Monterey Bay Aquarium
Seafood Watch®

Coonstripe shrimp, Dock shrimp, Pink shrimp, Northern shrimp, Sidestripe shrimp, Spot prawn, Ridgeback shrimp

Pandalus hypsinotus, Pandalus danae, Pandalus jordani, Pandalus borealis, Pandalus dispar, Pandalus platyceros, Sicyonia ingentis

Image © Monterey Bay Aquarium

Alaska, California, Washington

Bottom Trawl, Trap

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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 California, Washington and Alaska. Seven species of shrimp are reviewed: Northern shrimp *(Pandalus borealis* also called *Pandalus eous or Pandalus borealis eous),* Spot prawn *(Pandalus platyceros),* Sidestripe shrimp *(Pandalus dispar),* Coonstripe shrimp *(Pandalus hypsinotus),* Pink shrimp *(Pandalus jordani),* Dock shrimp (known as Coonstripe shrimp in California) *(Pandalus danae),* and Ridgeback shrimp *(Sicyonia ingentis)*. These species are captured with bottom trawls and traps. The Oregon pink shrimp fishery using bottom trawls is not included in this report as it is Marine Stewardship Council certified. All shrimp covered by this report caught in California and Washington receive a **Good Alternative** rating, while those caught in Alaska receive a **Best Choice** rating.

Impacts of the species under assessment: There are no quantitative stock assessments for any shrimp species caught on the west coast of the US, and no biological reference points have been defined. Stock status is unknown for all species. Fishing mortality reference points are similarly undefined, but the small size of many of the fisheries and the suite of measures applied in several fisheries to limit effort and protect spawning stocks increase the likelihood that those stocks are being fished sustainably.

Impacts on other species: Bycatch of unwanted species is frequently a problem in unselective gears such as bottom trawls. Bycatch Reduction Devices (BRDs) are required for all of the trawl fisheries assessed in this document, a measure that has generally minimized bycatch to a few % (relative to landings) across the board. The bycatch of the recently listed eulachon remains a major concern in the California and Washington pink shrimp fisheries however. Bycatch mortality in shrimp pot fisheries is poorly known. Multiple studies suggest the quantity of bycatch can be considerable, but most of it is invertebrate species that are generally thought to survive once released. Bait use in pot fisheries can also be significant, but few data are available for the fisheries assessed here.

Harvest Strategy: Harvest strategy rates as 'Moderate Concern' for all evaluated coldwater shrimp fisheries in California as well as the pink shrimp trawl fishery in Washington. There are generally effort controls in place where the fisheries are large enough to justify them, and measures in place to control effort if market interest in them increases considerably. However, there are relatively limited efforts to collect data on the impacts of the fisheries on the stocks and the lack of limits on total catch. Catch is more controlled in the Washington spot prawn and Alaskan fisheries, with area –specific quotas in place. These fisheries still suffer from a lack of biological information and fishery-independent data and therefore quantitative assessments on the health of the stock.

Bycatch Strategy: Measures in place to reduce bycatch in the Washington and California shrimp trawl fisheries (for pink shrimp and ridgeback) have proven effective in reducing the bycatch of rockfish. However, the catch of endangered eulachon is still a major problem in the pink shrimp fisheries. This is a relatively recent finding, and managers have generally put considerable effort into mitigating the catch of eulachon. Washington scores more highly than California in this regard

because Washington (and Oregon) has reduced the permitted grate size in the fishery while California has yet to do so. The Alaska trawl fishery does not have the same problems with eulachon bycatch. Managers believe bycatch to not be a problem in the Alaska trawl fishery and all of the pot fisheries assessed here, so do little to mitigate it. However, few data are available to corroborate this.

Impacts of the fishery on habitats and ecosystems: The impact of mobile gears like bottom trawls on seafloor habitats is generally greater than for static gears like pots, if fished over the same type of habitat. In the fisheries assessed here, trawling is prosecuted over sand and muddy habitat which is relatively resilient to changes, while pot fisheries are more generally targeting species that live in rocky habitat which are relatively vulnerable. Efforts to mitigate habitat impacts are often focused on trawl fisheries, which here include gear modifications and time and area closures. In some cases, closures also mitigate impacts from the pot fisheries too.

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	**Management** Rank Score	**Habitat and Ecosystem** Rank Score	**Overall** Recommendation Score
Coonstripe shrimp	California Trap	Yellow 2.64	Unspecified finfish Green, 3.32,3.15	Yellow 3	Yellow 3.12	**GOOD ALTERNATIVE 2.97**
Coonstripe shrimp	Alaska Trap	Green 3.32	Unspecified finfish, Spot prawn, Coonstripe shrimp, Unspecified invertebrates Green, 3.32,3.15	Green 4	Yellow 2.83	**BEST CHOICE 3.3**
Northern shrimp	Alaska Trawl	Green 3.32	Northern shrimp, Sidestripe shrimp, Unspecified finfish, Unspecified invertebrates Green, 3.32,3.32	Green 3.46	Green 3.46	**BEST CHOICE 3.39**
Pink shrimp	Washington Trawl	Yellow 2.64	Eulachon Red, 1,1	Green 3.46	Yellow 3	**GOOD ALTERNATIVE 2.29**

Pink shrimp	California Trawl	Yellow 2.64	Eulachon Red, 1,1	Yellow 3	Yellow 3	**GOOD ALTERNATIVE 2.21**
Ridgeback shrimp	California Trawl	Yellow 2.64	Unspecified finfish Green, 3.32,3.32	Green 3.46	Yellow 2.74	**GOOD ALTERNATIVE 3.02**
Sidestripe shrimp	Alaska Trawl	Green 3.32	Northern shrimp, Sidestripe shrimp, Unspecified finfish, Unspecified invertebrates Green, 3.32,3.32	Green 3.46	Green 3.46	**BEST CHOICE 3.39**
Spot prawn	Alaska Trap	Green 3.32	Unspecified finfish, Spot prawn, Coonstripe shrimp, Unspecified invertebrates Green, 3.32,3.15	Green 4	Yellow 2.83	**BEST CHOICE 3.3**
Spot prawn	California Trap	Green 3.32	Humpback whale Yellow, 2.24,1.9	Yellow 3	Yellow 2.6	**GOOD ALTERNATIVE 2.65**
Spot prawn	Washington Trap	Green 3.32	Unspecified finfish, Unspecified invertebrates, Spot prawn Green, 3.32,3.15	Green 4	Yellow 2.45	**GOOD ALTERNATIVE 3.18**

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 Washington state, Oregon, California and Alaska. Seven species of shrimp are reviewed: Northern shrimp *(Pandalus borealis* also called *P. eous or P. borealis eous),* Spot prawn *(P. platyceros), Sidestripe shrimp (P. dispar),* Coonstripe shrimp *(P. hypsinotus),* Pink shrimp *(P. jordani),* Dock shrimp (known as Coonstripe shrimp in California) *(P. danae)* and Ridgeback shrimp *(Sicyonia ingentis)*. These species are captured with bottom trawls and traps. The Oregon pink shrimp fishery using bottom trawls is not included in this report as it is Marine Stewardship Council certified.

Production statistics and importance to the 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.

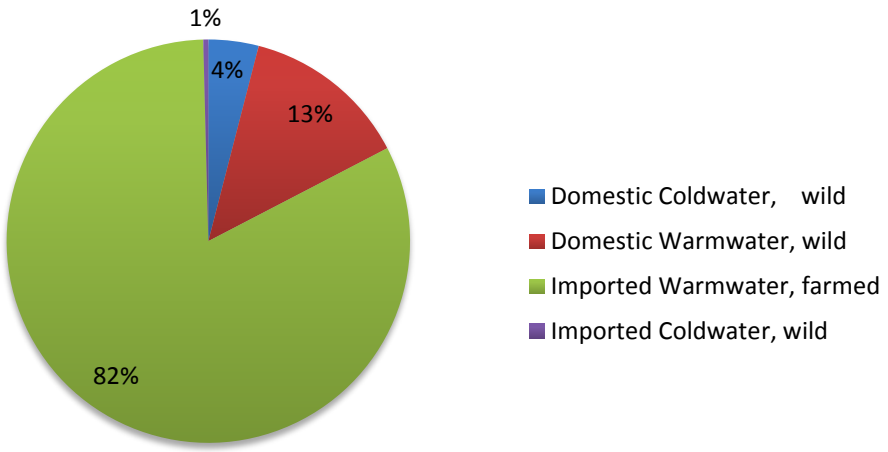


Figure 1. Domestic coldwater shrimp are harvested from the Atlantic and Pacific Oceans, warm water shrimp from the Gulf of Mexico and South Atlantic Ocean. Nearly all imports are of warm water shrimp (which are primarily farmed), the tiny amount of coldwater imports come from Canada (NOAA Fisheries 2011).

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. This model has worked well for them for the most part. 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).

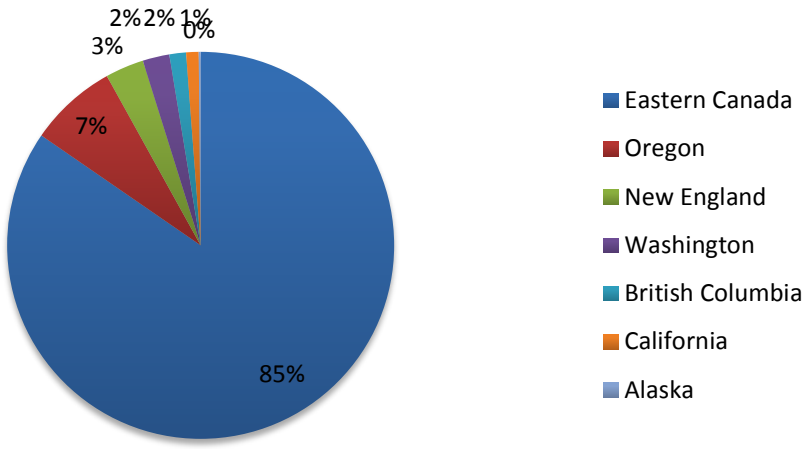


Figure 2. 2010 US and Canadian landings include all species of coldwater shrimp combined (NOAA Fisheries 2011).

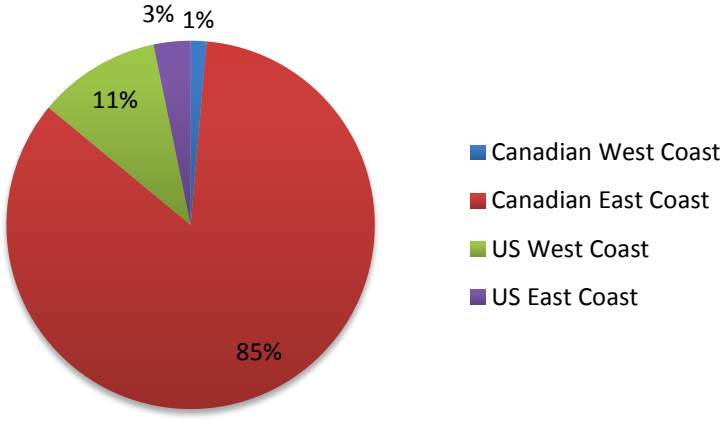
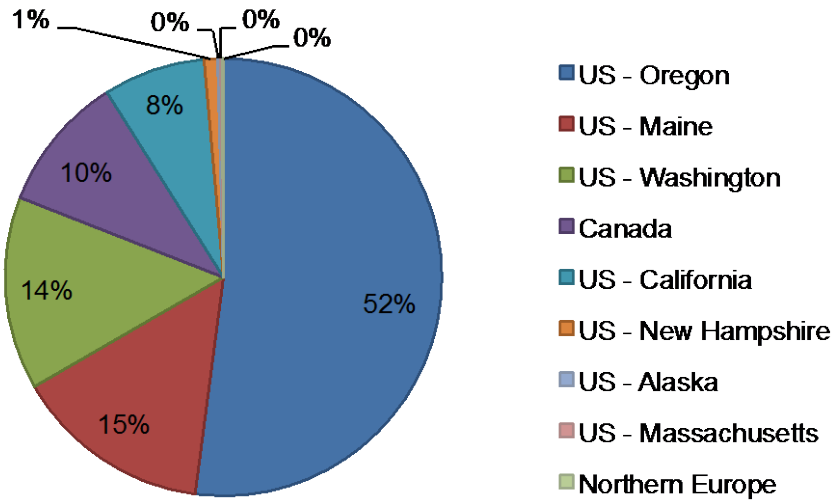


Figure 3. 2010 coldwater shrimp landings by coastal region: Eastern Canada and the Western US are the most productive shrimp regions in North America (NOAA Fisheries 2011).

a)



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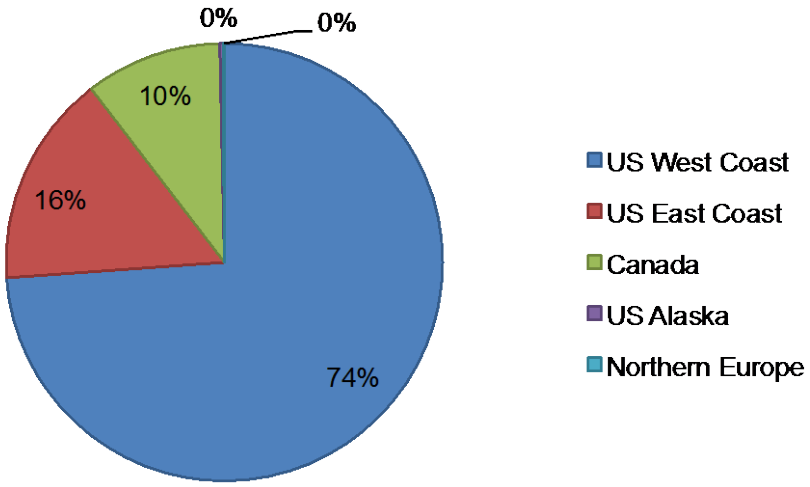
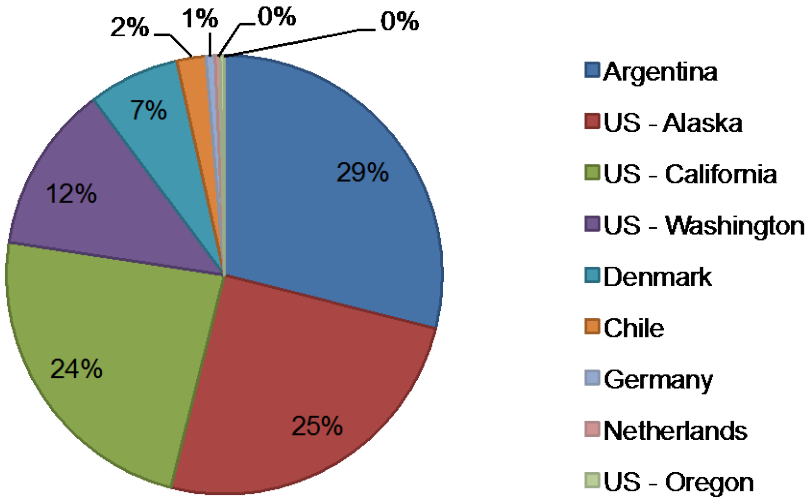


Figures 4a and 4b. Origin of lower-priced coldwater shrimp (including northern, pink and striped shrimp) available on the US market (based on data from 2009-2011) by a) state/country, b) region (NMFS 2013e, CDFG 2013c, ODFW 2011, Q. Smith ADFG). Note: Canadian shrimp are primarily of East Coast origin.

a)



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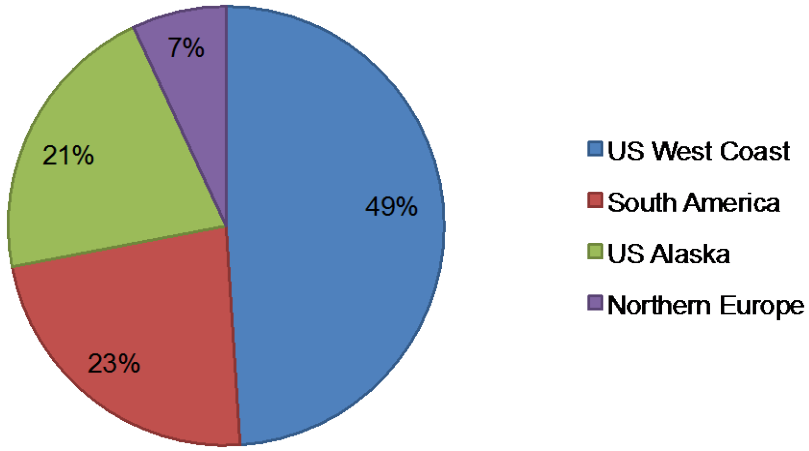

Figures 5a and 5b. Origin of higher-priced coldwater shrimp (including dock/coonstripe, sidestripe and coonstripe shrimp and spot and ridgeback prawns from the US, Argentine red shrimp from South America, and brown shrimp from the North Sea) available on the US Market (based on data from 2009-2011) by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

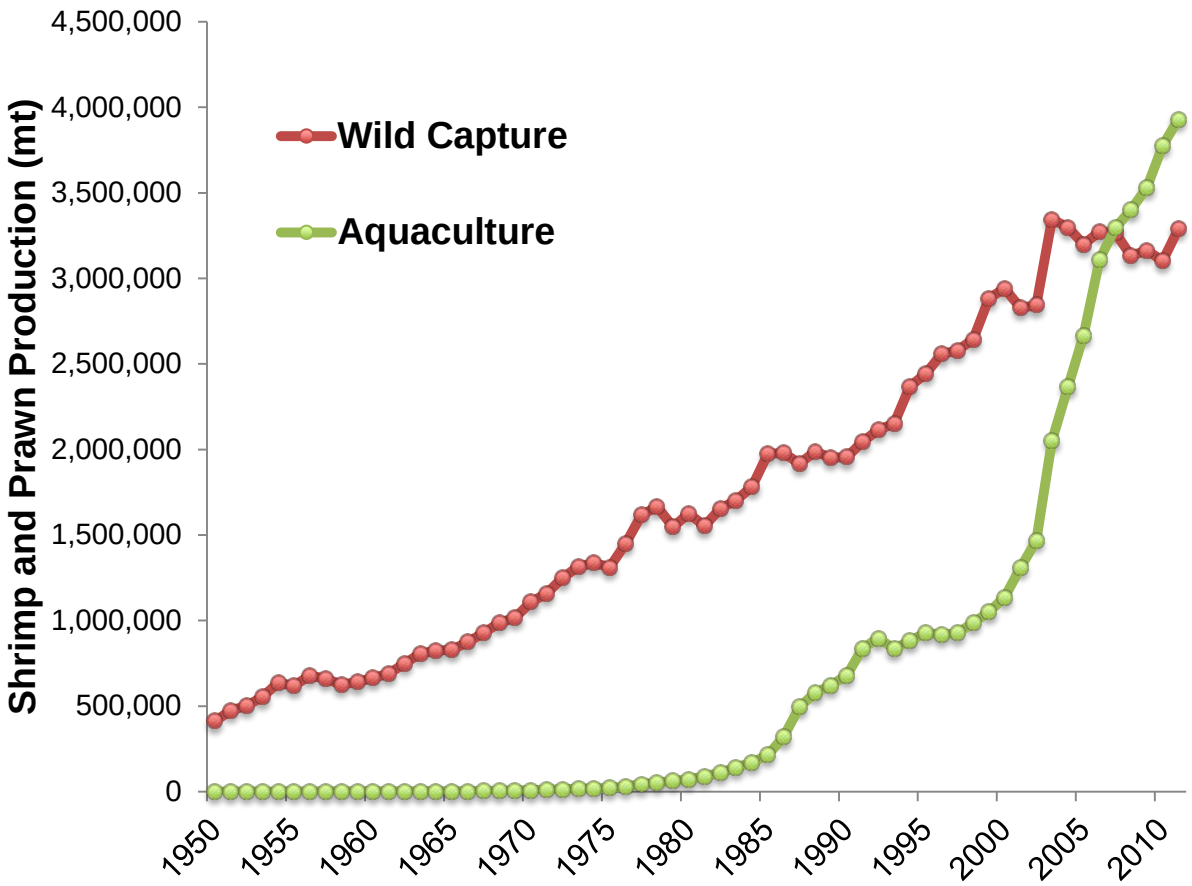

Figure 6. Global shrimp production, all species, wild captured and farmed 1950-2011. Based on data sourced from the FishStat database (FAO 2013a, FAO 2013b).

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, simply cannot compete. In 2011, only 45 of 243 fishing licenses were active and the last processor has long since closed up shop. 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.).

A similar fate befell Alaskan trawlers when, after 80 years, their main processor in Petersburg shut down. Without a local buyer, and unable to compete in the global market, fishing effort has fallen rapidly. Of the 5 fishing licenses active in 2010, these fishermen have also begun to focus more on sidestripe shrimp as a potential new market.

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 market value is many times more than for trawl harvested shrimp (e.g. in 2012 in California spot prawns, pink shrimp and ridgback shrimp were valued at USD$11.56/ lb., USD$0.45/lb, and USD$2.43/lb, respectively; CDFG 2013c).

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 can be confusing and are not well regulated. Market names for coldwater shrimp 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.

California, Oregon, Washington
US shrimp fisheries are managed at the state level although some federal regulations apply, namely for the pink shrimp trawl fishery which is managed according to open access rules fishery under the West Coast Groundfish Fishery Management Plan (though the fishery in all of Washington and Oregon and part of California in limited entry). California, Oregon and Washington have separate management agencies (California Department of Fish and Wildlife (CDFW), Oregon: Oregon Department of Fish & Wildlife (OR-DFW) Washington Department of Fish & Wildlife (WDFW)) responsible for shrimp fishery management, they formally cooperate over pink shrimp trawl management with the Pacific Fishery Management Council (PFMC) as of 2007. Pink shrimp account for the majority of landings and revenue from US West Coast shrimp fisheries, led by Oregon (Table 2). Oregon, whose pink shrimp fishery is MSC certified, carries out stock assessments for pink shrimp.

Of these three states, California has the largest and most successful trap fishery and leads landings for both spot prawns and the developing CA coonstripe (dock) shrimp market. California's spot prawn trap fishery is seasonal and is restricted access. It is regulated under a three-tiered permit system (as of 2004), which limits the number of vessels, traps per vessel and landings per vessel

(per year) (CDFG 2013a). Washington's spot prawn trap fishery is restricted access (since 1999), seasonal (as of 2006) and is currently capped at 8 licenses (as of 2011) (Wargo et al. 2013). Spot prawns are the most valuable, pound for pound.

The California ridgeback shrimp trawl fishery is seasonal with regulatory provisions for restricted access (although a restricted access system is not in place) (CDFG 2013a). Spot prawns are the most valuable, pound for pound.

Alaska

First recorded nearly 100 years ago, shrimp fisheries have historically occurred in Southeast Alaska, Prince William Sound, Kodiak, Chignik and the Alaska Peninsula and the Bering Sea/Aleutian Islands Area. Today, however, these fisheries have dwindled down to nearly nothing, with the exception of Southeast Alaska. Prince William Sound also has a very small trap fishery for spot prawns that just reopened four years ago after an 18-year closure due to the Exxon Valdez oil spill. Landings from Prince William Sound represent only about 10% of the landings in Southeast Alaska; therefore Southeast Alaska will be the focus of this report. If conditions change in the future, this approach may need to be modified.

The Alaska Department of Fish and Game (ADFG) manages the remaining trawl and trap fisheries. The current fleet is comprised of vessels outfitted with beam trawls (60' or less) and mesh panels to screen out bycatch. The trawl fishery has traditionally primarily targeted northern shrimp and secondarily sidestripe shrimp, but with the decline in price per pound for northern shrimp the catch in recent years has shifted to sidestripe. Since the 2008/09 season, sidestripe shrimp have comprised 56% of the harvest on average. Therefore, both northern and sidestripe shrimp will be assessed.

The trap fishery constitutes the bulk of Alaskan shrimp landings and accounted for approximately 80% of total landings in 2010/11. Shrimp derived from the trap fishery are many times more valuable than shrimp harvested by trawl. The trap fishery targets primarily spot prawns but also lands a small amount of coonstripe shrimp. Coonstripe are labeled as such and sold separately from spot prawns, therefore both species will be assessed.

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 ***. Sources: Atlantic (Bergstrom 2000, DFO 2003); Pacific (Bergstrom 2000, CDFG 2001, Hannah and Jones 2003); Not for human consumption (CDFG 2001, and online sources)

Common names U.S./Canada	Scientific name	Range	U.S./Canadian fishery location
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
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
***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 shrimp	*Crangon franciscorum* (primarily)	Alaska to Southern California	San Francisco area
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	

Table 2: 2011 coldwater shrimp landings on the US West Coast (CA data from CA-DFG, Oregon data from OR-DFW, Washington data from WDFW and NMFS, Alaska data from Quinn Smith A-DFW). 'Others' include the ghost shrimp (*Callianassa californiensis*), the blue mud shrimp (*Upogebia pugettensis*), the red rock shrimp (*Lysmata californica*), and the brine shrimp (*Artemia* spp.), species that are primarily used as bait and in the aquarium trade so are beyond the scope of this report. * The Oregon pink shrimp fishery is not assessed in this report. Totals for each species may not sum precisely due to rounding.

Fishery	**Catch (MT)**
Shrimp, Pink (*Pandalus jordani*)	
Oregon*	21914.8
Washington	4342.4
California	3345.3
Prawn, Spot (*Pandalus platyceros*)	
Alaska	282.3
California	190.9
Washington	25.6
Oregon	8.7
Shrimp, Ridgeback (*Sicyonia ingentis*)	
California	88.0
Coonstripe/dock (*Pandalus danae*)	
California	35.5
Coonstripe (*Pandalus hypsinotus*)	
Alaska	6.3
Shrimp, Northern (*Pandalus borealis*)	
Alaska	166.6
Shrimp, Sidestripe	
Alaska	58.1
Others	
California	105.1
Washington	93.1
Oregon	45.4

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** Rank	**Stock Status** Rank (Score)	**Fishing Mortality** Rank (Score)	**Criterion 1** Rank Score
Coonstripe shrimp	California Trap (coonstripe)	Low	Moderate Concern (3)	Moderate Concern (2.33)	Yellow 2.64
Coonstripe shrimp	Alaska Trap	Low	Moderate Concern (3)	Low Concern (3.67)	Green 3.32
Northern shrimp	Alaska Trawl	Low	Moderate Concern (3)	Low Concern (3.67)	Green 3.32
Pink shrimp	California Trawl (pink)	Low	Moderate Concern (3)	Moderate Concern (2.33)	Yellow 2.64
Pink shrimp	Washington Trawl	Low	Moderate Concern (3)	Moderate Concern (2.33)	Yellow 2.64
Ridgeback shrimp	California Trawl (ridge)	Low	Moderate Concern (3)	Moderate Concern (2.33)	Yellow 2.64

Sidestripe shrimp	Alaska Trawl	Low	Moderate Concern (3)	Low Concern (3.67)	Green 3.32
Spot prawn	Alaska Trap	Low	Moderate Concern (3)	Low Concern (3.67)	Green 3.32
Spot prawn	California Trap (spot)	Low	Moderate Concern (3)	Low Concern (3.67)	Green 3.32
Spot prawn	Washington Trap	Low	Moderate Concern (3)	Low Concern (3.67)	Green 3.32

There are no quantitative stock assessments for any shrimp species caught on the west coast of the US, and no biological reference points have been defined. Stock status is unknown for all species. Fishing mortality reference points are similarly undefined, but the small size of many of the fisheries and the suite of measures applied in several fisheries to limit effort and protect spawning stocks increase the likelihood that those stocks are being fished sustainably.

Scoring

Factor 1.1 - Inherent Vulnerability to Fishing

- Low = FishBase vulnerability score for species 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 = FishBase vulnerability score for species 36-55 OR life history characteristics that make it neither particularly vulnerable or 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 = FishBase vulnerability score for species 56-100 OR 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

- 5 (Very Low Concern) = Strong evidence that 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 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 species has a high inherent vulnerability to fishing.
- 1 (Very High Concern) = Population is listed as threatened or endangered.

Factor 1.3 - Fishing Mortality

- 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 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 (California, Washington)

Factor 1.1 Inherent Vulnerability Score**: Low inherent vulnerability**
All coldwater shrimp species are considered to have high resilience.

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: **Moderate Concern**
Stock assessments are not performed on pink shrimp anywhere on the US west coast (L. Wargo, WDFW, pers. comm.; B. Hannah, ODFW, pers. comm.; Frimodig 2012) so stock status is unknown.

Rationale:
Research from the Oregon fishery suggests that the stock-recruitment relationship is driven by environmental conditions rather than by the fishery (Hannah 2010, Hannah 2011). For this reason, no reference points have been defined. Instead, managers rely on CPUE indices, an indicator of relative stock biomass. These data are presented annually for shrimp landed into Oregon ports (which include some portion of the shrimp caught off Washington) (L.Wargo, pers.com.) (Figure 7), and a limited time series of CPUE data for the California fishery is also available (Figure 9). CPUE indices of the catch landed in Oregon ports have been at record highs in recent years (Figure 7). Early efforts at estimating relative biomass and establishing reference points for the Oregon fishery as a condition of MSC certification also indicate relatively high spawning biomass (in 2009, the latest year presented)(Figure 8). Given that genetic evidence suggests a single coast wide stock of pink shrimp (CDFG 2006), relatively high biomass off Oregon may be indicative of the same off California and Washington. WDFW are currently analyzing data from the newly re-established logbook program and state observer program, which may provide additional information on pink shrimp biomass off Washington in the near future (L.Wargo, pers.com.). For now, however, there are not enough data and analysis to conclude that managers have a robust estimate of stock status in California or Washington, resulting in a 'moderate' rating for both.

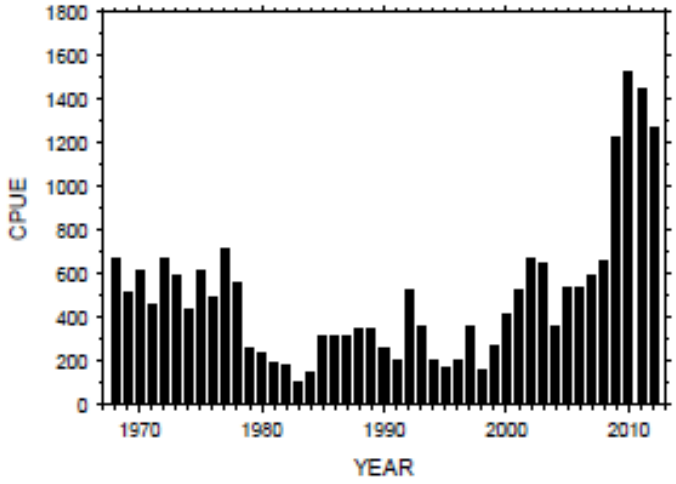

Figure 7: Catch-per-unit-of-effort (CPUE = lbs/SRE hour) for vessels landing pink shrimp into Oregon; 1968-2012 (Hannah and Jones 2013).

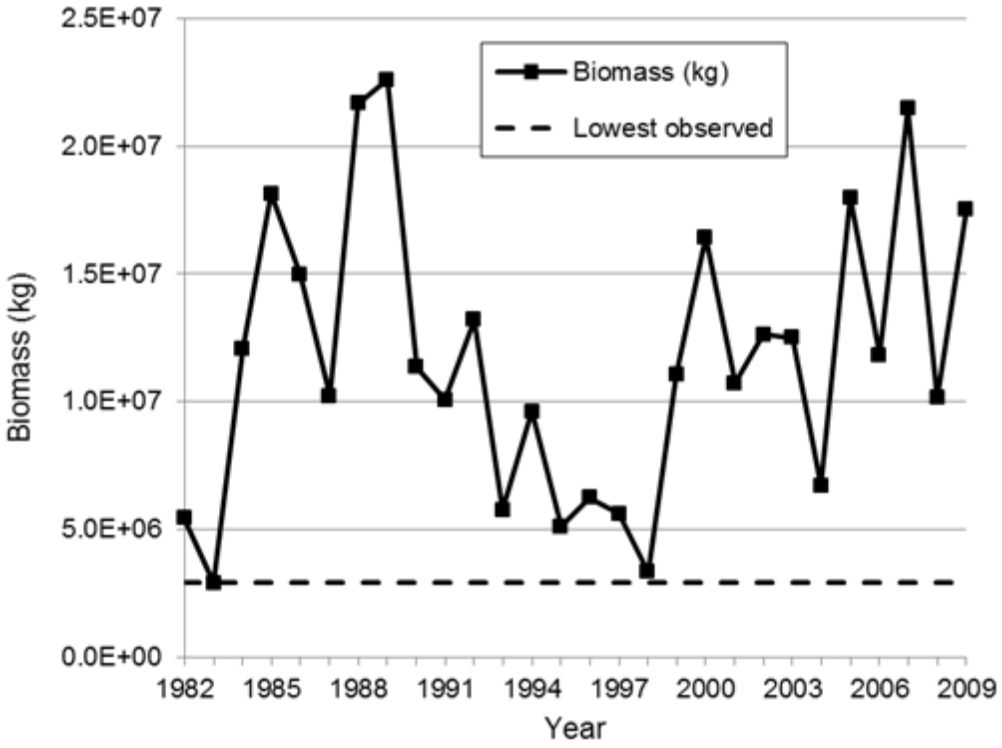

Figure 8: Model estimates of pink shrimp spawning biomass, 1982-2009 compared to the lowest observed spawning biomass (1983, heavy dashed line) (Hannah and Jones 2013).

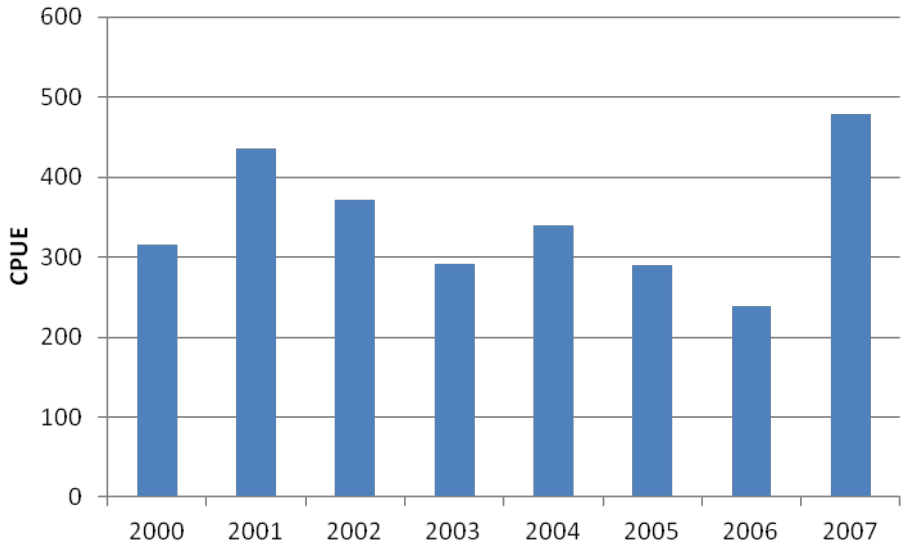

Figure 9: CPUE for pink shrimp in California from 2000-2007. CPUE is catch (kg) divided by trawl effort (SRE h). Source: CDFG pink shrimp logbook data and market receipt data from CFIS (2008) (from Frimodig et al. 2009).

Factor 1.3 Fishing Mortality Score: **Moderate Concern**
As noted above, there are no stock assessments or reference points for the pink shrimp fisheries off the west coast, though this is likely to change soon at least for the Oregon fishery. The effect of the fishery on the population is therefore currently unknown.

Spot Prawn (California, Washington, Alaska)

Factor 1.1 Inherent Vulnerability Score**: Low inherent vulnerability**
All coldwater shrimp species are considered to have high resilience.

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: **Moderate Concern**
No quantitative stock assessments have been conducted for spot prawns in California, Washington or Alaska, and no reference points have been established except in Alaska, where each management area has baseline relative abundances (M.O'Toole, WDFW, pers.com., Smith et al. 2012; Smith pers. comm.). Catches in these regions have varied over the years, but this is likely due to changes in market demand, fishing effort, and management regulations, rather than changes in abundance (Larson and Reilly 2007, Wargo and Ayres 2013).

In California, no studies to understand population structure have been conducted (Larson and Reilly 2007) and stock status is considered unknown.

In Washington, commercial spot prawn fishing occurs in the Puget Sound and on the coast. The fisheries are regulated separately (Wargo and Ayres 2013). There is some monitoring of the Puget Sound fishery, but no quantitative assessments have been conducted, and no reference points defined. There is no monitoring of coastal spot prawn populations, so abundance is unknown.

In Alaska, a stock assessment program is conducted annually for shrimp fisheries (though not necessarily published due to confidentiality concerns) using the limited fishery dependent and independent data available (Smith et al. 2012; Smith pers. comm.). The most recent assessment designated stock status as closed in 3, poor in 1, below average in 5, moderate in 9, above average in 3 (Q. Smith, ADFG, pers. comm.). The findings from this assessment are used for setting harvest limits rather than estimating shrimp population size (see factor 1.3 below), and data availability is generally insufficient to assess the latter (Smith et al. 2012). There is some evidence that some spot prawn populations are not as robust as in recent years however, as reflected by declining catch rates, decreased catch limits (GHLs), and biological evaluations of a few specific populations (Smith et al 2012). Overall, stock status of Alaskan spot prawn populations is considered a moderate concern.

Factor 1.3 Fishing Mortality Score: **Low conservation concern**

In California, the spot prawn fishery is a small, limited access and restricted effort fishery that is considered sustainable by managers (Larson and Reilly 2007, Sweetnam 2011). Effort is controlled through a limited access permit system comprised of three tiers (see management section). Of the 28 vessels with permits in 2010, 19 landed spot prawn (Sweetnam 2011). Fifteen of these operated off Southern California, where the fishery is closed annually to protect spawners. The fishery north of Point Arguello is closed during the winter, which does not protect spawners (it is to reduce gear conflicts), but effort (number of traps) is restricted year round in this area (Larson and Reilly 2007, Sweetnam 2011). Thus, while there are no quantitative estimates of fishing mortality relative to reference points, small size, restricted access, effort controls and/or closures to protect spawners, and management classification of sustainable suggests a 'low' conservation concern.

In Washington, the catch of the coastal fishery is capped at 200,000 lbs, split evenly between two regions (north and south). The TAC is based on MSY estimates of 99,000 lbs for the north and 104,000 lbs for the south (Wargo and Ayres 2013). TACs have not been exceeded in the last decade (Figure 11), suggesting fishing mortality is likely sustainable. In the Puget Sound, the spot prawn fishery is carried out through a State-Tribal Shrimp Management Plan process, whereby managers meet annually to make adjustments as needed. Harvest control rules are used to prevent exceeding quotas, which are set individually for each of the Shrimp Management Areas (Figure 10). The original quotas were set based on historical landings from the late 1980s and early 1990s. Adjustments are based on data from commercial logbooks, recreational catch rates and pre- and post-season surveys conducted by the state and tribal managers. Agreed upon quotas are then divided evenly between the state and the tribes per court order (M. O'Toole, WDFW, pers. comm., Childers 2012). Given that quotas have generally been adhered to, it is probable (but not highly likely) that fishing mortality is at a sustainable level. Therefore, fishing mortality is a 'low' conservation concern for the coastal and Puget Sound spot prawn populations.

In the Alaska spot prawn fishery, data availability is generally inadequate to estimate appropriate harvest rates for sustainable yield (Smith et. al 2012). For this reason, management sets conservative harvest limits for each of 21 management areas based on the results of the annual (limited) stock assessment, and closes the fishery in any area if the limits are exceeded (Smith et al.

2012). Managers have successfully avoided exceeding the limits for the past several years (Smith 2011). Therefore, conservation concern is 'low'.

Rationale:

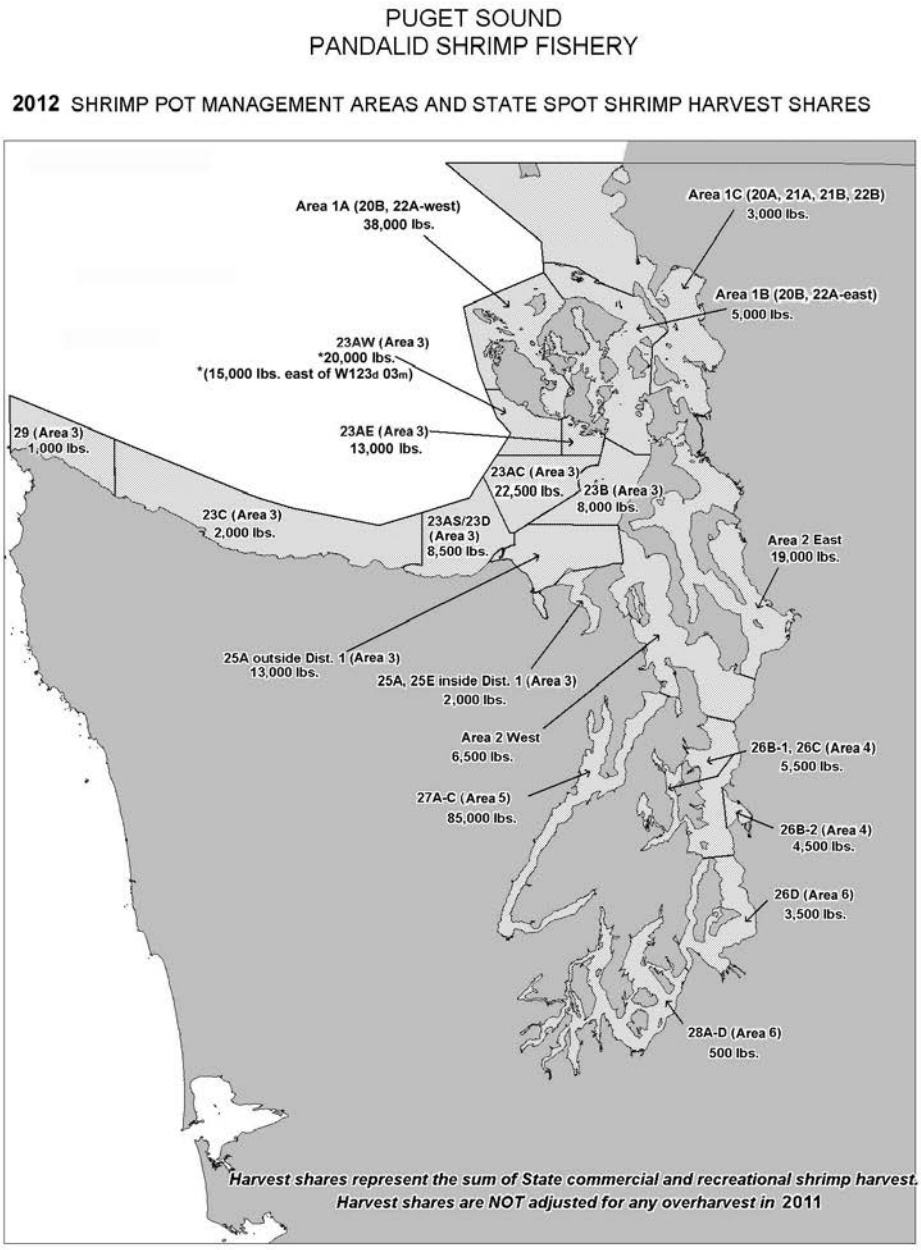

Figure 10. Map depicting individual quota areas for the spot prawn fishery in Puget Sound, Washington (M. O'Toole, WDFW, pers. comm.).

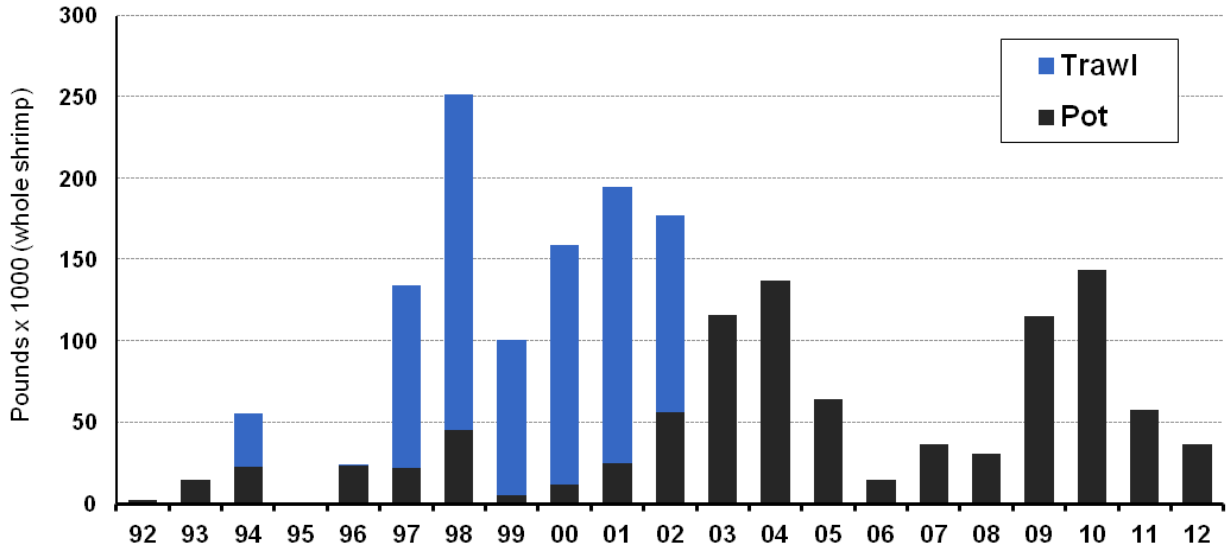

Figure 11: Coastal commercial non-treaty spot shrimp harvest (pounds) by year and gear type (trawls were banned in 2003) (Wargo and Ayres 2013).

Coonstripe (dock) Shrimp (California)

Factor 1.1 Inherent Vulnerability Score**: Low inherent vulnerability**
All coldwater shrimp species are considered to have high resilience.

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: **Moderate Concern**
Managers suggest that effort and landings of dock shrimp (called coonstripe shrimp in California) appear relatively stable (given the short history of the fishery) (McVeigh 2009). However, there

have been no estimates of abundance or other population parameters such as recruitment or mortality rates to date for dock shrimp, so stock status is unknown (McVeigh 2009).

Factor 1.3 Fishing Mortality Score: **Moderate Concern**
The CA coonstripe (dock) shrimp fishery consists of a handful of vessels that typically also fish for Dungeness crab (the seasons complement each other). In 2008, seven vessels landed dock shrimp, all of which also had permits to fish for Dungeness crab (McVeigh 2009). However, it is an open access fishery without effort controls, and about three times the number of permits are sold each year than vessels actually fishing (McVeigh 2009). Managers are aware of the potential problem, and have set a control date of November 1 2001 in case a limited access program is considered in the future (this is likely the reason so many more permits are sold than used each year). The relatively limited distribution of the fishable stock of dock shrimp may increase its vulnerability to overfishing, and the current closed area to protect spawners is based on very limited information and as such its effectiveness is unknown (McVeigh 2009). Due to the ambiguity over fishing mortality, this subfactor is rated as 'Moderate Concern'. See Figure 14 for CA coonstripe shrimp landings data from 1995 to 2008.

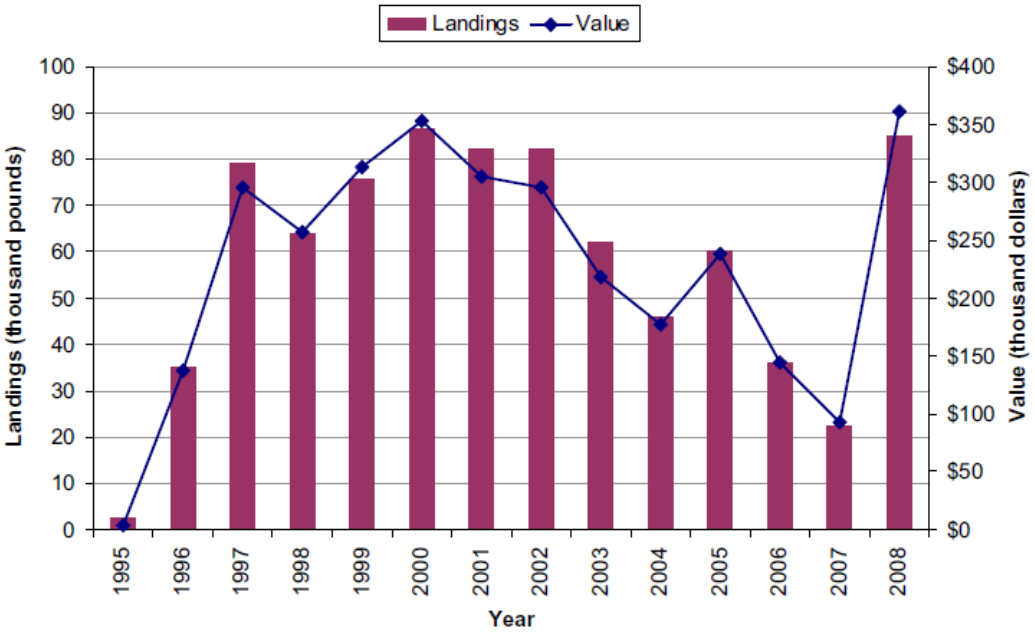

Figure 12: CA coonstripe (dock) shrimp commercial landings and value in California, 1995-2008 (McVeigh 2009).

Ridgeback shrimp (California)

Factor 1.1 Inherent Vulnerability Score**: Low inherent vulnerability**
All coldwater shrimp species are considered to have high resilience.
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: **Moderate Concern**

No population assessments have been conducted for ridgeback shrimp (Owens 2006). Trawl surveys suggest it is a relatively abundant species over parts of the continental shelf and upper slope in the Southern California Bight (Owens 2006). The landings and CPUE trend suggests population structure is environmentally driven: both of the peaks in CPUE in Figure 15 are two years after the biggest El Niño Southern Oscillation (ENSO) events in recent years (prior to 2006) and ridgeback prawns recruit to the fishery at age one or two (Owens 2006). The CPUE trend declines from 2000-2006 (Figure 15, Owens 2006). However, stock status remains unknown.

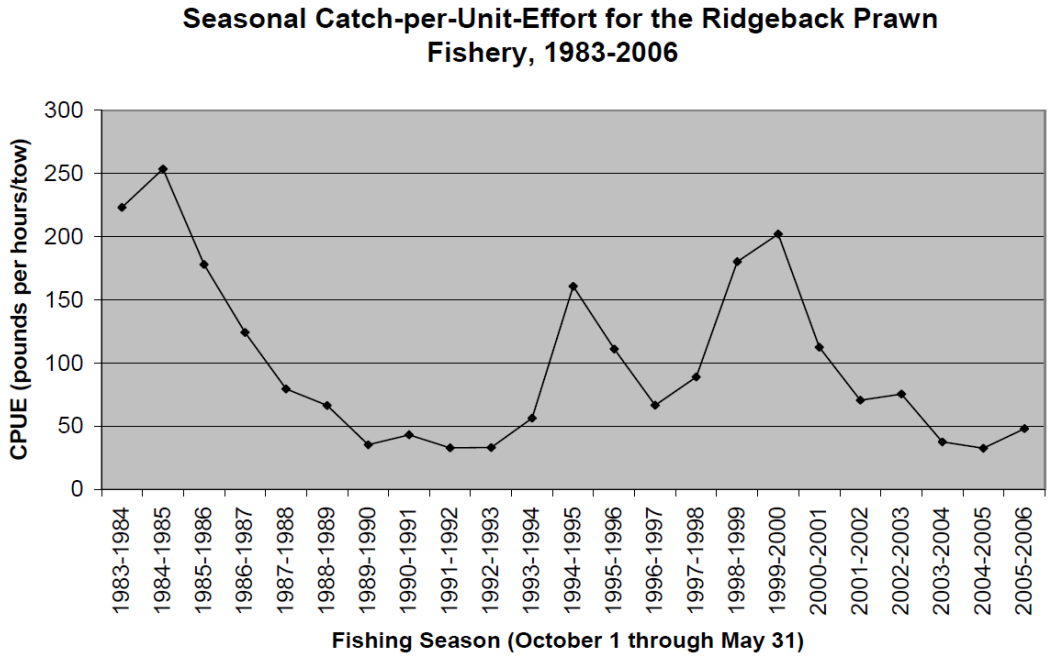

Figure 13: Commercial CPUE for ridgeback prawn by fishing season, 1983-2006 (Owens 2006).

Factor 1.3 Fishing Mortality Score: **Moderate Concern**

As noted above, ridgeback CPUE declined from 2000-2006 (Figure 15), but landings and CPUE appear strongly affected by ENSO events (Owens 2006), perhaps more so than by fishing mortality. There has also been a decline in the number of active vessels, from 38 in the 1999-2000 season to 11 in the 2005-2006 season (Owens 2006). A closure is in place from June to September to protect spawners (Owens 2006), trawl restrictions (closure of state waters and all depths less than 150 feet to ridgeback trawling), and federal closures to protect overfished groundfish may also restrict effort in the fishery (Owens 2006).

Coonstripe Shrimp (Alaska)

Factor 1.1 Inherent Vulnerability Score**: Low inherent vulnerability**
All coldwater shrimp species are considered to have high resilience.

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: **Moderate Concern**
As for spot prawns (noted above), data availability for coonstripe shrimp in Southeast Alaska is generally inadequate to estimate shrimp population size (Smith et. al 2012). The results of the minimal stock assessment program are used to set catch limits (Guideline Harvest Limits or GHLs) rather than estimate shrimp population size (see factor 1.3 below). Stock status is therefore deemed unknown.

Factor 1.3 Fishing Mortality Score: **Low conservation concern**
As for spot prawns (noted above), data availability for coonstripe shrimp stocks in Southeast Alaska is generally inadequate to estimate appropriate harvest rates for sustainable yield (Smith et. al 2012). For this reason, management sets conservative harvest limits for each of 21 management areas based on the results of the annual stock assessment, and closes the fishery in any area if the limits are exceeded (Smith et al. 2012). Also as noted above, GHLs are based on coonstripe rather than spot prawns for districts 15 and 16; these districts are doing relatively well (Q. Smith, ADFG,

pers. comm., Smith et al 2012). Managers have successfully avoided exceeding the limits for the past several years (Smith 2011).

Northern Shrimp and Sidestripe Shrimp (Alaska)

Factor 1.1 Inherent Vulnerability Score**: Low inherent vulnerability**
All coldwater shrimp species are considered to have high resilience.

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: **Moderate Concern**
No quantitative stock assessments are performed, but fishery dependent data is collected. For northern shrimp, available information indicates that stocks are low in the western and central Gulf of Alaska (where the fishery has been closed for decades), with higher abundances in the southeast Gulf (ADFG website). Stock status is considered unknown.

Factor 1.3 Fishing Mortality Score: **Low conservation concern**
While fishing mortality is unknown due to a lack of stock assessment, there has been a major reduction in effort has taken place so fishing mortality is likely relatively low (Smith 2011). Guideline Harvest Ranges (GHRs) have been used for years to avoid overfishing. This makes it probable that fishing mortality is at or below a sustainable level. In addition, susceptibility is believed to be low due to depressed fishing effort (Smith 2011).

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.

Washington pink shrimp trawl fishery

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)	High Concern (1)	1.00	1.00	Red
Pink shrimp	Low	Moderate Concern (3)	Moderate Concern (2.33)	2.64	2.64	Yellow

Washington spot prawn trap fishery

Stock	**Inherent Vulnerability** Rank	**Stock Status** Rank (Score)	**Fishing Mortality** Rank (Score)	**Subscore**	**Score** (subscore* discard modifier)	**Rank** (based on subscore)
Unspecified finfish	Moderate	Moderate Concern	Low Concern (3.67)	3.32	3.15	Green
Unspecified invertebrates	Moderate	Moderate Concern (3)	Low Concern (3.67)	3.32	3.15	Green
Spot prawn	Low	Moderate Concern (3)	Low Concern (3.67)	3.32	3.15	Green

California pink shrimp trawl fishery

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)	High Concern (1)	1.00	1.00	Red
Pink shrimp	Low	Moderate Concern (3)	Moderate Concern (2.33)	2.64	2.64	Yellow

California spot prawn trap fishery

Stock	**Inherent Vulnerability** Rank	**Stock Status** Rank (Score)	**Fishing Mortality** Rank (Score)	**Subscore**	**Score** (subscore* discard modifier)	**Rank** (based on subscore)
Humpback whale	High	Very High Concern (1)	Very Low Concern (5)	2.24	1.90	Yellow
Yelloweye rockfish	High	High Concern (2)	Very Low Concern (5)	3.16	2.69	Yellow
Cowcod	High	High Concern (2)	Very Low Concern (5)	3.16	2.69	Yellow
Spot prawn	Low	Moderate Concern (3)	Low Concern (3.67)	3.32	2.82	Green
Unspecified invertebrates	Moderate	Moderate Concern (3)	Low Concern (3.67)	3.32	2.82	Green
Unspecified finfish	Moderate	Moderate Concern (3)	Low Concern (3.67)	3.32	2.82	Green

California coonstripe (dock) shrimp trap fishery

Stock	**Inherent Vulnerability** Rank	**Stock Status** Rank (Score)	**Fishing Mortality** Rank (Score)	**Subscore**	**Score** (subscore* discard modifier)	**Rank** (based on subscore)
Coonstripe shrimp	Low	Moderate Concern (3)	Moderate Concern (2.33)	2.64	2.51	Yellow
Unspecified finfish	Moderate	Moderate Concern (3)	Low Concern (3.67)	3.32	3.15	Green
Unspecified	Moderate	Moderate Concern	Low Concern (3.67)	3.32	3.15	Green

California ridgeback prawn trawl fishery

Stock	**Inherent Vulnerability** Rank	**Stock Status** Rank (Score)	**Fishing Mortality** Rank (Score)	**Subscore**	**Score** (subscore* discard modifier)	**Rank** (based on subscore)
Ridgeback shrimp	Low	Moderate Concern (3)	Moderate Concern (2.33)	2.64	2.64	Yellow
Unspecified finfish	Moderate	Moderate Concern (3)	Low Concern (3.67)	3.32	3.32	Green
Unspecified invertebrates	Moderate	Moderate Concern (3)	Low Concern (3.67)	3.32	3.32	Green

Alaska spot prawn and coonstripe shrimp trap fishery

Stock	**Inherent Vulnerability** Rank	**Stock Status** Rank (Score)	**Fishing Mortality** Rank (Score)	**Subscore**	**Score** (subscore* discard modifier)	**Rank** (based on subscore)
Unspecified finfish	Moderate	Moderate Concern	Low Concern (3.67)	3.32	3.15	Green
Spot prawn	Low	Moderate Concern (3)	Low Concern (3.67)	3.32	3.15	Green
Coonstripe shrimp	Low	Moderate Concern (3)	Low Concern (3.67)	3.32	3.15	Green
Unspecified	Moderate	Moderate Concern	Low Concern (3.67)	3.32	3.15	Green

Alaska northern shrimp and sidestripe shrimp trawl fishery

Stock	**Inherent Vulnerability** Rank	**Stock Status** Rank (Score)	**Fishing Mortality** Rank (Score)	**Subscore**	**Score** (subscore* discard modifier)	**Rank** (based on subscore)
Northern shrimp	Low	Moderate Concern (3)	Low Concern (3.67)	3.32	3.32	Green
Sidestripe shrimp	Low	Moderate Concern (3)	Low Concern (3.67)	3.32	3.32	Green
Unspecified finfish	Moderate	Moderate Concern (3)	Low Concern (3.67)	3.32	3.32	Green
Unspecified invertebrates	Moderate	Moderate Concern (3)	Low Concern (3.67)	3.32	3.32	Green

Bycatch of unwanted species is frequently a problem in unselective gears such as bottom trawls. Bycatch Reduction Devices (BRDs) are required for all of the trawl fisheries assessed in this document, a measure that has generally minimized bycatch to a few % (relative to landings) across the board. The bycatch of the recently listed eulachon remains a major concern in the California and Washington pink shrimp fisheries however. Bycatch mortality in shrimp pot fisheries is poorly known. Multiple studies suggest the quantity of bycatch can be considerable, but most of it is invertebrate species that are generally thought to survive once released. Bait use in pot fisheries can also be significant, but few data are available for the fisheries assessed here.

The catch composition in many of the fisheries assessed in this report is unknown or poorly known. In these cases, the 'unknown bycatch matrix' provides a basis for identifying taxa at risk, consistent with the Seafood Watch criteria (SFW Criteria 2013).

Criterion 2 Assessment

Pink shrimp trawl (California, Washington)

The NMFS West Coast Groundfish Observer Program (WCGOP) provides annual summaries of the observed catch in many fisheries off the West Coast, including the pink shrimp trawl fishery (NWFSC 2011a). In 2011, pink shrimp comprised 96-98% of the catch in all three states (97.5%

combined). Therefore, no other species comprised a significant portion of the catch (i.e. >5%). However, several species caught in the fishery are considered overfished (cowcod *Sebastes levis*, Pacific ocean perch *S. alutus*, canary rockfish *S. pinneger*, yelloweye rockfish *S. ruberimmus*) and Pacific eulachon (*Thaleichthys pacificus)* have recently been designated Threatened under the Endangered Species Act (ESA). This assessment will focus on Pacific eulachon as the pink shrimp trawl fishery is known to be the major source of fishing mortality for the species (Al-Humaidhi 2012).

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

Factor 2.2 Stock status score – Very High Concern
Eulachon have been listed as threatened under the ESA since 2010 (NMFS 2012).

Factor 2.3 Fishing mortality score – High Concern
NMFS has declared that the pink shrimp trawl fisheries of Washington, Oregon and California are the largest source of eulachon bycatch for the entire West coast of the United States (Al-Humaidhi et al. 2012). Oregon has the highest amount of eulachon bycatch, but California generally has the highest bycatch ratio (Al-Humaidhi et al. 2012). This 2012 declaration comes despite the current bycatch reduction devices (BRDs) required on shrimp trawls. Additional regulations in all three states include maximum shrimp count per pound requirements, and vessel limits on maximum groundfish weights landed per trip (NWFSC 2011b).

NMFS has initiated the federal recovery planning process and a draft recovery plan is estimated for completion by September 2015 (see Appendix A). An interim federal recovery outline published in 2013 identified 16 threats to eulachon recovery. The top four primary threats are eulachon bycatch, dams/ water diversions, and climate impacts to both freshwater habitats and ocean conditions. Bycatch is ranked second, just behind climate impacts to ocean conditions, for the Columbia and Fraser Rivers and ranked third for the Klamath River (NMFS 2013f). The pink shrimp trawl fisheries of the West Coast encounter eulachon in almost all fishing areas (Al-Humaidhi et al. 2012); therefore these fisheries are considered to be a primary threat to eulachon recovery (NMFS 2013f).

As of the publication date of this report, the most recent regulation pertaining to eulachon bycatch is the 2012 rigid-grate BRD requirement with reduced grate size in Oregon and Washington (Wargo 2012).

Factor 2.4 Overall discard rate – 0-20%
In 2011, pink shrimp comprised 96-98% of the shrimp trawl catch (in mt) in all three states (97.5% combined) (NWFSC 2011a).

Ridgeback trawl

Ridgeback permit holders are permitted to land sea cucumbers in any number (assuming the permit holder also has a permit for sea cucumber), but the landing of other species is restricted to 1000lbs per trip including no more than 300lbs of groundfish (Owens 2006). Vessels must also use rigid-grate BRDs in their nets to minimize bycatch, devices that have proven effective in reducing bycatch in cold-water shrimp trawls (e.g. the pink shrimp fishery above) (Owens 2006).

Due to the lack of data on bycatch in the fishery, the ridgeback trawl fishery will be scored according to the unknown bycatch matrix (SFW Criteria 2013). The matrix lists the following taxa as the most likely to interact with coldwater shrimp trawl fisheries: Benthic invertebrates, finfish, forage fish, sharks and corals and other biogenic habitats. Sharks are excluded from this assessment as they are most likely excluded by the BRD, and corals and other biogenic habitats are excluded because the fishery operates over soft bottom habitat composed of green mud, shell and sand (see Criterion 4.1). Benthic invertebrates, finfish and forage fish all score the same in the matrix and so are assessed together below.

Factor 2.1 Inherent Vulnerability score– Moderate
High = marine mammals, turtles, sharks, seabirds, deepwater and shallow biogenic habitat (seagrass beds, coral, sponges, etc.). Moderate = invertebrates and fish (SFW Criteria 2013).

Factor 2.2 Stock Status score - Moderate Concern
Factor 2.2 is scored as "moderate concern" if the taxon is comprised largely of species that are either of high vulnerability as scored in Factor 2.1, or overfished, endangered or threatened within the range of the fishery (e.g., sea turtles, seabirds, marine mammals and sharks); in these cases, it is scored as "high concern." (SFW Criteria 2013). There are a number of Pacific groundfish classified as 'overfished' but the vast majority are not (NMFS 2013d). No forage fish populations likely to interact with the ridgeback fishery are classified as overfished (NMFS 2013d). There is very little known about sea cucumber populations (CDFG 2013b).

Factor 2.3 Fishing Mortality score– Low Concern
Coldwater shrimp trawl fisheries score as a 'moderate' concern for benthic invertebrates, finfish and forage fish in the unknown bycatch matrix (SFW criteria 2013). However, given the very small size of the fishery and the use of BRDs, a score of 'low' concern is more appropriate.

Factor 2.4 Overall Discard Rate – 0-20%
It is likely that overall discard rates are low in this fishery because of the known low rates in other fisheries that use rigid-grate fish excluder devices (e.g. see pink shrimp fishery above).

Spot prawn trap (California, Washington)

(Alaska addressed below with the coonstripe trap fishery)

Directed studies or observations of bycatch in the spot prawn trap fisheries are few. A 2007 PhD

dissertation on the biology and fisheries of the spot prawn in Washington describes research conducted on this subject in 2003, and summarizes a similar study (Reilly and Geibel 2002) carried out by the California Department of Fish and Wildlife (CDFW) in 2000/01 (Lowry 2007). The earlier study found bycatch to spot prawn ratios were 0.79:1 in Washington, around 1:1 in Northern California, and around 2:1 in Southern California (Table 3). Observations by the WDFW in the coastal spot prawn fishery off Washington found highly variable bycatch ratios, but on average found a bycatch to spot prawn ratio of about 0.56 (Table 4)(Wargo and Ayres 2013). Invertebrates made up the vast majority of the non-prawn catch, especially echinoderms such as sea stars and urchins (primarily the fragile sea urchin *Allocentrotus fragilis)*. Yelloweye rockfish and cowcod were caught in small numbers in the California study (Reilly and Geibel 2002); both are currently overfished (NMFS 2011). No species of particular concern (e.g. overfished, or undergoing overfishing) were observed caught in the Washington studies (Lowry 2007, Wargo and Ayres 2013). In both cases, most invertebrates and fish other than rockfish could be returned to the water alive (Reilly and Geibel 2002, Lowry 2007), although there are no studies on post-release mortality. No other species are permitted to be retained in spot prawn traps in California, so all bycatch is usually returned to the water alive and with little harm (Larson and Reilly 2007, Sweetnam 2010).

The California spot prawn fishery is also listed as a Category 2 fishery in the Marine Mammal Protection Act List of Fisheries, meaning that the fishery causes occasional incidental mortality and serious injuries to marine mammals (NMFS 2013a). Specifically, the fishery is known to have entangled one humpback whale (*Megaoptera novaeangliae*) in 2005, and US West Coast pot fisheries in general (sablefish, Dungeness crab, and spot prawn fisheries only) are known to have entangled other humpback whales, though which specific fishery or fisheries is unknown (NOAA 2013b). The List of Fisheries also lists gray whales as being potentially caught in the spot prawn fishery, but no known interaction has actually occurred (Reilly, CDFW, pers.com.). Gray whales are also no longer listed under the Endangered Species Act, so this assessment will focus on humpback whales, which are listed as Endangered (NMFS 2012c).

Table 3. Summary of existing studies on US West Coast spot prawn trap fisheries (based on Lowry 2007, Reilly and Geibel 2003).

Year	#Pots	Bycatch to spot prawn ratio					Area
		Fish	Rockfish	Inverts	Total	Dead discards ratio*	
2000-2001	1600	0.15	0.04	0.9	1.09	0.24	Northern California
2000-2001	3000	0.22	0.07	1.8	2.09	0.47	Southern California
2003	958	0.03	0.002	0.7	0.732	0.15	Washington
2003-2007 (mean)	510	0.08	0.001	0.48	0.56	0.11	Washington Coastal
Mean		0.13	0.04	1.13	1.3	0.29	

Table 4. At-sea observations of the Washington coastal spot shrimp pot fishery, 2003-2007 (Wargo and Ayres 2013). * The dead discards ratio assumes that all other than spot prawns are discarded. According to Reilly (pers.com.), observed mortality upon release is very low in invertebrates and finfish other than rockfish and, in some cases, spotted cusk eel. A precautionary mortality rate of 20% is used here for species other than rockfish to account for the lack of post-release mortality studies. Rockfish mortality is assumed to be 100%.

Month/year	April 03	June 03	April 04	June 06	April 07	April 07	Mean	catch/ spot prawn landings ratio	Mort-ality rate (%)*	dead discards ratio*
#lifts observed	804	279	300	178	1248	250	3059			
Spot prawn	1245	445	295	137	2620	227	4969	100.00		
Bycatch	1029.4	213	456.9	4.8	991.2	73.7	2769	55.73		10.5
Finfish	**105.4**	**81.6**	**153.8**	**0.1**	**39.6**	**7.1**	**388**	7.80		0.91
Rockfish	**2**	**1.4**	**2.8**	**0.1**	**0.2**	**0.7**	**7**	0.14	**100**	0.14
Canary Rockfish	-	-	-	-	-	0.1	0	0.00		
Red banded rf	0.5	0.2	0.7	-	0.2	0.2	2	0.04		
Rockfish sp.	0.2	0.4	1.6	-	-	-	2	0.04		
Rosethorn Rockfish	1.3	0.8	0.5	0.1	-	0.4	3	0.06		
Other finfish	**51.7**	**40.1**	**75.5**	**0**	**19.7**	**3.2**	**190**	3.83	**20**	0.77
Hagfish sp.	18.2	23.4	42.1	-	15	-	99	1.99		
Kelp Greenling	-	5	0.6	-	-	-	6	0.11		
Lingcod	-	-	-	-	-	2.4	2	0.05		
Pacific Cod	3.1	-	-	-	-	-	3	0.06		
Poacher sp.	0.2	-	0.3	-	-	-	1	0.01		
Rat fish	2						2	0.04		
Sablefish	16.5	-	-	-	-	-	17	0.33		
Sculpin sp.	11.7	11.7	32.5	0	4.7	0.8	61	1.24		
Inverts	**924**	**131.4**	**303.1**	**4.7**	**951.6**	**66.6**	**2381**	47.93	**20**	9.59
Crab sp.	5.9	17.3	24.1	1.5	26.6	1.5	77	1.55		
Jellyfish sp.	-	0.2	-	-	-	-	0	0.00		
Octopus sp.	30.7	0.7	5	0	1.5	1.5	39	0.79		
Sea Stars sp.	130.3	75	201	3.2	323.4	34.7	768	15.45		
Snail sp.	117.7	14.9	10.4	-	250.5	8.2	402	8.08		
Urchin sp.	639.4	23.3	62.6		349.6	20.7	1096	22.05		

For the purposes of this assessment, two taxa will be assessed using the unknown bycatch matrix - non-shrimp invertebrates and rockfish. In addition, yelloweye rockfish, cowcod, and humpback whale will be included in the assessment for California.

Factor 2.1 Inherent Vulnerability score

Yelloweye rockfish (CA)- High
FishBase vulnerability score is 73 (Froese and Pauly 2012).

Cowcod (CA) - High
FishBase vulnerability score is 70 (Froese and Pauly 2012).

Humpback whale (CA)- *High*
All mammals are considered to have low resilience (SFW 2012).

Unknown invertebrates - Moderate
High = marine mammals, turtles, sharks, seabirds, deepwater and shallow biogenic habitat (seagrass beds, coral, sponges, etc.). Moderate = invertebrates and fish (SFW Criteria 2013).

Unknown finfish - Moderate
High = marine mammals, turtles, sharks, seabirds, deepwater and shallow biogenic habitat (seagrass beds, coral, sponges, etc.). Moderate = invertebrates and fish (SFW Criteria 2013).

Factor 2.2 Stock status score

Yelloweye rockfish and cowcod (CA) – High Concern
Yelloweye rockfish and cowcod are considered overfished (NOAA Fisheries 2011b).

Humpback whale (CA) – Very High Concern
Some 2000 humpback whales are estimated to live off the West Coast of the US, and numbers seem to be increasing (NMFS 2012d). Nonetheless, the species remains listed as Endangered under the US ESA throughout its range *(*NMFS 2012c).

Unknown invertebrates– Moderate Concern
Factor 2.2 is scored as "moderate concern" if the taxon is comprised largely of species that are either of high vulnerability as scored in Factor 2.1, or overfished, endangered or threatened within the range of the fishery (e.g., sea turtles, seabirds, marine mammals and sharks); in these cases, it is scored as "high concern." (SFW Criteria 2013). There is no evidence to suggest that any of the invertebrates caught in the fishery are of high vulnerability or otherwise of concern, so a ranking of 'moderate' concern was selected.

Unknown finfish – Moderate Concern
Factor 2.2 is scored as "moderate concern" if the taxon is comprised largely of species that are either of high vulnerability as scored in Factor 2.1, or overfished, endangered or threatened within the range of the fishery (e.g., sea turtles, seabirds, marine mammals and sharks); in these cases, it is scored as "high concern." (SFW Criteria 2013). There are a number of Pacific groundfish

classified as 'overfished' but the vast majority are not (NMFS 2013d). Other than yelloweye rockfish and cowcod (two overfished populations) which are assessed separately for the California fishery, there are no finfish of particular concern observed caught in the fishery. A ranking of 'moderate' concern was thus selected.

Factor 2.3 Fishing mortality score

Yelloweye rockfish and cowcod (CA) – Very Low Concern

The major contributors to fishing mortality of yelloweye rockfish and cowcod are the directed groundfish fisheries (NWFSC 2012a). While rockfish are not likely to survive even if discarded, the trap fishery is likely a minor contributor to the overall fishing mortality of these species (NWFSC 2012a, Lowry 2007, Reilly and Geibel 2003).

Humpback whale (CA) – Very Low Concern

The maximum number of deaths (including serious injuries that could lead to deaths) the California/Oregon/Washington population of humpback whales can sustain while still being able to reach its optimum sustainable population (i.e. it's Potential Biological Removal or PBR) is estimated at 11.3 individuals per year across the region (NMFS 2013c). Total estimated mortality is >=3.6 whales a year, >=1.8 of which are from pot and trap fisheries, and >=1.4 are from unidentified fisheries (the remaining 0.4 is from ship strikes). Between 2004 and 2008, 11 humpbacks were reported as entangled in pot/trap fishing gear in the region. Of these 11 reports, one humpback whale was seriously injured in 2006 as a result of entanglement in spot prawn trap gear (NMFS 2013c). It is unknown if additional entanglements may also be attributed to this fishery (NMFS 2013c). As the fishery is Category 2 (cumulative take is greater than 10% of PBR), and the relative contribution of the spot prawn fishery to total fishing mortality is unclear but quite possibly less than 10% of PBR, the Seafood Watch criteria deem fishing mortality a 'very low' conservation concern.

Unknown invertebrates– Low Concern

Pot fisheries score as a 'low' concern for benthic invertebrates and finfish in the unknown bycatch matrix (SFW criteria 2013).

Unknown finfish – Low Concern

Pot fisheries score as a 'low' concern for benthic invertebrates and finfish in the unknown bycatch matrix (SFW criteria 2013).

Factor 2.4 Overall discard+bait/landings rate – 20-40% in Washington, 60-80% in California

The dead discards to spot prawn landings ratio ranges from 11-15% in Washington, to 24% in Northern California, to over 47% in Southern California (Table 3 and discussion above).

The quantity of bait used in the Washington and California fisheries relative to landings of spot prawn is not known (K. Barsky, pers.com., D. Ayres, pers.com), but it thought to be relatively low (D. Ayres, pers.com.). In Washington, each trap is baited with ¼ pound of baitfish (preferably herring, but also squid and anchovies depending on what is available), the rest is dog food or fishmeal pellets (D. Ayres, pers.com.). It is unclear what baits are used in the spot prawn fisheries

in California other than pellets (e.g. K. Barsky, pers.com.). This assessment assumes that the weight of bait is around 20% of landings, thus increasing the discards+bait/landings rate by 20%.

Coonstripe (dock) shrimp trap (California)

Onboard observers in the CA coonstripe fishery have documented bycatch species including crabs (hermit, juvenile Dungeness and rock, decorator, umbrella, butterfly), snails, sunflower stars, hagfish, juvenile finfish (rockfish, lingcod, cabezon), sculpin and octopus (McVeigh 2009). Discards of invertebrates are typically alive (K. Barsky, CDFW, pers.com.), and all discards including finfish are returned alive if possible (McVeigh 2006). The fishery operates in very shallow waters (25-50 meters) and so does not interact with humpback whales (K. Barsky, CDFW, pers. comm.) and less likely to cause mortality in rockfish. Given this information two taxa will be assessed using the unknown bycatch matrix - non-shrimp invertebrates and rockfish.

Factor 2.1 Inherent Vulnerability score - Moderate

Unknown invertebrates - Moderate

High = marine mammals, turtles, sharks, seabirds, deepwater and shallow biogenic habitat (seagrass beds, coral, sponges, etc.). Moderate = invertebrates and fish (SFW Criteria 2013).

Unknown finfish - Moderate

High = marine mammals, turtles, sharks, seabirds, deepwater and shallow biogenic habitat (seagrass beds, coral, sponges, etc.). Moderate = invertebrates and fish (SFW Criteria 2013).

Factor 2.2 Stock Status score – Moderate Concern

Unknown invertebrates– Moderate Concern

Factor 2.2 is scored as “moderate concern” if the taxon is comprised largely of species that are either of high vulnerability as scored in Factor 2.1, or overfished, endangered or threatened within the range of the fishery (e.g., sea turtles, seabirds, marine mammals and sharks); it is scored as “high concern.” (SFW Criteria 2013). There is no evidence to suggest that any of the invertebrates caught in the fishery are of high vulnerability or otherwise of concern, so a ranking of ‘moderate’ concern was selected.

Unknown finfish – Moderate Concern

Factor 2.2 is scored as “moderate concern” if the taxon is comprised largely of species that are either of high vulnerability as scored in Factor 2.1, or overfished, endangered or threatened within the range of the fishery (e.g., sea turtles, seabirds, marine mammals and sharks); it is scored as “high concern.” (SFW Criteria 2013). There are a number of Pacific groundfish classified as ‘overfished’ but the vast majority are not (NMFS 2013d). A ranking of ‘moderate’ concern was thus selected.

Factor 2.3 Fishing mortality score – Low Concern

Unknown invertebrates– Low Concern

Pot fisheries score as a ‘low’ concern for benthic invertebrates and finfish in the unknown bycatch matrix (SFW criteria 2013).

Unknown finfish – Low Concern
Pot fisheries score as a 'low' concern for benthic invertebrates and finfish in the unknown bycatch matrix (SFW criteria 2013).

Factor 2.4 Overall Discard Rate – 20-40%
Overall fishing mortality related to discards is unknown but likely low. California coonstripe (dock) shrimp bait typically consists of fresh fish, which may include mackerel, sardines, herring or albacore (McVeigh 2009). This assessment assumes that the weight of bait is around 20% of landings, thus increasing the discards+bait/landings rate by 20%.

Northern shrimp and sidestripe shrimp trawl (Alaska)

There are no bycatch data available for the trawl fishery (Q. Smith, pers.com.), so the trawl fishery will be scored according to the unknown bycatch matrix (SFW Criteria 2013). The matrix lists the following taxa as the most likely to interact with coldwater shrimp trawl fisheries: Benthic invertebrates, finfish, forage fish, sharks and corals and other biogenic habitats. Sharks, crabs and large finfish are likely screened out by the large mesh panels used by fishermen to screen out unwanted catch (Q. Smith, pers.com.), and so are excluded from the assessment. Corals and other biogenic habitats are also excluded from this assessment because the fishery operates with beam trawls over soft bottom habitat (see Criterion 4.1). Benthic invertebrates, finfish and forage fish all score the same in the matrix and so are assessed together below.

Factor 2.1 Inherent Vulnerability score – Moderate
High = marine mammals, turtles, sharks, seabirds, deepwater and shallow biogenic habitat (seagrass beds, coral, sponges, etc.). Moderate = invertebrates and fish (SFW Criteria 2013).

Factor 2.2 Stock status score– Moderate Concern
Factor as "moderate concern" if the taxon is comprised largely of species that are either of high vulnerability as scored in Factor 2.1, or overfished, endangered or threatened within the range of the fishery (e.g., sea turtles, seabirds, marine mammals and sharks); it is scored as "high concern." (SFW Criteria 2013). There are no Alaska groundfish classified as 'overfished' (NMFS 2013d). No forage fish populations likely to interact with the shrimp trawl fishery are classified as overfished (NMFS 2013d). A rating of 'moderate' concern was thus selected.

Factor 2.3 Fishing mortality score– Low Conservation Concern
Given the depressed level of fishing effort, the mesh panels used to screen bycatch, and that the directed groundfish fisheries are likely the largest source of mortality of most of the finfish bycatch species, it is reasonable to assume that the fishing mortality of finfish and non-shrimp invertebrate species from this trawl fishery is likely low.

Factor 2.4 Overall discard rate – 0-20%
The Alaska trawl fishery has low effort and low landings. The fishery does not interact with other commercial fisheries so conflicts over potential bycatch of other fisheries is not currently an issue.

There is no specific program designed to reduce bycatch as it is not deemed a management concern. Any bycatch that does occur would be at low levels (Q. Smith, ADFG, pers. comm.).

Alaska spot prawn and coonstripe shrimp trap

A bycatch study was carried out for the trap fishery from 1996 – 2003 (Love 2005). Although a wide array of species were caught, including invertebrates and fish, spot shrimp and coonstripe shrimp were the two species caught in the greatest number, at 90% and 8% of the catch, respectively. No other species comprised more than 0.8% of the catch but the data were presented in terms of numbers (no estimates of weight are presented in Love 2005). In terms of weight, the discard rate is likely higher, as seen in other spot prawn trap fisheries (in this assessment and in the separate British Columbia assessment). For this reason, we have used the default scores from the unknown bycatch matrix for two groups – non-shrimp invertebrates and finfish. No species caught is known to be overfished or undergoing overfishing. In addition, coonstripe shrimp are included in the 'main' species for the spot prawn fishery, and vice versa. The fishery's impact on these species was assessed in Criterion 1 above.

Factor 2.1 Inherent Vulnerability score

Unknown invertebrates - Moderate

High = marine mammals, turtles, sharks, seabirds, deepwater and shallow biogenic habitat (seagrass beds, coral, sponges, etc.). Moderate = invertebrates and fish (SFW Criteria 2013).

Unknown finfish - Moderate

High = marine mammals, turtles, sharks, seabirds, deepwater and shallow biogenic habitat (seagrass beds, coral, sponges, etc.). Moderate = invertebrates and fish (SFW Criteria 2013).

Factor 2.2 Stock Status score

Unknown invertebrates– Moderate Concern

Factor 2.2 is scored as "moderate concern" if the taxon is comprised largely of species that are either of high vulnerability as scored in Factor 2.1, or overfished, endangered or threatened within the range of the fishery (e.g., sea turtles, seabirds, marine mammals and sharks); it is scored as "high concern." (SFW Criteria 2013). There is no evidence to suggest that any of the invertebrates caught in the fishery are of high vulnerability or otherwise of particular concern, so a ranking of 'moderate' concern was selected.

Unknown finfish – Moderate Concern

Factor 2.2 is scored as "moderate concern" if the taxon is comprised largely of species that are either of high vulnerability as scored in Factor 2.1, or overfished, endangered or threatened within the range of the fishery (e.g., sea turtles, seabirds, marine mammals and sharks); it is scored as "high concern." (SFW Criteria 2013). There are no Alaskan groundfish classified as overfished or overfishing occurring. (NMFS 2013d). A ranking of 'moderate' concern was thus selected.

Factor 2.3 Fishing mortality score

Unknown invertebrates– Low Concern
Pot fisheries score as a 'low' concern for benthic invertebrates and finfish in the unknown bycatch matrix (SFW criteria 2013).

Unknown finfish – Low Concern
Pot fisheries score as a 'low' concern for benthic invertebrates and finfish in the unknown bycatch matrix (SFW criteria 2013).

Factor 2.4 Overall discard rate – 20-40%
Together, spot prawns and coonstripe shrimp make up 98% of the catch (by number) in the Alaska trap fishery (Love 2005), so discard rates are likely very low. Bait used in the trap fishery varies, but is often a combination of commercial pellets and salmon parts not fit for human consumption such as heads, or parts from dark, or "spawned out" salmon caught in the commercial salmon fisheries. Forage fish, such as herring or sardines, are also used (Q. Smith, ADFG, pers. comm.). This assessment assumes that the weight of bait is around 20% of landings, thus increasing the discards+bait/landings rate by 20%.

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
Washington Trap	Low Concern (4)	Low Concern (4)	Green 4
Washington Trawl	Moderate Concern (3)	Low Concern (4)	Green 3.46
California Trap (spot)	Moderate Concern (3)	Moderate Concern (3)	Yellow 3
California Trap (coonstripe)	Moderate Concern (3)	Moderate Concern (3)	Yellow 3
California Trawl (pink)	Moderate Concern (3)	Moderate Concern (3)	Yellow 3
California Trawl (ridge)	Moderate Concern (3)	Low Concern (4)	Green 3.46
Alaska Trap	Low Concern (4)	Low Concern (4)	Green 4
Alaska Trawl	Low Concern (4)	Moderate Concern (3)	Green 3.46

Factor 3.1 Harvest Strategy

Fishery	**Critical?**	Mgmt strategy and implement.	Recovery of stocks of concern	Scientific research and monitoring	Scientific advice	Enforce.	Track record	Stakeholder inclusion	**Management of Retained Species Rank (Score)**
Washington Trap	No	Highly Effective	N/A	Highly Effective	Moderately Effective	Highly Effective	Moderately Effective	Highly Effective	Low Concern (4)
Washington Trawl	No	Moderately Effective	N/A	Moderately Effective	Moderately Effective	Highly Effective	Moderately Effective	Highly Effective	Moderate Concern (3)
California Trap (spot)	No	Moderately Effective	N/A	Moderately Effective	Moderately Effective	Highly Effective	Moderately Effective	Highly Effective	Moderate Concern (3)
California Trap (coonstripe)	No	Moderately Effective	N/A	Moderately Effective	Moderately Effective	Highly Effective	Moderately Effective	Highly Effective	Moderate Concern (3)
California Trawl (pink)	No	Moderately Effective	N/A	Moderately Effective	Moderately Effective	Highly Effective	Moderately Effective	Highly Effective	Moderate Concern (3)
California Trawl (ridge)	No	Moderately Effective	N/A	Moderately Effective	Moderately Effective	Highly Effective	Moderately Effective	Highly Effective	Moderate Concern (3)
Alaska Trap	No	Highly Effective	N/A	Highly Effective	Highly Effective	Highly Effective	Moderately Effective	Moderately Effective	Low Concern (4)
Alaska Trawl	No	Highly Effective	N/A	Moderately Effective	Highly Effective	Highly Effective	Moderately Effective	Moderately Effective	Low Concern (4)

Harvest strategy rates as 'Moderate Concern' for all evaluated coldwater shrimp fisheries in California as well as the pink shrimp trawl fishery in Washington. There are generally effort controls in place where the fisheries are large enough to justify them, and measures in place to control effort if market interest in them increases considerably. However, there are relatively limited efforts to collect data on the impacts of the fisheries on the stocks and the lack of limits on total catch. Catch is more controlled in the Washington spot prawn and Alaskan fisheries, with area –specific quotas in place. These fisheries still suffer from a lack of biological information and fishery-independent data and therefore quantitative assessments on the health of the stock.

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.

Pink shrimp trawl (Washington, California)

Management Strategy and Implementation –Moderately Effective

The pink shrimp fisheries off the US West Coast are state managed. Uniform regulations across the states include an open season from April 1 through October 31, a maximum count per pound, and a minimum mesh size (California only) (Collier et al 2006). In addition, in areas where there is relatively high fishing effort, managers have restricted effort through limited entry programs (e.g. northern California above Point Conception is limited entry while southern California is not; Washington commercial shrimp fisheries are all limited entry) (Collier et al 2006). No other restrictions on fishing mortality (e.g. TACs or quotas) are used. There are also no stock assessments or reference points, due to the prevailing assertion that fishing mortality is far less of an influence on stock abundance than environmental conditions (e.g. Hannah 2012, Hannah 2011, CHF 2006). However, reference point-based management strategies have been employed in other states and countries that manage shrimp, some of which also manage pink shrimp (British Columbia), closely related shrimp, or even shrimp with shorter life spans than pink shrimp (New England). Efforts to further assess the value of reference points are underway (Hannah 2010), and a requirement that this be done for continued certification under the MSC may lead to reference-point based management in the next few years (Hannah and Jones 2013).

Recovery of stocks of concern
There are no stocks of concern targeted or landed by the fishery.

Scientific Research and Monitoring – Moderately Effective
Fishery-dependent information such as size, age and sex composition of catches, fishing effort and catch-per-unit-effort are routinely collected (particularly in Oregon) and are used to provide an assessment of the relative abundance of the stock. Oregon publishes an in-depth annual review of the previous season's landing and potential implications for current and future seasons (e.g. Hannah and Jones 2013). The WDFW is also working on an analysis of logbook data (the program was reinstated in 2010) as well as observer data related to better quantifying eulachon bycatch in the fishery (L.Wargo, pers.com.). The analysis may help better understand how the Washington catch of pink shrimp compares to that in Oregon.

Scientific Advice - Moderately Effective
As there are no management plans, stock assessments, quotas or TACs, management decisions that require scientific advice do not take place regularly.

Enforcement – Highly Effective

Several species of groundfish were declared endangered in 2000 and NMFS has imposed and enforces various requirements on this fishery because groundfish are taken as bycatch. Measures include a mandatory vessel monitoring system, observers, and incidental trip limits (Collier et al 2007, WCGOP 2013). Eulachon, declared threatened in 2010, are also taken as bycatch, and their bycatch management is discussed in 3.2. State enforcement personnel, including police officers, marine patrol officers, wildlife officers, park rangers and US Coast Guard officers, carry out general enforcement (e.g. K. Barsky, CDFW, pers.com.).

Track Record – Moderately Effective
The pink shrimp fisheries have expanded and contracted, without pattern, over time. Managers believe that these fisheries fluctuate naturally, hence the more relaxed approach to management.

Stakeholder inclusion – Highly Effective
All states have public meetings where stakeholders are invited to participate and provide input before management decisions are made.

Ridgeback shrimp trawl (California)

Management Strategy and Implementation – Moderately Effective
The ridgeback shrimp trawl fishery is small scale, with limited management. In 2006, there were only 11 vessels operating (Owens 2006). It is a limited access commercial fishery (with a control date of January 1st, 1999) (CDFG 2013a). The fishery closes every summer, from June 1st through September 30th, to protect spawners (Owens 2006, CDFG 2013a). Trawling gear specifications, such as a minimum mesh size (CDFG 2013a), may also help control effort and fishing mortality (Owens 2006).

Recovery of stocks of concern
There are no known stocks of concern targeted or landed by the fishery.

Scientific Research and Monitoring – Moderately Effective
As stated above, only minimal fishery-dependent information is collected via commercial landing receipts and logbooks and provides information necessary to calculate CPUE. CDFW does not collect fishery independent data, but notes that some incidental data on the ridgeback population has been collected by city and county agencies when assessing water quality, and by trawl surveys carried out in 1994 and 2003 by the Southern California Coastal Research Project (Owens 2006).

Scientific Advice - Moderately Effective
While logbook information is collected, there are no management plans, stock assessments, quotas or TACs, so management decisions that require scientific advice do not take place regularly.

Enforcement – Highly Effective
State enforcement personnel, including police officers, marine patrol officers, wildlife officers, park rangers and US Coast Guard officers, carry out general enforcement (e.g. K. Barsky, CDFW, pers.com.).

Track Record – Moderately Effective
The ridgeback shrimp fishery's landings have fluctuated over time. Due to the lack of population estimates, it is difficult to say whether management has had a good track record of maintaining abundance levels over time. However, because CPUE data positively correlate with ENSO events, it is possible that that water conditions have a strong effect ridgeback population (Owens 2006).

Stakeholder inclusion – Highly Effective
California has regularly-set public meetings where stakeholders are invited to participate and provide input before management decisions are made.

Spot prawn trap (Washington, California)

Management Strategy and Implementation – Moderately effective (California), Highly Effective (Washington)
California's management of the spot prawn trap fishery is structured through a limited entry permit system consisting of three different tiers. Effort is controlled in all permits through a limit on the number of traps permitted (and a catch limit for Tier 2 permittees). The majority of the catch is made by Tier 1 permittees (15 of the 17 permittees landed 86% of the catch in 2010 (Sweetnam 2010)). There are some 28 permittees/vessels total in the fishery (LOF 2013). The fishery is closed south of Point Arguello (15 of the 19 total vessels fishing in 2010) from November to January to protect spawning females (Sweetnam 2010). While there are no estimates of population abundance or reference points, effort controls restrict the fishery to a level that management feels is sustainable.

Washington's commercial spot prawn fishery occurs in the Puget Sound and on the coast. These regions are managed separately but share common management measures: limited entry, area-specific quotas, bans on trawl gear, trip limits, gear requirements (pot size, minimum mesh size), and a closed season to protect spawners (Childers 2012, Wargo and Ayres 2013). In the Puget Sound, quotas are evaluated and adjusted annually using logbook information and test fishery data (Childers 2012). Quotas are fully utilized by the state and Tribal fisheries. A recent increase in recreational effort has put pressure on managers to adhere to the area specific quotas (Childers 2012). In the coastal fishery, the MSY-based TAC of 200,000lbs is divided equally between a 'north' region and a 'south' region (Wargo and Ayres 2013). There is little Tribal or recreational catch in this fishery, and catch has been below the TACs for a number of years (Wargo and Ayres 2013).

Recovery of stocks of concern
There are no stocks of concern targeted or landed by the fishery.

Scientific Research and Monitoring – Moderately Effective (California), Highly Effective (Washington)
Scientific monitoring of spot prawn populations is limited in California. Managers consider the trawl surveys needed to gather data for population estimates economically infeasible (Larson and Reilly 2007). Data collection is therefore only through the logbooks that permittees are required to

fill out after each day of fishing. These help to provide a historical database of catch and effort, but are recognized as having a very broad spatial resolution (Larson and Reilly 2007).

The Washington trap fisheries operate on a quota system and therefore management closely monitors landings in-season, closes fishing areas when quotas are met and collects data to inform annual management meetings with tribal managers. Monitoring in the Puget Sound fishery is conducted through commercial logbooks, occasional at-sea sampling, recreational catch rates and pre- and post-season test surveys (M O'Toole, WDFW, pers.com). On the coast monitoring is conducted through commercial logbooks and primarily dockside sampling (which is used to determine prawn egg-bearing season and population size structure). Dockside sampling information has been collected since 2002, with overall sampling of landings exceeding 25% on an annual basis (Wargo et al. 2013).

Scientific Advice – Moderately effective
In California, while there are quotas for Tier 2 commercial spot prawn trap fishers (Tiers 1 and 3 do not have quotas) and logbook information is collected, there are no management plans or stock assessments, so management decisions that require scientific advice do not take place regularly.

In Washington, scientific information about the spot prawn fishery is collected from dockside sampling and starting in the 2008 season, the state established a northern and southern TAC for the coastal fishery based on MSY estimates (prior to 2008 there was a quota for the southern portion of the coast but it was not MSY based). The new management system has not been in place long enough to judge their effectiveness. The state is required to submit a report in 2016 assessing the effects of the fishery on the marine environment and recommending any necessary changes to the fishery (Wargo et al. 2013).

Enforcement – Highly Effective
In California, state enforcement personnel, including police officers, marine patrol officers, wildlife officers, park rangers and US Coast Guard officers, enforce regulations in this fishery (e.g. K. Barsky, CDFW, pers.com.). In Washington, the state enforces regulations on this fishery, but information on enforcement effectiveness is not available.

Track Record – Moderately Effective
In California there are no population estimates for spot prawns, so it is difficult to say whether management has had a good track record of maintaining abundance levels over time. In Washington, the management limited entry regime in the coastal fishery is too recent to assess its effect on the spot prawn population.

Stakeholder inclusion – Highly Effective
Both states have public meetings where stakeholders are invited to participate and provide input before management decisions are made.

Coonstripe (dock) shrimp trap (California)

Management Strategy and Implementation – Moderately effective
The California coonstripe trap fishery is a small scale open access fishery, with no limit on the number of traps/pots per vessel (McVeigh 2009). The season (May 1 through October 31) complements the Dungeness crab season; all seven of the vessels fishing CA coonstripe shrimp in 2008 also fished for Dungeness crab that year (McVeigh 2009). There are frequently many more permits sold than fished (21 permits were sold in 2008) (McVeigh 2009), an indication that effort could possibly increase in the future. Should a limited entry program be necessary, managers have set a control date of November 1, 2001 (the likely explanation for the number of unfished permits sold each year) (McVeigh 2009).

Recovery of stocks of concern
There are no stocks of concern targeted or landed by the fishery.

Scientific Research and Monitoring – Moderately effective
The fishery is too small for any monitoring efforts other than landings. Logbooks are not required (McVeigh 2009).

Scientific Advice – Moderately effective
As there are no management plans, stock assessments, quotas or TACs, management decisions that require scientific advice do not take place regularly.

Enforcement – Highly Effective
State enforcement personnel, including police officers, marine patrol officers, wildlife officers, park rangers and US Coast Guard officers enforce regulations in this fishery (e.g. K. Barsky, CDFW, pers.com.).

Track Record – Moderately Effective
As there is little in the way of population estimates, it is difficult to say whether management has had a good track record of maintaining abundance levels over time.

Stakeholder inclusion – Highly Effective
Both states have public meetings where stakeholders are invited to participate and provide input before management decisions are made.

Northern shrimp and sidestripe shrimp trawl/spot prawn and coonstripe shrimp trap (Alaska)

Management Strategy and Implementation – Highly Effective
Based on limited scientific information (stock assessments are not carried out), both the trawl and trap fisheries operate within Guideline Harvest Ranges (GHRs), which are similar to quotas or fishing mortality thresholds. Within the GHRs, managers annually set Guideline Harvest Levels (GHLs), which function as fishing mortality targets. GHLs have not been set for the trawl fishery for the last few seasons due to lack of data (Q. Smith, ADFG, pers. comm.). GHLs have been

continuously and proactively adjusted downward to address the apparent stock declines. Managers shut down fishing areas by emergency closure in-season if the GHL is exceeded, but have successfully avoided this for the past several years (Smith 2011).

In addition to GHRs, management measures for the trawl fishery include shrimp size restrictions, limiting numbers of permits issued, gear restrictions (such as minimum mesh size and the prohibition of otter trawls) and area closures. These measures protect egg-bearing females and larvae, spread out the harvest period, and reduce effort during recruitment and growth (Smith 2011).

The trap fishery uses many of the same approaches as the trawl fishery, such as fishing seasons, size restrictions, limiting numbers of permits issued and gear restrictions. The large increase in permits and landings prompted the initiation of a limited entry program in 1998 and a fishery management plan was written in 2000. The use of harvest control rules is appropriate and reporting requirements for catcher-processors began in 2000 to allow managers to accurately track the in-season harvest (Smith 2011). It is not clear if this is sufficient, however, as the fishery struggles to address declines in biomass.

Scientific Research and Monitoring – Moderately Effective (Trawl), Highly Effective (Trap)
For the trawl fishery, fishery-dependent data is collected via dockside sampling and skipper interviews. Data gathered includes size frequency, sex, fishing location and effort (used to calculate CPUE). While useful for determining catch composition, stock structure and pre-recruit status, this may be insufficient or too uncertain to maintain the stock of trawl captured stocks (Smith 2011).

For the trap fishery, fishery dependent data is collected via commercial catch sampling and logbooks. Fishery independent data is collected via pot surveys in 6 of the 21 management areas (covering approximately 66% of the harvest). Information on shrimp size, size at which 50% are female, CPUE rates and harvest rate estimates are analyzed to designate stock status annually (Smith 2011).

Scientific Advice – Highly Effective
The Alaska Board of Fisheries approves regulations, such as the GHR, while ADFG makes implementation decisions, such as the GHL, to more finely tune management. For regulatory decision-making, the Board of Fisheries relies heavily on, and follows, the scientific advice contained in the ADFG recommendations prior to voting on each regulation. For management decision-making, the ADFG scientists and managers are empowered to design and carry out implementation plans (Q. Smith, ADFG, pers. comm.).

Enforcement – Highly Effective
ADFG is in constant communication with fishermen throughout the season, collecting fishery dependent data and carrying out surveys. There is full compliance with voluntary measures and fishery monitoring on the fishing grounds (Q. Smith, ADFG, pers. comm.). While enforcement duties fall within the purview of the Alaska State Troopers, ADFG has an open door policy and routinely receives input, questions and potential violation information from the public.

Track Record – Moderately Effective
The trawl fishery has been active for more than 90 years, but total harvest and numbers of permits fished have been steadily declining since 1997 due to low prices for northern shrimp, a lack of processing priority for northern shrimp, and fewer active participants (Smith 2012). However, sidestripe shrimp landings are increasing, which may prevent further decline in the trawl fishery. ADFG has outlined management needs and concerns related to increased landings of sidestripe shrimp, so appears to be proactively addressing this newly developing potential market (Q. Smith, ADFG, pers. comm.).

Although the trap fishery is a lucrative and long-standing fishery, there is an apparent decline in abundance in about half of the management areas. While the GHLs have steadily been reduced over the last several years to combat this, it has not yet necessarily produced the intended effect of increasing abundance back to previous levels (Smith 2011).

Stakeholder inclusion – Moderately Effective
A previously appointed task force did not fare well and a new Ad-Hoc Committee was established this year to improve transparency and engage all stakeholders (Q. Smith, ADFG, pers. comm.). It is too early to tell the effectiveness of the new regime.

Factor 3.2 Management of fishing impacts on bycatch species

Fishery	**All Species Retained?**	**Critical?**	Mgmt strategy and implement.	Scientific research and monitoring	Scientific advice	Enforce.	**Management of bycatch species Rank (Score)**
Washington Trap	No	No	Highly Effective	Moderately Effective	Highly Effective	Highly Effective	Low Concern (4)
Washington Trawl	No	No	Highly Effective	Highly Effective	Moderately Effective	Highly Effective	Low Concern (4)
California Trap (spot)	No	No	Moderately Effective	Moderately Effective	Moderately Effective	Highly Effective	Moderate Concern (3)
California Trap (coonstripe)	No	No	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Moderate Concern (3)
California Trawl (pink)	No	No	Moderately Effective	Highly Effective	Moderately Effective	Highly Effective	Moderate Concern (3)
California Trawl (ridge)	No	No	Highly Effective	Moderately Effective	Moderately Effective	Highly Effective	Low Concern (4)
Alaska Trap	No	No	Highly Effective	Moderately Effective	Highly Effective	Highly Effective	Low Concern (4)
Alaska Trawl	No	No	Moderately Effective	Moderately Effective	Highly Effective	Highly Effective	Moderate Concern (3)

Measures in place to reduce bycatch in the Washington and California shrimp trawl fisheries (for pink shrimp and ridgeback) have proven effective in reducing the bycatch of rockfish. However, the catch of endangered eulachon is still a major problem in the pink shrimp fisheries. This is a

relatively recent finding, and managers have generally put considerable effort into mitigating the catch of eulachon. Washington scores more highly than California in this regard because Washington (and Oregon) has reduced the permitted bar spacing on excluders in the fishery while California has yet to do so. The Alaska trawl fishery does not have the same problems with eulachon bycatch. Managers believe bycatch to not be a problem in the Alaska trawl fishery and all of the pot fisheries assessed here, so do little to mitigate it. However, few data are available to corroborate this.

While the strategy, implementation and research for bycatch is good, over 1 million eulachon were captured in these fisheries in 2010. The eulachon's threatened status, and the observer study findings that pink shrimp trawl fisheries are the single largest source of eulachon bycatch, demonstrate current bycatch measures need improvement.

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.

Pink shrimp trawl (Washington, California)

Moderate Concern (California), Low Concern (Washington)

Management Strategy and Implementation – Moderately Effective (California), Highly Effective (Washington)
BRDs are required for all pink shrimp trawl vessels in all three US West Coast states to reduce groundfish bycatch. California requires the use of a rigid-excluder (such as the Nordmore grate) with a maximum of two inches between bars, a soft-panel excluder, or a fisheye excluder (CDFG 2013a). The Nordmore grate is generally regarded as being the most effective in reducing bycatch

while minimizing shrimp loss (Hannah and Jones 2007), and is used by the majority of California vessels (CHF 2006, Frimodig 2008). While such measures have reduced bycatch to low levels, the bycatch of over 1 million threatened eulachon in 2010 (after the requirement for BRDs was implemented) suggests bycatch measures need further improvement. As of January 2012, Washington (as well as Oregon) requires the use of rigid-grate excluders, banning soft panel excluders. Washington (and Oregon) also reduced the maximum bar spacing on rigid-grate excluders from 2 inches to 0.75 inches specifically to reduce eulachon bycatch (Wargo, 2012). These efforts result in Washington bycatch management being deemed 'highly' effective, while that for California remains only 'moderately' effective.

Scientific Research and Monitoring – Highly Effective
The federal West Coast Groundfish Observer Program (WCGOP) monitors the California, Oregon and Washington pink shrimp trawl fisheries (coverage began in 2004 for CA and OR, and 2010 for WA), and catch data on retained and discarded species is made available to managers and the public. Observer coverage rates in 2010 were 9% for Washington and 15% for California (NWFSC 2011b). During 2011 and 2012, Washington conducted an observer program (in addition to the WCGOP program) that achieved 20% and 15%, respectively (Wargo 2012). Observation of the Washington fishery continued, but only under the WCGOP. Fishery managers in Washington and California often look toward Oregon for additional research (as the majority of pink shrimp are landed in Oregon). These efforts include: numerous studies regarding the efficacy of different bycatch reduction strategies (including most recently a field study using high definition cameras to record eulachon interaction with the Nordmore grates) and research on shrimp trawl groundline configurations and gear surveys. All three states share data and findings and often coordinate when setting regulations.

Scientific Advice – Moderately Effective
While managers have followed scientific advice by requiring more restrictive BRDs in Washington (and Oregon), it is unclear whether these regulations are reducing threatened eulachon bycatch to acceptable levels (Al-Humaidhi et al. 2012). California has yet to implement a smaller bar spacing on rigid grates to reduce eulachon bycatch.

Enforcement – Highly Effective
See Factor 3.1 above.

Ridgeback shrimp trawl (California)

Low Concern

Management Strategy and Implementation – Highly Effective
Several measures are in place to minimize bycatch in the shrimp trawl fishery. During the open season, maximum limits are in place for possession of incidental catch species including groundfish species. Closures to protect overfished groundfish in the federal groundfish fisheries are also closures for the ridgeback prawn fishery (Owens 2006). Vessels must also use rigid-grate BRDs, which are proven effective in other coldwater shrimp fisheries (e.g. Hannah et al. 2011). Ridgeback

shrimp trawl nets have minimum mesh requirements and special mesh minimums for the cod-end of the net (K. Barsky, pers.com.). Unlike the pink shrimp trawl fishery, eulachon are not an issue as this fishery is prosecuted south of their most southern range.

Scientific Research and Monitoring – Moderately Effective
See Factor 3.1 for ridgeback shrimp above.

Scientific Advice – Moderately Effective
See Factor 3.1 above.

Enforcement – Highly Effective
See Factor 3.1 above.

Spot prawn trap (Washington, California)

Moderate Concern (California), Low Concern (Washington)

While the spot prawn trap fisheries in California and Washington are not taking large numbers of protected species, the few studies that have been conducted show high overall bycatch rates. These rates are much lower for fish and protected rockfish species, but can be very high for invertebrates.

Detailed rationale:

Management Strategy and Implementation – Highly Effective (Washington), Moderately Effective (California)
There do not appear to be any major problems with bycatch in the Washington spot prawn trap fishery (see Criterion 2), so little management of bycatch species appears to be needed. The bycatch of overfished and endangered species in the California fishery is a bigger concern and further research is needed to uncover the impacts on those species and to help develop a mitigation strategy if necessary. The biggest bycatch problem in the California spot prawn fishery is the very infrequent entanglement of humpback whales (see Criterion 2 above). The fishery is closed here during May-July when humpback whales occur more frequently than in winter (P. Reilly, CDFW, pers.com.).

Scientific Research and Monitoring – Moderately Effective
There are no observers in the US West Coast prawn trap and pot fisheries. While bycatch studies exist for these fisheries, they are few, and none use data more recent than 2003 (2007 for Washington). More recent data and more study on the impacts of bycatch on invertebrates is necessary. Better understanding of the impacts of the California fishery on humpback whales is also needed.

Scientific Advice – Highly Effective (Washington), Moderately Effective (California)
See Factor 3.1 above.

Enforcement – Highly Effective
See Factor 3.1 above.

Coonstripe (dock) shrimp trap (California)

Moderate Concern

The California coonstripe trap fishery operates at small scale (both in terms of landings and spatial extent) in shallow coastal waters and it is unknown if bycatch concerns are warranted. No logbooks are required and there is no observer coverage as with other West Coast shrimp trap fisheries. If this fishery expands, bycatch concerns may be warranted.

Detailed rationale:
Management Strategy and Implementation –Moderately Effective
There is limited management of the CA coonstripe trap fishery, and there is no accounting for potential bycatch due to a lack of observer coverage and lack of logbook data. However, there is no evidence that bycatch should be a significant concern in the fishery.

Scientific Research and Monitoring – Moderately Effective
See Factor 3.1 for coonstripe above.

Scientific Advice –Moderately Effective
See Factor 3.1 above.

Enforcement – Moderately Effective
See Factor 3.1 above.

Northern shrimp and sidestripe shrimp trawl/spot prawn and coonstripe shrimp trap (Alaska)

Moderate Concern (Trawl), Low Concern (Trap)

Trawl

Managers consider bycatch of minimal concern due to the low effort in the fishery, the voluntary mesh excluders used to separate out larger species at the mouth of the trawl, and closed areas to prevent bycatch of other commercially important species (primarily rockfish) (Smith et al. 2012; Smith pers. comm.). However, there are no bycatch data available or collected to corroborate this (Q. Smith, ADFG, pers. comm.).

Detailed rationale:

Management Strategy and Implementation – Moderately Effective

There is no management strategy to address bycatch because it has not been identified as a problematic issue. Due to few interactions and overlap with other fisheries or protected species, this fishery has not had to address the bycatch of any particular species. While fishermen use mesh panels to screen out large bycatch, this is not required by regulation. In addition, with fishing pressure at an all time historic low, the overall amount of bycatch captured is also at an all time low (Q. Smith, ADFG, pers. comm.).

Scientific Research and Monitoring – Moderately Effective
According to managers, bycatch rates are very low (see Criterion 2 above). However, there is no research and monitoring of bycatch, and there are no data or studies to corroborate this (Q. Smith, ADFG, pers. comm.).

Scientific Advice – Highly Effective
See Factor 3.1 above.

Enforcement – Highly Effective
See Factor 3.1 above.

Trap

Overall, this fishery appears to have relatively little bycatch. However, there are few studies that examine bycatch.

Detailed rationale:

Management Strategy and Implementation –Highly Effective
Based on the limited data collected (i.e. Love 2005), there is little need to address any particular bycatch issues.

Scientific Research and Monitoring – Moderately Effective
The management strategy for bycatch species is based on an assessment in 2005 using data from 1998-2003 (Love 2005). A more recent assessment with bycatch expressed in terms of weight would be needed to score 'highly' effective.

Scientific Advice – Highly Effective
See Factor 3.1 above.

Enforcement – Highly Effective
See Factor 3.1 above.

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
Washington Trap	Moderate Concern (2)	No mitigation (0)	Moderate (3)	2.45	Yellow
Washington Trawl	Moderate Concern (2)	Strong mitigation (1)	Moderate (3)	3.00	Yellow
California Trap (spot)	Moderate Concern (2)	Minimal mitigation (0.25)	Moderate (3)	2.60	Yellow
California Trap (coonstripe)	Low Concern (3)	Minimal mitigation (0.25)	Moderate (3)	3.12	Yellow
California Trawl (pink)	Moderate Concern (2)	Strong mitigation (1)	Moderate (3)	3.00	Yellow
California Trawl (ridge)	Moderate Concern (2)	Moderate mitigation (0.5)	Moderate (3)	2.74	Yellow
Alaska Trap	Moderate Concern (2)	No mitigation (0)	Improving (4)	2.83	Yellow
Alaska Trawl	Moderate Concern (2)	Strong mitigation (1)	Improving (4)	3.46	Green

The impact of mobile gears like bottom trawls on seafloor habitats is generally greater than for static gears like pots, if fished over the same type of habitat. In the fisheries assessed here, trawling is prosecuted over sand and muddy habitats which are relatively resilient to changes, while pot fisheries are more generally targeting species that live in rocky habitat which are relatively vulnerable. Efforts to mitigate against habitat impacts are often focused on trawl fisheries, which here include gear modifications and time and area closures. In some cases, closures also mitigate impacts from the pot fisheries too.

Scoring

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.
-

Pink shrimp trawl (California, Washington)

Factor 4.1 Impact of the fishing gear on the substrate score – Moderate Concern

This fishery employs vessels that are double-rigged with high-rise box trawls, and occurs over on soft and muddy substrate (CHF 2006). Bottom trawling on this type of substrate is considered a 'Moderate-to-Severe' impact in the Seafood Watch criteria. The only fishery-specific study assessing impacts to seafloor biota was conducted in four sites in Nehalem Bank off Oregon (Hannah et al 2010). The data presented indicate a decrease in invertebrate diversity and a negative impact on the abundance of several common macro-invertebrate taxa, such as sea whips, flat mud stars, sea stars, sea cucumbers, and squat lobsters. Habitat complexity at a macro scale was actually increased by the trawl door tracks (Hannah et al 2010).

Factor 4.2 Modifying factor: Mitigation of fishing gear impacts – Strong Mitigation

The combination of gear modifications, effort restrictions, closures in federal waters (through EFH and HAPC designations) and ban on bottom trawling in the majority of California state waters and the entirety of Washington state waters, result in a score of 'Strong mitigation.'

Rationale:

Effort Restrictions

Until recently, effort in the pink shrimp fishery has been in decline since the peak in the late 1980s (Hannah and Jones 2012, WDFW 2012). While both the Oregon and Washington fisheries are limited entry (and part of the California fishery), the number of active fishers has been far less than the number of licenses (e.g. in Washington there are currently around 80 limited entry licenses, but only 20 are actively fished – L. Wargo, WDFW, pers.comm.). Improving abundance and market conditions may spur more fishers to use their licenses (as seen in the Oregon fleet, which saw a sharp increase in effort in 2010 and again in 2011 (Hannah and Jones 2012)).

Gear modifications

The gear used to catch ocean shrimp is a semi-pelagic box trawl (Hannah et al 2010, CFF 2008). The gear is designed so that the net itself is not dragged along the seabed. The only fishery-specific study indicates the potential for this type of gear to have fewer impacts on the seafloor than more traditional otter trawl gear (Hannah et al 2010).

Time/Area closures

Federal regulations to protect essential fish habitat (EFH) for groundfish have resulted in area closures for all trawls, including shrimp trawls, in federal waters (Figure 16). The states have also closed areas where groundfish EFH has been identified. California prohibits bottom trawling in most state waters (an exception is made for the California halibut trawling grounds in Southern California state waters). Washington prohibits bottom trawling in all state waters. All three states have marine protected areas where one or more type of fishing is disallowed (often bottom tending gear) in state waters, and all are engaged in processes to review and improve the effectiveness of these MPA networks (e.g. CDFG 2012, OOI 2012, Van Cleeve 2009).

Factor 4.3 Ecosystem and Food Web Considerations score – Moderate

An expanding body of literature exists related to EBFM off the US West Coast, including research to better understand the roles of shrimp and other species (e.g. Field and Francis 2006, Lester et al. 2010, Kaplan and Leonard 2012, Link et al. 2012). Federal fishery managers are in the planning stages of EBFM implementation (e.g. PFMC 2012). In addition, the networks of MPAs noted in 4.2 above will likely have a subset that are no take marine reserves (some already do), which are designed to protect ecosystem functioning (e.g. CDFG 2012, OOI 2012, Van Cleeve 2009).

Ridgeback shrimp trawl

Factor 4.1 Impact of the fishing gear on the substrate score– Moderate Concern

The fishery occurs over soft bottom habitat composed of green mud, shell and sand (Owens 2006).

Factor 4.2 Modifying factor: Mitigation of fishing gear impacts – Moderate Mitigation

All of the measures noted above for pink shrimp also apply for the ridgeback fishery with a number of exceptions. Firstly, the fishery does not use the pelagic box trawl design so habitat impacts may be greater (Owens 2006). Secondly, the fishery is not permitted in waters less than 150 feet deep

(Owens 2006), though it is unclear whether this has any additional benefit over the trawl closure covering most of state waters.

Factor 4.3 Ecosystem and Food Web Considerations score– Moderate
See pink shrimp above.

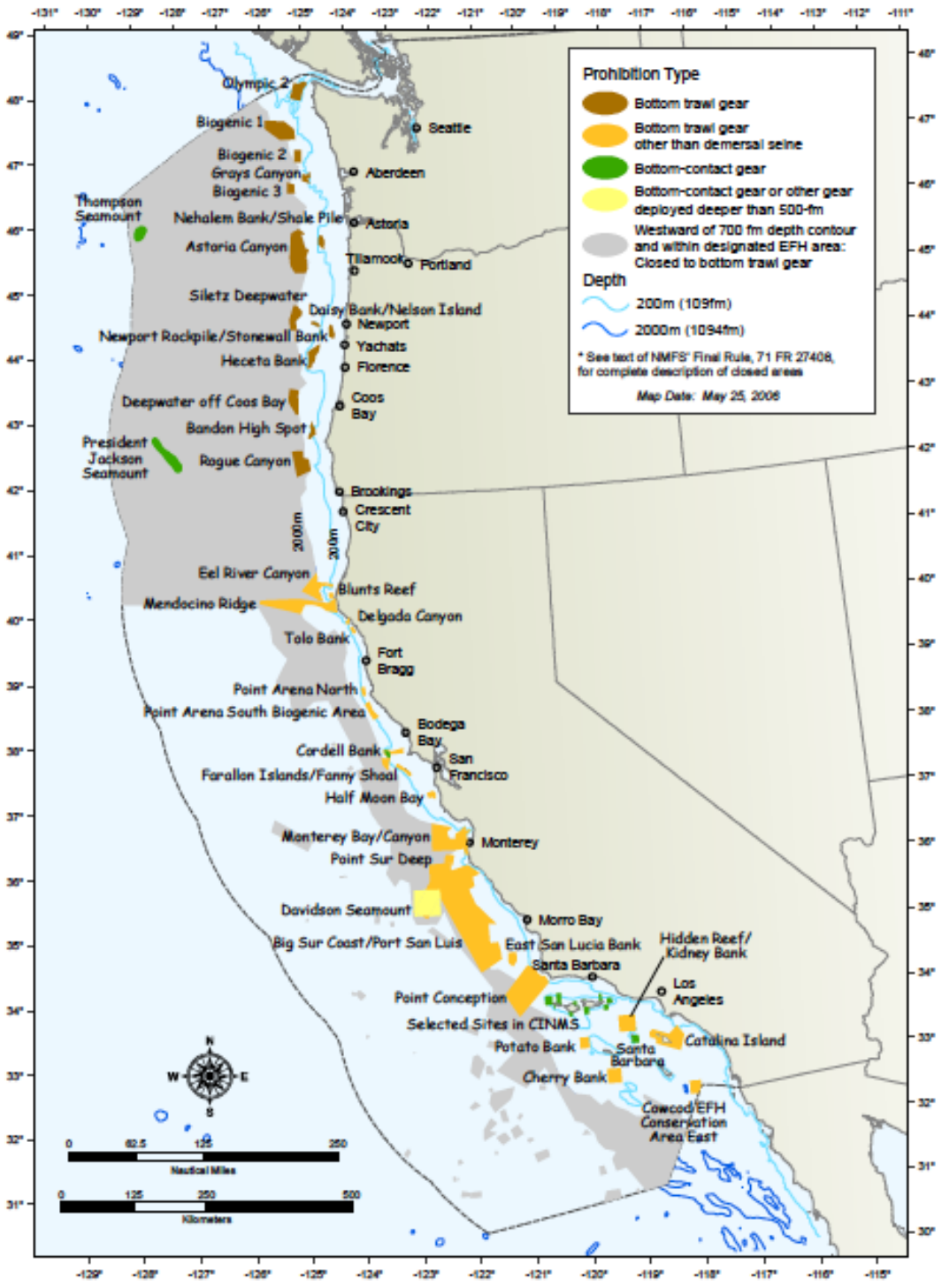

Figure 14. Essential fish habitat area closures to protect Pacific Coast groundfish habitat coast wide (PFMC 2005).

Spot Prawn Trap (California, Washington)

Factor 4.1 Impact of the fishing gear on the substrate score – Moderate Concern
This fishery occurs over rocky, biogenic substrate, where traps can cause damage to fragile glass sponges and corals (CFF 2008).

Factor 4.2 Modifying factor: Mitigation of fishing gear impacts – Minimal Mitigation (CA), No effective Mitigation (WA)
Area closures in federal waters to protect EFH have primarily focused on restricting bottom trawling, though some 17 areas are closed to all bottom contact (PFMC 2012b). In addition, the work being done by all three states on MPAs will likely result in areas where trap fishing is prohibited (e.g. CDFG 2012, OOI 2012, Van Cleeve 2009). In California, the new MPAs were implemented in 2007 in the Central Coast, and in 2012 for the southern coast (CDFG 2012). On the southern coast (where the majority of spot prawn fishing is occurring – CDFG 2001), the California trap fisheries have more than 50 State Marine Conservation Areas in southern California that are closed to commercial fishing to protect representative habitats (CA Fish and Game Code 2853, See Figure 17). There are also closures to trap fishing around the Channel Islands (CDFG 2010). As such, 'Minimal Mitigation' is in place for the California fishery, and Washington remains scored as 'No effective mitigation' until the network of state marine protected areas is completed and is considered likely to be effective.

Factor 4.3 Ecosystem and Food Web Considerations score– Moderate
See 4.3 for pink shrimp above.

Coonstripe (dock) Shrimp Trap (California)

Factor 4.1 Impact of the fishing gear on the substrate score – Low Concern
This fishery occurs over muddy seafloor close to rocky reefs (McVeigh 2009).

Factor 4.2 Modifying factor: Mitigation of fishing gear impacts – Minimal Mitigation
See 4.2 for spot prawn above.

Factor 4.3 Ecosystem and Food Web Considerations score – Moderate
See 4.3 for pink shrimp above.

Trawl Fishery (Alaska)

Factor 4.1 Impact of the fishing gear on the substrate score– Moderate Concern
This fishery occurs over soft and muddy substrate. In addition, this fishery employs beam trawls which are unable to access rocky habitat and are designed specifically for soft bottom habitat (Smith 2011).

Factor 4.2 Modifying factor: Mitigation of fishing gear impacts – Strong Mitigation
Historically productive shrimp fishing grounds that are now closed to bottom trawling occur in the Kodiak, Chignik and South Peninsula districts (ADFG 2014). Since 2001, over 90,000 square nautical miles (nm^2) of Alaska's Exclusive Economic Zone (EEZ) have been closed to bottom trawling year round, with an additional 40,000 nm^2 closed seasonally. In 2009, another 148,300 nm^2 were added. Today nearly 65% of the EEZ is closed, as well as nearly all state waters (Olson 2009). Therefore, at least 50% of the representative habitat is protected.

Factor 4.3 Ecosystem and Food Web Considerations score– Low
Management regulations already include ecosystem-based fishery management measures such as control of directed and incidental catches; a prohibition on fishing of forage species (on which other fish, seabirds, and marine mammals depend); protection of habitat for fish, crabs and marine mammals; and temporal and spatial controls of fishing (Witherell and Woodby 2005; Pikitch et al. 2004). These efforts combined with the lack of capture of species of exceptional importance constitute a low conservation concern.

Trap (Alaska)

Factor 4.1 Impact of the fishing gear on the substrate score– Moderate Concern
This fishery occurs over rocky, biogenic habitat including reefs, glass sponge reefs and corals (Smith 2011).

Factor 4.2 Modifying factor: Mitigation of fishing gear impacts – No Effective Mitigation
No plans have been enacted to specifically protect areas of this habitat type, nor are there future efforts to do so.

Factor 4.3 Ecosystem and Food Web Considerations score– Low
See factor 4.3 for trawl above.

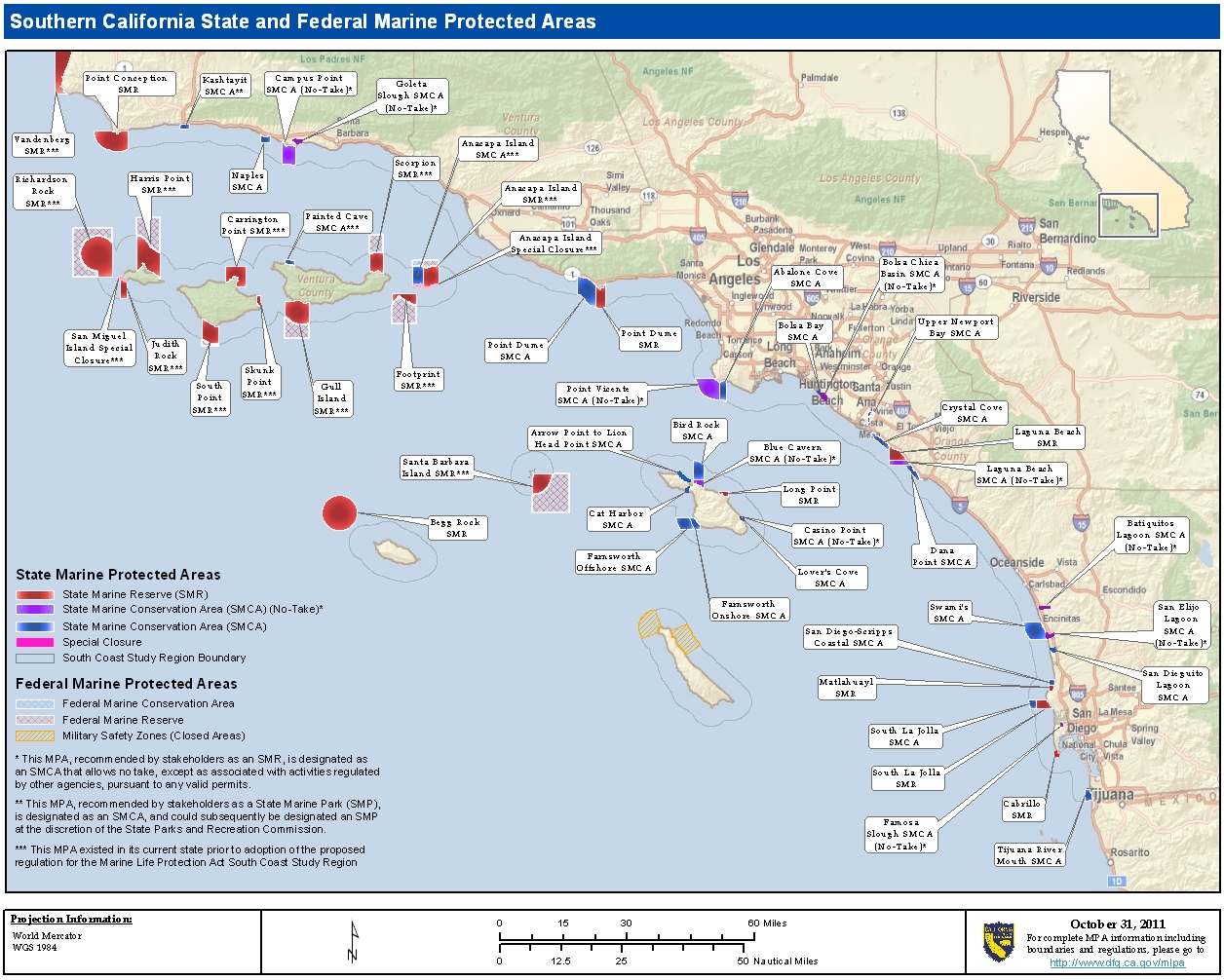

Figure 15. Location of Protected Areas along South Coast. Figure from CDFG 2011d

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Appendix A: Review Schedule

NOAA Fisheries listed Pacific Eulachon as “threatened” under the ESA on March 16, 2010. They identified at least two Distinct Population Segments (DPS) of eulachon on the West Coast, but have only listed the Southern DPS, which extends from the Mad River in California north into British Columbia. Critical habitat was identified on October 20, 2011 and only includes freshwater rivers, where spawning takes place.

Currently, the NMFS Northwest Regional Office in Washington is gathering additional information and will begin drafting a proposed 4(d) rule to address take prohibitions. ESA prohibits the take of any listed species, unless otherwise authorized under a 4(d) rule. As eulachon are currently taken in the pink shrimp fishery, a 4(d) rule will likely outline how this fishery can continue without jeopardizing eulachon recovery efforts.

Recovery planning has been initiated and a draft recovery plan is targeted for completion by September 2015. The lead contact person is Robert Anderson, Eulachon Recovery Coordinator, 1201 NE Lloyd Blvd., Suite 1100, Portland, OR 97218, Robert.C.Anderson@noaa.gov, (503) 231-2226.