2013), however with the recent listing of eulachon as endangered in two DUs, further steps will likely be taken to address the bycatch of eulachon specifically.

Rationale:

Management Strategy and Implementation – Highly Effective
As discussed above in Criterion 2, reducing the bycatch of eulachon is the primary focus of trawl fishery managers. Eulachon bycatch has decreased in the shrimp trawl fishery over time, and its further reduction is a primary focus for the fishery. The DFO actively manages eulachon bycatch via 1) Eulachon Action Levels (EALs) (introduced in 1998), which are described in 2.3 above, closing the fishery within individual SMAs if EALs are reached, and 2) mandatory Bycatch Reduction Devices (BRDs) (introduced in 2000). These action steps were taken 11 years before eulachon were listed as endangered and without formal SARA listing. The reduction in bycatch may be due to these bycatch strategies, the large overall reduction in fishing effort over time, or a combination of both.

We note that the BRD grate size in the BC trawl fishery is required to be at 1.75 inches (DFO 2013b), whereas Oregon recently implemented a BRD regulation of at most 0.75 inches and found that reduced eulachon bycatch by 16% compared to 1 inch spacing. However, effort in the BC trawl fishery is much lower than the Oregon trawl fishery, so BRD spacing may not be as much of an issue in BC. According to the IFMP The shrimp trawl industry caucus recommends a maximum BRD grate spacing of 25 mm (0.98 inches) to more effectively reduce bycatch, while the requirement is a maximum of 44.5 mm (1.75 inches).

As discussed above, whether or not the trawl fishery is the cause of the decline of eulachon, the mortality related to bycatch may impede eulachon's potential recovery (Schweigert 2012). Therefore, managers acknowledge that future regulations aimed specifically at eulachon will likely be forthcoming (D. Clark, DFO, pers. comm.).

Scientific Research and Monitoring – Moderately Effective
The bycatch studies discussed above reveal that while observer data exists, coverage is severely limited both spatially and temporally (Olsen 2000, Rutherford 2013). The data is so inadequate, that bycatch trends cannot be drawn. Researchers recommend that if coast-wide sampling is an objective, then a new program is needed beyond simple monitoring (Olsen 2000).

Scientific Advice – Highly Effective
Managers receive science advice through peer-reviewed reports from the DFO's Canadian Science Advisory Secretariat (CSAS). In-season stock status advice is communicated via shrimp bulletins (DFO 2013b). In general, managers follow scientific advice and use it as a basis for recommendations. We note here, according to the Integrated Fishery Management Plan (IFMP), the shrimp trawl industry caucus (not a scientific body) recommends a maximum BRD grate spacing of 25 mm (0.98 inches) to more effectively reduce bycatch, while the requirement is a maximum of 44.5 mm (1.75 inches) (DFO 2013b).

Enforcement – Highly Effective
See subfactor 3.1 above

Trap fishery

Juvenile rockfish (particularly quillback rockfish, the most frequently encountered rockfish in the trap fishery (DFO 2013a)) are the primary bycatch concern in the shrimp trap fishery in BC. Early steps have been taken to address rockfish bycatch and fishery independent monitoring occurs in the trap fishery.

Rationale:

Management Strategy and Implementation – Highly Effective
Similar to the trawl fishery, action to address overall bycatch concerns was taken years before COSEWIC declared quillback rockfish "Threatened" in 2009 (quillback rockfish is currently under consideration for SARA listing). A rockfish conservation strategy was first proposed in 1998, and rockfish bycatch in the shrimp/prawn trap fishery has been monitored since 2002 (DFO 2013a). DFO deems rockfish encounters in the shrimp/prawn trap fishery as rare events (0.000 to 0.045 rockfish/trap), so allows shrimp/prawn trap fishing to occur in Rockfish Conservation Areas (RCAs) (RCAs were first established in 2002) (DFO 2013a). Based on the COSEWIC assessment of recovery potential for quillback rockfish, DFO allows the shrimp trap fishery to persist (DFO 2013a). In 2014, trap modifications to include a biodegradable ('rot') cord or panel will become mandatory for all commercial prawn traps. This modification was

recommended by the prawn industry to facilitate release of bycatch species in the event traps are lost (DFO 2013a).

Scientific Research and Monitoring – Moderately Effective
Scientific monitoring of rockfish bycatch occurrences and estimates of coast-wide catch are produced (Rutherford 2010), although species specific bycatch estimates are not available. However, no new research efforts are underway to further reduce their incidence of capture.

Scientific Advice – Highly Effective
See subfactor 3.1 above

Enforcement – Highly Effective
As indicated above in 3.1, nearly all of the vessels underwent vessel monitoring (DFO 2012d).

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 (plus the mitigation of gear impacts score) and the Ecosystem Based Fishery Management 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 cannot be Critical for Criterion 4.

Criterion 4 Summary

Fishery	Gear type and substrate Rank (Score)	Mitigation of gear impacts Rank (Score)	EBFM Rank (Score)	Criterion 4 Score	Criterion 4 Rank
British Columbia Trap	Moderate Concern (2)	Moderate mitigation (0.5)	Moderate (3)	2.74	Yellow
British Columbia Trawl	Moderate Concern (2)	Moderate mitigation (0.5)	Moderate (3)	2.74	Yellow

Criterion 4 Summary

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

- 5 (None) = Fishing gear does not contact the bottom
- 4 (Very Low) = Vertical Line Gear
- 3 (Low) = 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. Bottom seine on resilient mud/sand habitats. Midwater trawl that is known to contact bottom *occasionally* (<25% of the time) or purse seine known to commonly contact bottom
- 2 (Moderate) = Bottom dragging gears (dredge, trawl) fished on resilient mud/sand habitats. Gillnet, trap, or bottom longline fished on sensitive boulder or coral reef habitat. Bottom seine except on mud/sand;

- 1 (High) = Hydraulic clam dredge. Dredge or trawl gear fished on moderately sensitive habitats (e.g. cobble or boulder).
- 0 (Very High) = 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 - Mitigation of Gear Impacts

- +1 (Strong Mitigation) = Examples include large proportion of habitat protected from fishing (>50%) with gear, fishing intensity low/limited, gear specifically modified to reduce damage to seafloor and modifications shown to be effective at reducing damage, or an effective combination of 'moderate' mitigation measures.
- +0.5 (Moderate Mitigation) = 20% of habitat protected from fishing with gear or other measures in place to limit fishing effort, fishing intensity, and spatial footprint of damage caused from fishing.
- +0.25 (Low Mitigation) = A few measures in place, e.g., vulnerable habitats protected but other habitats not protected; some limits on fishing effort/intensity, but not actively being reduced.
- 0 (No Mitigation) = No effective measures are in place to limit gear impacts on habitats.

Factor 4.3 – Ecosystem-Based Fisheries Management

- 5 (Very Low Concern) = Substantial efforts have been made to protect species' ecological roles and ensure fishing practices do not have negative ecological effects (e.g. large proportion of fishery area protected with marine reserves, abundance is maintained at sufficient levels to provide food to predators).
- 4 (Low Concern) = Studies are underway to assess the ecological role of species and measures are in place to protect the ecological role of any species that plays an exceptionally large role in the ecosystem. If hatchery supplementation or fish aggregating devices (FADs) are used, measures are in place to minimize potential negative ecological effects.
- 3 (Moderate Concern) = Fishery does not catch species that play an exceptionally large role in the ecosystem, or if it does, studies are underway to determine how to protect the ecological role of these species. OR negative ecological effects from hatchery supplementation or FADs are possible and management is not place to mitigate these impacts.
- 2 (High Concern) = The fishery catches species that play an exceptionally large role in the ecosystem and no efforts are being made to incorporate their ecological role into management.

- 1 (Very High Concern) = The use of hatchery supplementation or Fish Aggregating Devices (FADs) in the fishery is having serious negative ecological or genetic consequences. OR fishery has resulted in trophic cascades or other detrimental impacts to the food web.

Trawl fishery

Factor 4.1 Impact of the fishing gear on the substrate score: **Moderate Concern**
Shrimp trawl gear contacts the bottom. This fishery generally occurs on mud and sand in high energy environments (DFO 2013). Where sensitive habitats are known to exist within SMAs, DFO bans shrimp trawling in those areas (DFO 2013).

Factor 4.2 Modifying factor: Mitigation of fishing gear impacts score**: Moderate Mitigation**
The Pacific region Integrated Fishery Management Plan (IFMP) addresses the spatial footprint of shrimp trawl effort. Since 2003, four sponge reef areas in eastern Queen Charlotte Sound and Hecate Straight have been protected as 'Sensitive Benthic Areas' and have been closed to shrimp trawling (DFO 2013). DFO is currently determining fishing risk and the necessity of mitigation measures to newly identified sponge reefs in the Strait of Georgia, via its Ecological Risk Assessment Framework (drafted under the national Policy for Managing the Impacts of Fishing on Sensitive Benthic Areas) (DFO 2013). Within SMAs, there are areas closed to shrimp trawling, which include rockfish conservation areas, ecological reserves, national parks and National Marine Conservation Areas (DFO 2013). It is not apparent that the shrimp trawl industry is taking action to mitigate the impact of gears on sensitive areas beyond DFOs efforts.

Factor 4.3 Ecosystem and Food Web Considerations score: **Moderate**
No species of exceptional importance to the ecosystem are caught in this fishery. DFO has extensive general policies related to harvesting of forage species and ecosystem based management. However, the ecological role of shrimp has not yet been studied, nor specifically addressed within these policies (DFO 2009).

Trap fishery

Factor 4.1 Impact of the fishing gear on the substrate score: **Moderate Concern**
This fishery occurs on rocky, hard substrate (DFO 2012e).

Factor 4.2 Modifying factor: Mitigation of fishing gear impacts score**: Moderate Mitigation**
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. For example, the number of licenses decreased from 900 in 1989 to 260 by the following year due to license limitation regulations implemented in 1990. And an additional 10 licenses have been retired that were grandfathered in, leaving a total of 250 licenses in 2013. The number of traps has decreased by 5,000 since 1994 and in-season stacking (where two trap allotments are fished from a single vessel) further reduces this number. And regulations reducing the number of

times traps may be set and hauled per day to just one, constitute an effective gear modification that is enforced by industry funding (Harbo 2006). Lastly, the season is now the shortest it has ever been (less than 50 days in 2012 and 2013) due to a more intensive spawner index management regime (L. Convey, DFO, pers. comm.). The Strait of Georgia ecological risk assessment (see trawl above) is also being applied to the trap fishery (DFO 2013). Together, these provisions provide moderate mitigation of the traps' impacts to the seafloor.

Factor 4.3 Ecosystem and Food Web Considerations score: **Moderate**
See Factor 4.3 for trawl above.

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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.

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Appendix A

Catch composition data from the British Columbia commercial shrimp trawl bycatch monitoring program, 2002 – 2011 (Rutherford et. al 2013).

Sum of Weight (kg)			
	Beam Trawl	**Otter Trawl**	**Grand Total**
Shrimp	**87.65%**	**88.67%**	**87.95%**
Smooth pink shrimp	62.09%	63.18%	62.42%
Sidestripe shrimp	11.08%	15.53%	12.40%
Spiny pink shrimp	6.03%	8.26%	6.69%
Coonstripe shrimp	4.45%	0.77%	3.36%
Prawn	1.81%	0.55%	1.44%
Humpback shrimp	1.33%	0.31%	1.03%
Flexed pink shrimp	0.48%	0.00%	0.34%
Crangons	0.17%	0.05%	0.13%
Crangonidae	0.10%	0.01%	0.07%
Northern crangon	0.05%	0.01%	0.04%
Shrimp	0.05%	0.00%	0.03%
Glass shrimp	0.01%	0.00%	0.01%
Horned shrimp	0.01%	0.00%	0.00%
Pandalid shrimp	0.00%	0.00%	0.00%
Spiny side shrimp	0.00%	0.00%	0.00%
Yellowleg shrimp	0.00%	0.00%	0.00%
Ghost shrimp	0.00%	0.00%	0.00%
Non-shrimp	**12.35%**	**11.33%**	**12.05%**
Pacific hake	0.92%	1.90%	1.21%
Slender sole	0.86%	1.28%	0.99%
Walleye pollock	1.11%	0.48%	0.92%
Spotted ratfish	1.14%	0.35%	0.90%
Eelpouts	1.00%	0.47%	0.84%
Pacific sanddab	0.63%	0.90%	0.71%
Rex sole	0.66%	0.67%	0.67%
Flathead sole	0.66%	0.64%	0.65%
Eulachon	0.42%	1.09%	0.62%
Dover sole	0.56%	0.71%	0.61%
English sole	0.63%	0.22%	0.51%
Arrowtooth flounder	0.30%	0.44%	0.34%
Plainfin midshipman	0.28%	0.20%	0.25%
Shiner perch	0.15%	0.49%	0.25%
Poachers	0.22%	0.08%	0.18%
Sculpins	0.17%	0.11%	0.16%
Southern rock sole	0.19%	0.04%	0.15%
Spiny dogfish	0.16%	0.06%	0.13%
Petrale sole	0.10%	0.19%	0.13%
Wattled eelpout	0.15%	0.02%	0.11%
Pacific herring	0.07%	0.18%	0.10%
Octopus	0.11%	0.06%	0.10%
Dungeness crab	0.10%	0.00%	0.07%

Twoline eelpout	0.05%	0.12%	0.07%
Squat lobster	0.08%	0.04%	0.07%
Longnose skate	0.09%	0.02%	0.07%
Pacific cod	0.09%	0.03%	0.07%
Sea Cucumbers	0.07%	0.03%	0.06%
Blackbelly eelpout	0.08%	0.00%	0.06%
Pacific bobtail squid	0.07%	0.02%	0.05%
Smelts	0.05%	0.02%	0.04%
Great sculpin	0.06%	0.00%	0.04%
Starfish	0.05%	0.01%	0.04%
Righteye flounders	0.05%	0.00%	0.04%
(blank)	0.03%	0.05%	0.04%
Sea urchins	0.03%	0.06%	0.04%
Big skate	0.05%	0.01%	0.04%
Lingcod	0.05%	0.00%	0.03%
Sablefish	0.04%	0.00%	0.03%
Scallop	0.02%	0.05%	0.03%
Greenstriped rockfish	0.03%	0.03%	0.03%
Squids	0.01%	0.05%	0.02%
Inanimate objects(s)	0.03%	0.00%	0.02%
Starry flounder	0.03%	0.00%	0.02%
Speckled sanddab	0.03%	0.01%	0.02%
Darkblotched rockfish	0.01%	0.06%	0.02%
Pacific tomcod	0.03%	0.01%	0.02%
Surf smelt	0.03%	0.00%	0.02%
Bigfin eelpout	0.03%	0.00%	0.02%
Anemone	0.03%	0.01%	0.02%
Lefteye flounders	0.03%	0.00%	0.02%
Flatfishes	0.02%	0.00%	0.02%
Jellyfish	0.02%	0.00%	0.02%
Rougheye rockfish	0.02%	0.00%	0.02%
Northern ronquil	0.02%	0.00%	0.02%
Cabezon	0.02%	0.00%	0.02%
Buffalo sculpin	0.02%	0.00%	0.01%
Spinyhead sculpin	0.02%	0.00%	0.01%
Northern spearnose poacher	0.02%	0.00%	0.01%
Sharpchin rockfish	0.01%	0.02%	0.01%
Lumpfishes and snailfishes	0.02%	0.00%	0.01%
Quillback rockfish	0.02%	0.00%	0.01%
Eelpout	0.01%	0.00%	0.01%
Sandpaper skate	0.01%	0.00%	0.01%
Yellowtail rockfish	0.01%	0.00%	0.01%
Redstripe rockfish	0.01%	0.00%	0.01%
Bivalve molluscs	0.01%	0.00%	0.01%
Pacific staghorn sculpin	0.01%	0.00%	0.01%
Opalescent inshore squid	0.01%	0.00%	0.01%
Sand sole	0.01%	0.01%	0.01%
Rockfishes	0.01%	0.01%	0.01%
Blackfin poacher	0.01%	0.00%	0.01%
Slipskin snailfish	0.01%	0.00%	0.01%
Splitnose rockfish	0.01%	0.01%	0.01%

Bigmouth sculpin	0.01%	0.00%	0.01%
Blackgill rockfish	0.01%	0.00%	0.01%
Shortspine thornyhead	0.01%	0.00%	0.01%
Pacific sardine	0.00%	0.01%	0.01%
Shortfin eelpout	0.01%	0.00%	0.01%
Skates	0.01%	0.00%	0.00%
Glass sponges	0.00%	0.00%	0.00%
Heart urchins	0.00%	0.00%	0.00%
Silvergray rockfish	0.00%	0.00%	0.00%
Harlequin rockfish	0.00%	0.00%	0.00%
Roughback sculpin	0.00%	0.00%	0.00%
Northern sculpin	0.00%	0.00%	0.00%
Spiny tapirfishes	0.00%	0.00%	0.00%
Giant blobsculpin	0.00%	0.00%	0.00%
Unknown fish	0.00%	0.00%	0.00%
Showy snailfish	0.00%	0.00%	0.00%
Chitons	0.00%	0.00%	0.00%
Rainbow smelt	0.00%	0.00%	0.00%
Blackfin sculpin	0.00%	0.00%	0.00%
Cephalopods	0.00%	0.00%	0.00%
Sturgeon poacher	0.00%	0.00%	0.00%
Smalldisk snailfish	0.00%	0.00%	0.00%
Bath sponges	0.00%	0.00%	0.00%
Sponges	0.00%	0.00%	0.00%
Copper rockfish	0.00%	0.00%	0.00%
Mussels	0.00%	0.00%	0.00%
Pricklebacks	0.00%	0.00%	0.00%
Schoolmaster gonate squid	0.00%	0.00%	0.00%
Decapods	0.00%	0.00%	0.00%
Unidentified organic matter	0.00%	0.00%	0.00%
Slimy snailfish	0.00%	0.00%	0.00%
Gunnels	0.00%	0.00%	0.00%
Giant Pacific octopus	0.00%	0.00%	0.00%
Isopods	0.00%	0.00%	0.00%
Sea whip	0.00%	0.00%	0.00%
Northern anchovy	0.00%	0.00%	0.00%
Slickheads	0.00%	0.00%	0.00%
Threadfin sculpin	0.00%	0.00%	0.00%
Daubed shanny	0.00%	0.00%	0.00%
Hagfishes	0.00%	0.00%	0.00%
Seaslugs	0.00%	0.00%	0.00%
True crabs	0.00%	0.00%	0.00%
Segmented worms	0.00%	0.00%	0.00%
Black eelpout	0.00%	0.00%	0.00%
Ronquils	0.00%	0.00%	0.00%
Snake prickleback	0.00%	0.00%	0.00%
Curlfin sole	0.00%	0.00%	0.00%
Tanner crabs	0.00%	0.00%	0.00%
Slim sculpin	0.00%	0.00%	0.00%
Bocaccio	0.00%	0.00%	0.00%
Gastropods	0.00%	0.00%	0.00%

Greenlings	0.00%	0.00%	0.00%
Brown algae	0.00%	0.00%	0.00%
Yelloweye rockfish	0.00%	0.00%	0.00%
Hydroid	0.00%	0.00%	0.00%
Pacific sandfish	0.00%	0.00%	0.00%
Pacific softpout	0.00%	0.00%	0.00%
Chilipepper	0.00%	0.00%	0.00%
Pygmy rockfish	0.00%	0.00%	0.00%
Pacific Ocean perch	0.00%	0.00%	0.00%
Stripetail rockfish	0.00%	0.00%	0.00%
Sea pens	0.00%	0.00%	0.00%
Dwarf wrymouth	0.00%	0.00%	0.00%
Oxeye oreo	0.00%	0.00%	0.00%
Sailfin sculpin	0.00%	0.00%	0.00%
American shad	0.00%	0.00%	0.00%
Invertebrates	0.00%	0.00%	0.00%
Sunflower starfish	0.00%	0.00%	0.00%
Dusky rockfish	0.00%	0.00%	0.00%
Redbanded rockfish	0.00%	0.00%	0.00%
Box crabs	0.00%	0.00%	0.00%
Yellowfin sole	0.00%	0.00%	0.00%
Tadpole sculpin	0.00%	0.00%	0.00%
Wrymouths	0.00%	0.00%	0.00%
Right-handed hermits	0.00%	0.00%	0.00%
Spotfin sculpin	0.00%	0.00%	0.00%
Butter sole	0.00%	0.00%	0.00%
Surfperches	0.00%	0.00%	0.00%
Medusafish	0.00%	0.00%	0.00%
Stony corals	0.00%	0.00%	0.00%
Roughtail skate	0.00%	0.00%	0.00%
Pedunculate barnacles	0.00%	0.00%	0.00%
Swimming anemone	0.00%	0.00%	0.00%
Grenadiers	0.00%	0.00%	0.00%
Inshore Tanner crab	0.00%	0.00%	0.00%
Tube worms	0.00%	0.00%	0.00%
Decorated warbonnet	0.00%	0.00%	0.00%
Salps	0.00%	0.00%	0.00%
Gray starsnout	0.00%	0.00%	0.00%
Pacific spiny lumpsucker	0.00%	0.00%	0.00%
Spider crabs	0.00%	0.00%	0.00%
Basket stars	0.00%	0.00%	0.00%
Marbled snailfish	0.00%	0.00%	0.00%
Roughspine sculpin	0.00%	0.00%	0.00%
Large eyed eualid	0.00%	0.00%	0.00%
Canary rockfish	0.00%	0.00%	0.00%
Molluscs	0.00%	0.00%	0.00%
Pile perch	0.00%	0.00%	0.00%
Chub mackerel	0.00%	0.00%	0.00%
Polychaete worms	0.00%	0.00%	0.00%
Peanutworms	0.00%	0.00%	0.00%
Barbed eualid	0.00%	0.00%	0.00%

Dana's bladed shrimp	0.00%	0.00%	0.00%
Ribbed sculpin	0.00%	0.00%	0.00%
Boreal clubhook squid	0.00%	0.00%	0.00%
Common argid	0.00%	0.00%	0.00%
Giant wrymouth	0.00%	0.00%	0.00%
Pacific pompano	0.00%	0.00%	0.00%
Warty poacher	0.00%	0.00%	0.00%
Alaska skate	0.00%	0.00%	0.00%
Pink scallop	0.00%	0.00%	0.00%
Gorgonian corals	0.00%	0.00%	0.00%
Viperfishes	0.00%	0.00%	0.00%
Sweet potato sea cucumber	0.00%	0.00%	0.00%
Brown Irish Lord	0.00%	0.00%	0.00%
Amphipods	0.00%	0.00%	0.00%
Lumpfishes	0.00%	0.00%	0.00%
Red Irish lord	0.00%	0.00%	0.00%
Aleutian skate	0.00%	0.00%	0.00%
Mosshead warbonnet	0.00%	0.00%	0.00%
Vermillion starfish	0.00%	0.00%	0.00%
Thornback sculpin	0.00%	0.00%	0.00%
Coho salmon	0.00%	0.00%	0.00%
Thornyheads	0.00%	0.00%	0.00%
Lanternfishes	0.00%	0.00%	0.00%
Eels	0.00%	0.00%	0.00%
Red rock crab	0.00%	0.00%	0.00%
Tiger rockfish	0.00%	0.00%	0.00%
Longsnout eelpout	0.00%	0.00%	0.00%
Graceful decorator crab	0.00%	0.00%	0.00%
Gobies	0.00%	0.00%	0.00%
Puget Sound rockfish	0.00%	0.00%	0.00%
Grand Total	**100.00%**	**100.00%**	**100.00%**