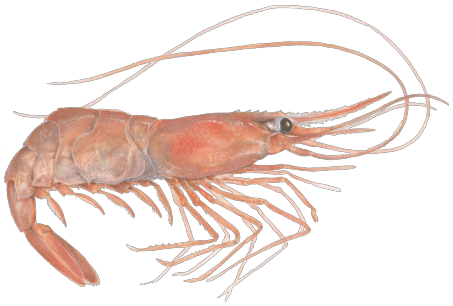
Coldwater shrimp

Coonstriped shrimp (*Pandalus hypsinotus*)
Northern shrimp (*Pandalus borealis*)
Ocean shrimp (*Pandalus jordani*)
Ridgeback prawn (*Sicyonia ingentis*)
Sidestripe shrimp (*Pandalopsis dispar*)
Spot shrimp (*Pandalus platyceros*)



Alaska, Washington, California

Pots, Beam trawls, Bottom trawls

Seafood Watch Consulting Researcher

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

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About Seafood Watch

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

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

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

Guiding Principles

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

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

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

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

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

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

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

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

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

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

Summary

This report addresses commercial coldwater shrimp fisheries in California, Washington, and Alaska. Six species of shrimp are reviewed: northern shrimp *(Pandalus borealis),* spot shrimp (commonly known as spot prawn *[Pandalus platyceros]),* sidestripe shrimp *(Pandalus dispar),* coonstriped shrimp *(Pandalus hypsinotus),* ocean shrimp (commonly known as pink shrimp *[Pandalus jordani]*), and ridgeback shrimp *(Sicyonia ingentis)*. These species are captured with bottom trawls and pots.

Due to the complex life histories and growth strategies of harvested shrimp species, most shrimp stocks along the US west coast are generally not managed using traditional quantitative stock assessments. Biological reference points are typically undefined for shrimp along the US west coast, and stock status is unknown for most species. Fishing mortality reference points are similarly undefined. Modified stock assessments based on catch and effort data (and in some cases fishery independent data) are used to set catch limits for Alaska and Washington shrimp fisheries. Despite the lack of biological reference points, comprehensive in-season monitoring in most regions, in conjunction with measures to limit effort and protect spawning stocks, suggests shrimp stocks along the US west coast are being fished sustainably.

Bycatch data are limited in shrimp fisheries, as the majority of fisheries are currently unobserved (except California pink and ridgeback prawn trawl as of the 2017 season), and most of the bycatch is discarded at sea. However, bycatch reduction devices (BRDs) are required for the California pink shrimp and ridgeback prawn trawl fisheries, a measure that has effectively reduced bycatch relative to landings in the pink shrimp fishery. Although the ratio of bycatch to landings in the pink shrimp fishery is low (<10%), bycatch of eulachon, which are listed as threatened under the Endangered Species Act (ESA), remains a concern in pink shrimp fisheries. Bycatch data are unavailable for the Alaska sidestripe and northern shrimp trawl fisheries, but these fisheries likely interact with corals.

Data are also limited for bycatch in shrimp pot fisheries in most regions. Studies suggest the quantity of bycatch in shrimp pots can be considerable, but the majority of bycatch (by weight and number) are invertebrate species that are generally presumed to survive when released. Bait use in pot fisheries can also be significant, but data are limited.

The impact of mobile gears like bottom trawls on seafloor habitats is generally greater than for static gear like pots (if fished over the same type of habitat). Trawling for US west coast shrimp occurs over sandy and muddy habitat, which is relatively resilient to perturbation from fishing gear. Conversely, shrimp pot fisheries generally target species over rocky habitats, which are relatively vulnerable. Efforts to mitigate habitat impacts are often focused on trawl fisheries, and include gear modifications and time and area closures. Additional no-take reserves or Marine Protected Areas in California and Washington restricts pot fishing in certain conservation zones.

Establishing Ecosystem-Based Fisheries Management (EBFM) is a federal and state priority along the US west coast. In 2013, the Pacific Fishery Management Council finalized the Pacific Coast Fishery Ecosystem Plan to enhance state and federal fisheries management programs with more ecosystem science and broader ecosystem and socio-economic considerations. Alaska similarly employs a number of EBFM tools to manage shrimp stocks, including large-scale ecosystem function research programs, such as the Gulf of Alaska Integrated Ecosystem Research Program.

All of the fisheries covered in this report receive a "Good Alternative" rating.

Final Seafood Recommendations

SPECIES | FISHERY	CRITERION 1 TARGET SPECIES	CRITERION 2 OTHER SPECIES	CRITERION 3 MANAGEMENT	CRITERION 4 HABITAT	OVERALL RECOMMENDATION
Coonstriped shrimp | Northeast Pacific | Pots | United States | California	2.644	1.732	3.000	3.162	**Good Alternative (2.567)**
Coonstriped shrimp | Northeast Pacific | Pots | United States | Alaska	2.644	1.000	3.000	3.536	**Good Alternative (2.301)**
Northern shrimp | Northeast Pacific | Beam trawls | United States | Alaska	2.644	1.000	3.000	3.536	**Good Alternative (2.301)**
Ocean shrimp | Northeast Pacific | Bottom trawls | United States | California | Pink Shrimp Fishery	3.318	1.000	3.000	3.162	**Good Alternative (2.369)**
Pacific rock shrimp | Eastern Central Pacific | Bottom trawls | United States | California | Ridgeback Shrimp Fishery	2.644	1.526	3.000	3.162	**Good Alternative (2.487)**
Sidestriped shrimp | Northeast Pacific | Beam trawls | United States | Alaska	2.644	1.000	3.000	3.536	**Good Alternative (2.301)**
Spot shrimp | Northeast Pacific | Pots | United States | Washington	2.644	2.644	4.000	3.162	**Good Alternative (3.066)**
Spot shrimp | Northeast Pacific | Pots | United States | California	2.644	1.732	3.000	3.162	**Good Alternative (2.567)**
Spot shrimp | Northeast Pacific | Pots | United States | Alaska	2.644	1.000	3.000	3.536	**Good Alternative (2.301)**

Summary

Northern shrimp and sidestriped shrimp caught in Alaska with beam trawls is a "Good Alternative". The status of shrimp stocks in Alaska is unknown. Bycatch likely includes vulnerable corals and high amounts of other fish. The management measures are rated moderately effective overall. Bottom trawling takes place over more resilient sandy and muddy seafloor, and closed areas and the use of beam trawls reduce overall habitat impacts.

Spot shrimp caught in Alaska, California, and Washington with pots is a "Good Alternative." Coonstriped shrimp caught in Alaska and California with pots is also a "Good Alternative." The status of spot and coonstriped shrimp stocks is unknown. Bycatch information was generally unavailable, and pot gear may entangle vulnerable marine mammals in California and Alaska. The conservation measures for this fishery are rated moderately effective. Pot fishing takes place over rocky or hard bottom habitat, and the gear can damage vulnerable reefs and corals. Closed areas reduce overall habitat impacts, and there are policies in place to protect the ecosystem.

Pacific rock/ridgeback shrimp and ocean/pink shrimp caught with bottom trawls in California is a "Good Alternative." Ocean shrimp stocks are healthy, while the status of rock shrimp stocks is unknown. The ocean shrimp fishery may be impeding the recovery of eulachon, an ecologically important forage fish listed as "endangered." Bycatch information in the rock shrimp fishery was unavailable, but it's likely to include vulnerable corals and benthic invertebrates. The conservation measures for this fishery are rated moderately effective. Bottom trawling takes place over more resilient sandy and muddy seafloor, and closed areas and gear modifications reduce overall habitat impacts. There are some policies in place to protect the ecosystem.

Scoring Guide

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

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

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

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

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

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

Introduction

Scope of the analysis and ensuing recommendation

This report focuses on the commercial coldwater shrimp fisheries of the states of Washington, California and Alaska. Six species of shrimp are reviewed: Northern shrimp *(Pandalus borealis),* spot shrimp or spot prawn *(P. platyceros),* sidestripe shrimp *(P. dispar),* coonstripe shrimp *(P. hypsinotus),* pink shrimp *(P. jordani),* and ridgeback shrimp *(Sicyonia ingentis)*. These species are captured with bottom trawls and pots. The Oregon and Washington pink shrimp bottom trawl fisheries are not included in this report as they are Marine Stewardship Council (MSC) certified. The Oregon spot prawn fishery is also not reviewed because it is small in scale (with only one vessel harvesting), and the majority of the data are confidential.

Species Overview

Shrimp along the US west coast and Alaska are typically benthic omnivores, feeding on organic surface sediments, diatoms, infaunal polychaetes, gastropods, and crustaceans (Owens 2006). Some shrimp species, such as spot prawns, undergo diurnal feeding migrations, moving shoreward along the bottom into shallower waters at night and back to deeper waters during the day (Butler 1964) (Smith et al. 2014). Shrimp distributions are principally determined by temperature, salinity, and bottom type (Cadrin et al. 2004). Environmental factors have profound influence on life histories within and among shrimp populations {Anderson and Piatt 1999} (Hannah 2011). For instance, ocean climate and ice cover significantly affect shrimp population dynamics and fishery yields (Cadrin et al. 2004). Although adult spot prawns and coonstripe shrimp can be found on rocky habitats {Larson and Reilly 2006}, pink, northern, sidestripe and ridgeback shrimp are typically found over muddy or sandy substrates (Smith et al. 2014) {Collier et al. 2006}.

With the exception of ridgeback shrimp, all species reviewed in this assessment are *pandalid* shrimp (pink, northern, spot prawn, and sidestripe). Ridgeback shrimp (also known as rock shrimp) employ a different life history strategy and are broadcast spawners. Spawning can occur after the first or second year of growth, and females are known to produce 86,000 eggs on average during a spawning season (Owens 2006).

Pandalid shrimp are protandric hermaphrodites, beginning life as males and becoming females at a later stage {Larson and Reilly 2007} (Smith et al. 2014). In contrast to many marine species that broadcast gametes into the water column, pandalid shrimp have internal fertilization, and females brood eggs until larvae are hatched (Cadrin et al. 2004). Overall fecundity (number of eggs produced) and ontogeny vary by species. Shrimp are particularly challenging to age because shrimp growth is a discontinuous process and is associated with molting of the exoskeleton (Cadrin et al. 2004); therefore, age estimates are uncertain. On average, pandalids may reach maturity between 1 to 3 years and female pandalids may brood up to 1,000 to 2,000 eggs per reproductive cycle (Cadrin et al. 2004). Spot prawns are the longest-lived of the pandalid shrimp, and studies from Alaska suggest they can live up to 8 to 10 years or longer (Smith et al. 2014).

Production Statistics

Shrimp is the most popular seafood item in the US. Average annual per capita consumption of shrimp in the US has doubled since the mid-1980s and has generally been greater than or equal to 4 lb since 2003. The US is the world's leading shrimp importer. The majority (~90%) of shrimp consumed in the large US market is imported, warm-water shrimp, primarily from Asia (India, Indonesia, Thailand) and South America (Ecuador) (Figure 1). The majority of imported shrimp in the US are farmed shrimp (NMFS 2021b).

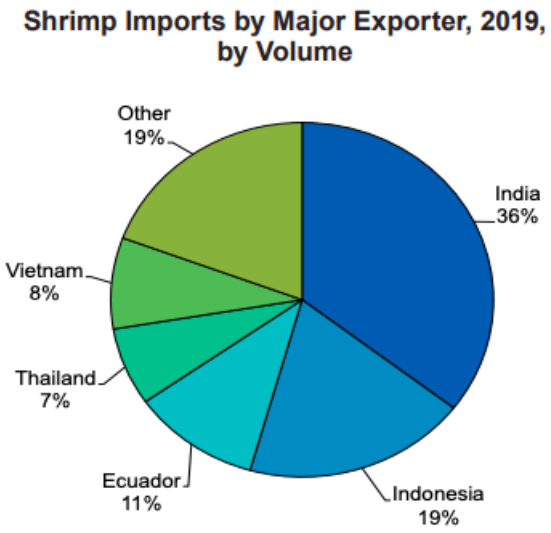

Figure 1: Shrimp imports by foreign country (NOAA 2021b).

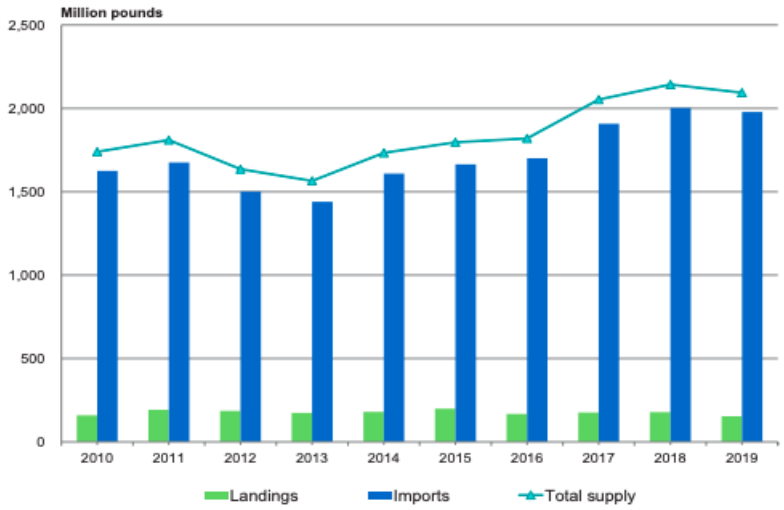

Figure 2: US supply of shrimp, 2010-2019 (NMFS 2021b).

Shrimp ranked eighth in terms of overall landings (lb) in the US in 2019 (NMFS 2021b). The majority of US shrimp landings (lb) occur in the Gulf region (LA, TX, etc.). Coldwater shrimp production from the US west coast comprises a relatively small percentage of the total US shrimp supply. US-wide, coldwater shrimp production has been stable since the early 2000's (Figure 4), with notable exceptions being major increases in pink shrimp production in Oregon and Washington (not assessed in this review due to MSC certification) in 2014 and 2015 (NMFS 2017b).

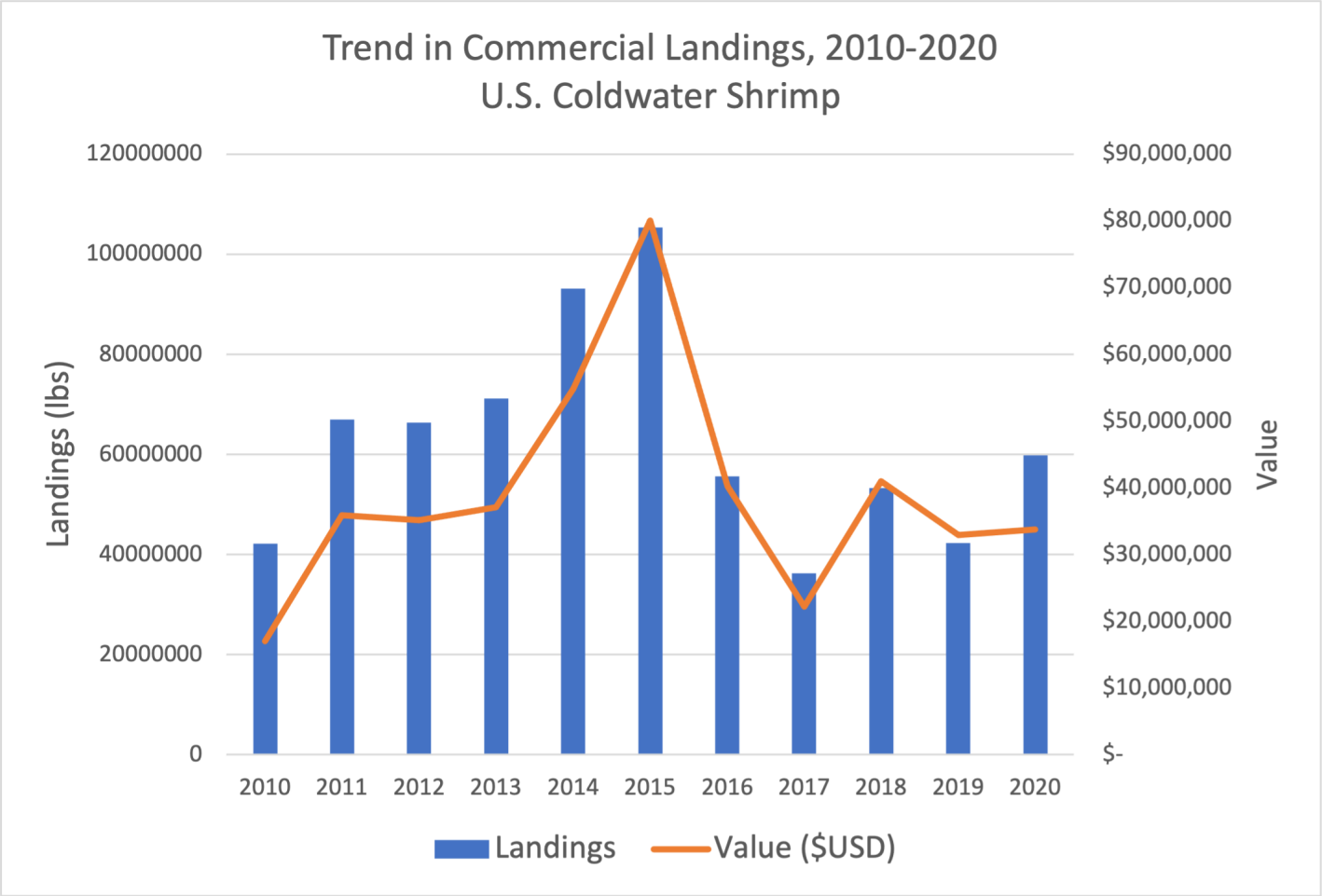

Figure 3: Trend in commercial landings of US shrimp, 2010-2020, all shrimp species combined in OR, WA, CA, and AK {NMFS 2021}.

By Pacific state, Oregon and Washington land the most shrimp, and the vast majority of shrimp landings in both states are pink shrimp. Of the species and states included in this assessment, California pink shrimp account for the greatest production, followed by Alaskan Penaeid shrimp, west coast spot prawn.

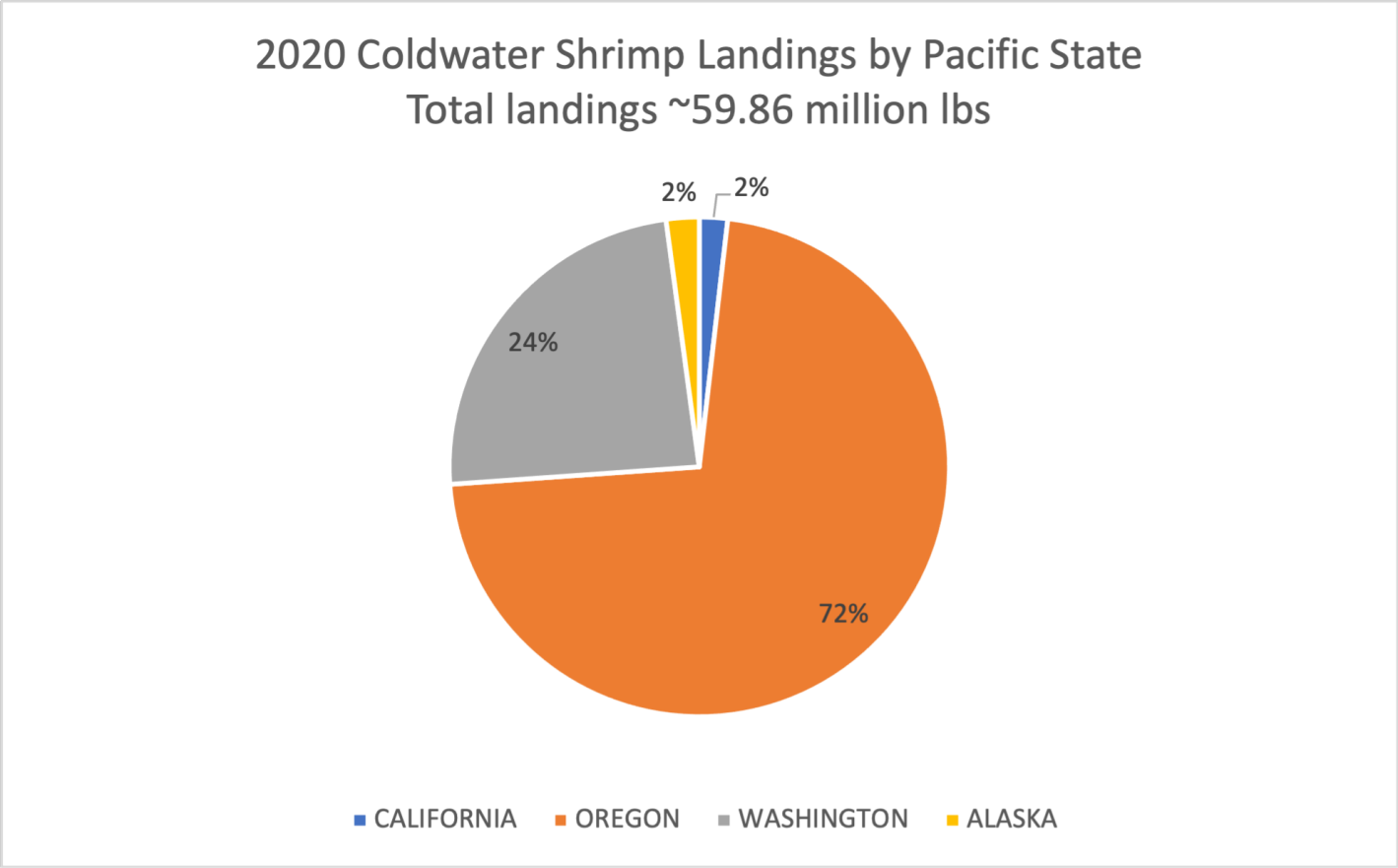

Figure 4: Pacific coast (excluding Canada) shrimp landings by state (NOAA 2021).

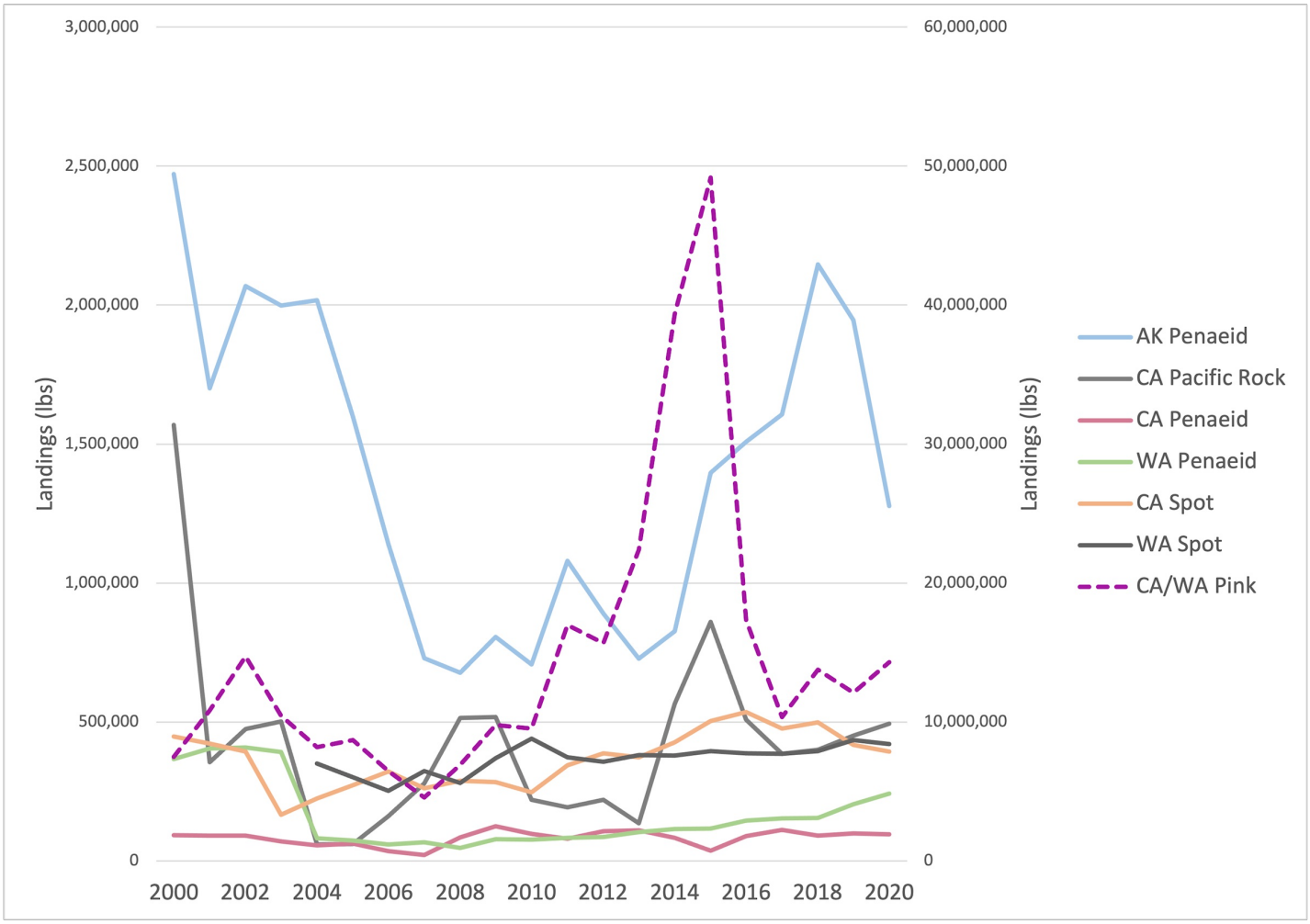

Figure 5: Landings by shrimp species included in this assessment, 2000-2020 (NOAA 2021). Note the different scale for California and Washington combined pink shrimp landings.

Importance to the US/North American market.

Shrimp is an integral component of the US North American fishing economy. In 2019, shrimp was the fifth most valuable ($/lb landed) fishery in the US and ranked eighth in terms of overall pounds landed (NMFS 2021b) (Table 1). In 2015, US landings of shrimp were 248 million lb, valued at over $467.4 million, which was an decrease of 41.1 million lb (-14%), and a decrease in value of $28.7 million (-6%)) compared with 2018 (NMFS 2021b).

Major U.S. Domestic Species Groups Landed in 2019

Ranked by Volume and Value

Volume of Landings

Rank	Species	Thousand Pounds
1	Pollock (Alaska)	3,352,595
2	Menhaden	1,507,831
3	Salmon	838,267
4	Hakes	701,595
5	Flatfish	561,741
6	Cod	466,195
7	Crabs	271,933
8	Shrimp	248,055
9	Rockfishes	227,297
10	Lobsters	130,321

Value of Landings

Rank	Species	Thousand Dollars
1	Salmon	707,251
2	Lobsters	668,399
3	Crabs	635,695
4	Scallops	571,992
5	Shrimp	467,437
6	Pollock (Alaska)	387,601
7	Flatfish	264,510
8	Oysters	253,212
9	Clams	218,281
10	Menhaden	156,301

Figure 6: Major US domestic species groups landed in 2019, ranked by volume and value (NMFS 2021b).

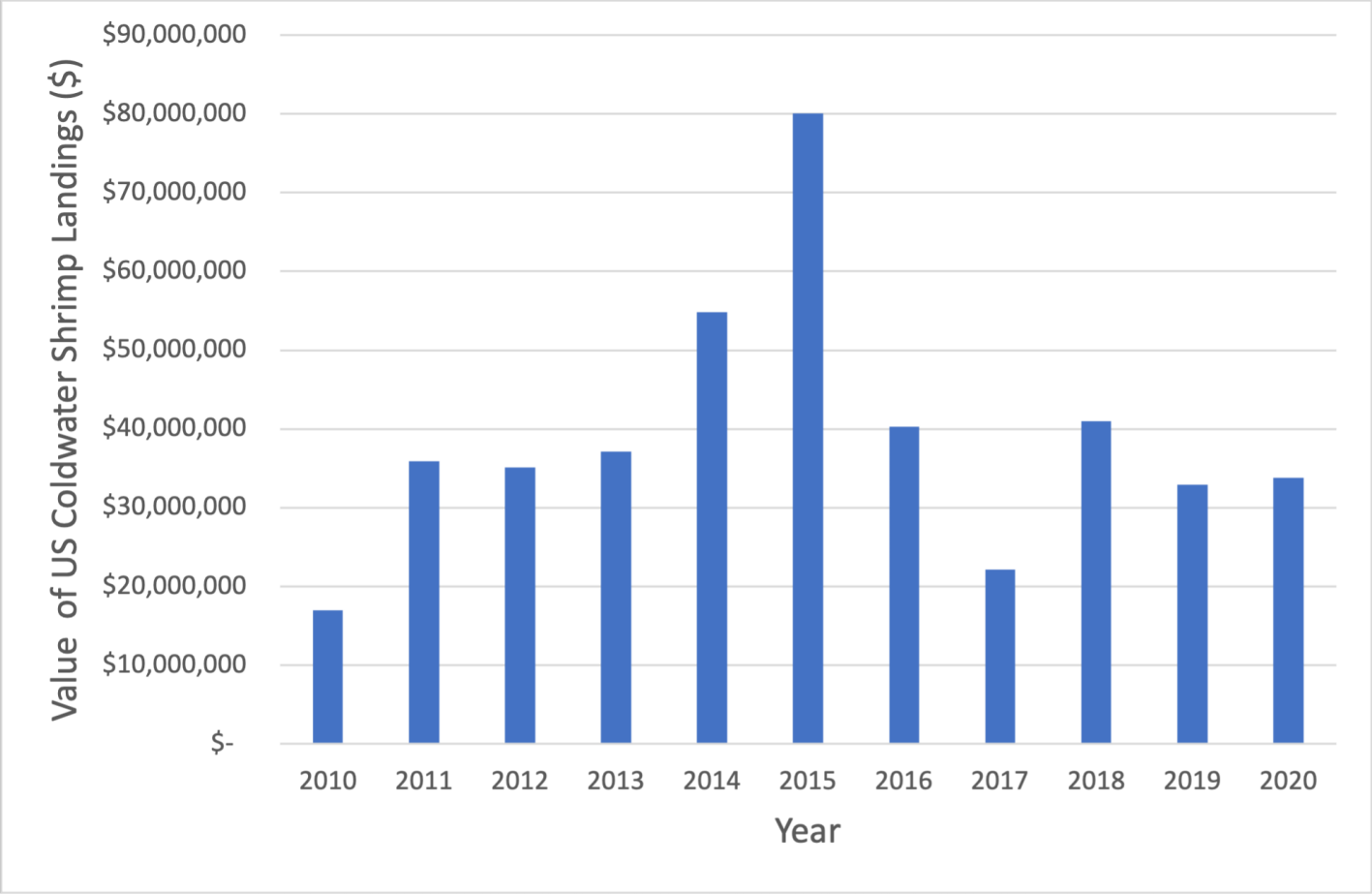

Figure 7: Overall value of landings of Pacific coast shrimp, 2010-2020 {NMFS 2021}.

Oregon accounted for almost half (48%) of the region's shrimp landings revenue in 2014, increasing 21% from 2013 levels and 325% from 2005 levels (NOAA 2016). This increase was due in large part to larger than average landings in the pink shrimp fisheries in California, Oregon, and Washington. Increases in domestic shrimp production and landings seen in recent years are related to increased prices of shrimp in the US market. Increased prices of shrimp products have resulted from a decline in the supply of shrimp imported from Asian countries due to issues with early mortality syndrome (EMS) at aquaculture facilities in Southeast Asia {Reed and Royales 2014}.

Common and market names.

Common names vary by region, but this report will adhere to the nomenclature listed below (Figure 9). Market names for coldwater shrimp tend to vary and are not well-regulated.

Table 2: Coldwater and US west coast shrimp fisheries (not globally comprehensive). Common names used in this report appear in bold. Species assessed in this report are denoted by ***.

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

, Pacific intertidal shrimp, crawfish, mud prawn, burrowing shrimp, red ghost shrimp, orange mud shrimp	*Callianassa californiensis*	Alaska to Baja California	NA
Brine shrimp, sea monkey, fairy shrimp	*Artemia salina, Artemia fransciscana*	Salty lakes in Utah and West Coast	

Primary product forms

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

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

Assessment

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

Criterion 1: Impacts on the species under assessment

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

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

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

Guiding principles

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

Criterion 1 Summary

COONSTRIPED SHRIMP			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Northeast Pacific | Pots | United States | California	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Northeast Pacific | Pots | United States | Alaska	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

NORTHERN SHRIMP			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Northeast Pacific | Beam trawls | United States | Alaska	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

OCEAN SHRIMP			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Northeast Pacific | Bottom trawls | United States | California | Pink Shrimp Fishery	3.670: Low Concern	3.000: Moderate Concern	Green (3.318)

PACIFIC ROCK SHRIMP			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Eastern Central Pacific | Bottom trawls | United States | California | Ridgeback Shrimp Fishery	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

SIDESTRIPED SHRIMP			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Northeast Pacific | Beam trawls | United States | Alaska	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

SPOT SHRIMP			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Northeast Pacific | Pots | United States | Washington	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Northeast Pacific | Pots | United States | California	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Northeast Pacific | Pots | United States | Alaska	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

Criterion 1 Assessments

SCORING GUIDELINES

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

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

Factor 1.2 - Fishing Mortality

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

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

Coonstriped shrimp

Factor 1.1 - Abundance

Northeast Pacific | Pots | United States | Alaska

Moderate Concern

Data for coonstripe shrimp in Alaska *(Pandalus hypsinotus)* are inadequate to estimate abundance and harvests for sustainable yield, and there is no formal stock assessment for coonstripe shrimp in Alaska (Smith et al. 2014)(Smith and Gray 2017). Therefore, stock status is unknown. Coonstripe shrimp in Alaska have a "medium" vulnerability to fishing, and stock status receives a "moderate" concern rating.

Justification:

Table 1. Coonstripe shrimp, Alaska coonstripe shrimp (*Pandalus hypsinotus*) pot

Productivity	**Value**	**Score (1 = low risk, 2 = medium risk, 6 = high risk)**	**Reference**		**Susceptibility Attribute**	**Information**	**Score (1 = low risk, 2 = medium risk, 6 = high risk)**	**Reference**
Average age at maturity (years)	2	1	DFO Canada 2017, Butler 1964		**Areal overlap**	Unknown	3	
Average maximum age (years)	4	1	DFO Canada 2017, Butler 1964		**Vertical overlap**	Target	3	
Fecundity (eggs/yr)	2,000	2	Allen 1959		**Selectivity of fishery**	Unknown	2	
Reproductive strategy	Demersal egg layer or brooder	2	Cadrin et al. 2004		**Post-capture mortality**		3	
Trophic level	2.6	1	seaaroundus.org		**Susceptibility Subscore**	**2.325**		
Density dependence (invertebrates only)	Compensatory	1	McVeigh 2008, Butler 1964					
Quality of Habitat	Robust	1	Butler 1964, Smith et al. 2014		**Productivity-Susceptibility Score**	**2.66**		
Productivity Subscore	**1.28571**				**Vulnerability Rating (high, medium, low)**	**MEDIUM**		

Northeast Pacific | Pots | United States | California

Moderate Concern

There are no abundance estimates available for coonstripe shrimp (dock shrimp, *Pandalus danae*) in California {McVeigh 2008}. Fishery and survey data suggest that the coonstripe shrimp range along the US west coast extends from southeast Alaska to Baja, Mexico. However, coonstripe shrimp are only captured in commercially viable quantities in northern California, Washington, and British Columbia. Coonstripe shrimp breed throughout the year, which confounds life history parameter determinations {McVeigh 2008}. Catch per trip and overall landings have increased since 2007 (Figure 10). Abundance of California coonstripe shrimp remains unknown, and this stock receives a "moderate" concern.

Justification:

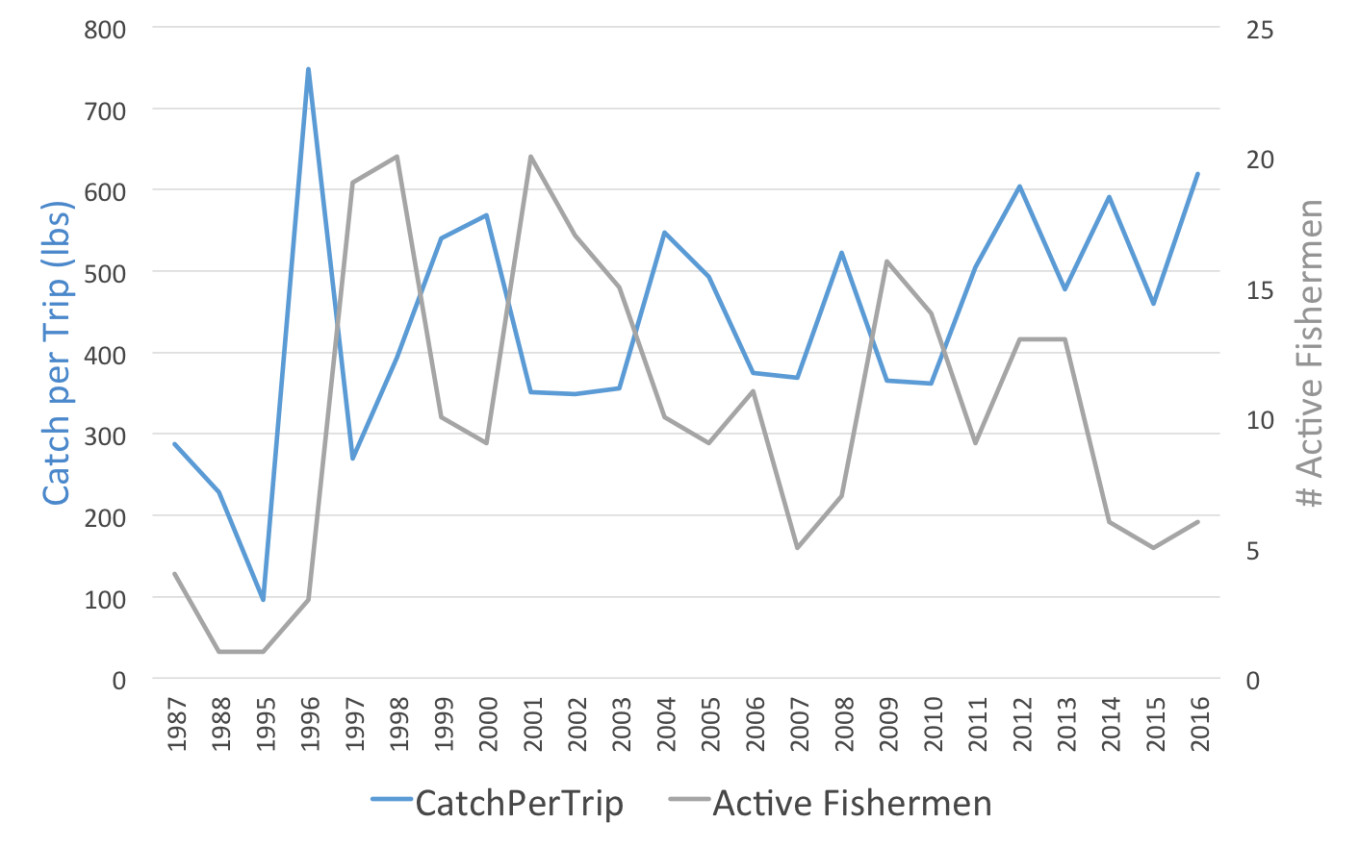

Figure 8: California coonstripe shrimp fishery catch per trip (lbs, blue line) and number of active participants (grey line), 1987-2016. CDFW 2017.

Table 2. California coonstripe, California coonstripe/dock shrimp (*Pandalus danae*) pot

Productivity	**Value**	**Score (1 = low risk, 2 = medium risk, 6 = high risk)**	**Reference**		**Susceptibility Attribute**	**Information**	**Score (1 = low risk, 2 = medium risk, 6 = high risk)**	**Reference**
Average age at maturity (years)	1	1	McVeigh 2008, Butler 1964		**Areal overlap**	Unknown	3	
Average maximum age (years)	4	1	McVeigh 2008, Butler 1964		**Vertical overlap**	Target	3	
Fecundity (eggs/yr)	1,140	2	McVeigh 2008, Butler 1964		**Selectivity of fishery**	Unknown	2	
Reproductive strategy	Demersal egg layer or brooder	2	McVeigh 2008, Cadrin et al. 2004		**Post-capture mortality**		3	
Trophic level	2.6	1	seaaroundus.org		**Susceptibility Subscore**	**2.325**		

Density dependence (invertebrates only)	Compensatory	1	McVeigh 2008, Butler 1964				
Quality of Habitat	Robust	1	McVeigh 2008	**Productivity-Susceptibility Score**	**2.66**		
Productivity Subscore	**1.28571**			**Vulnerability Rating (high, medium, low)**	**MEDIUM**		

Factor 1.2 - Fishing Mortality

Northeast Pacific | Pots | United States | Alaska

Moderate Concern

Coonstripe shrimp are harvested in the Prince William Sound (PWS) and Southeast Alaska (SEAK) management regions. Guideline Harvest Levels (GHLs) for coonstripe shrimp in SEAK are based on average historic landings 1995 to 2000 (Smith et al. 2014). GHLs in two (out of twenty) SEAK districts are based on coonstripe shrimp, and the GHL in one more district is based on spot and coonstripe shrimp combined (Smith et al. 2014). Landings of coonstripe have been well below the 15,000 lb regional GHLs and averaged approximately 13,000 lb from 2009 to 2014 in one SEAK district (15). Data are unavailable (due to confidentiality) for the second district where coonstripe were specifically targeted (16) (Smith et al. 2014). In PWS, specific coonstripe GHLs are not set because they are a small percentage of the harvests (approximately 6% of overall landings). Coonstripe harvests averaged approximately 2,250 lb from 2010 to 2014, and CPUE has been fairly stable during that time (Wessel et al. 2015). Although biological reference points are limited for coonstripe shrimp in Alaska, GHLs are set annually in SEAK based on extant landings and sampling data and have not been exceeded in recent years for coonstripe shrimp. Therefore, fishing mortality receives a "moderate" concern.

Northeast Pacific | Pots | United States | California

Moderate Concern

The coonstripe shrimp pot fishery is a relatively small fishery with limited participation. The number of active fishery participants declined since the mid-1990s, and from 2010 to 2016 there was an average number of nine participants per year (Figure 11). Yet, the limited distribution of coonstripe shrimp coupled with the open access nature of the fishery could render coonstripe shrimp vulnerable to overharvest should participation levels in the fishery increase. Because data are limited for coonstripe shrimp in California, data on fishing mortality in relation to a reference point is unavailable, and the fishery receives a "moderate" concern for fishing mortality.

Justification:

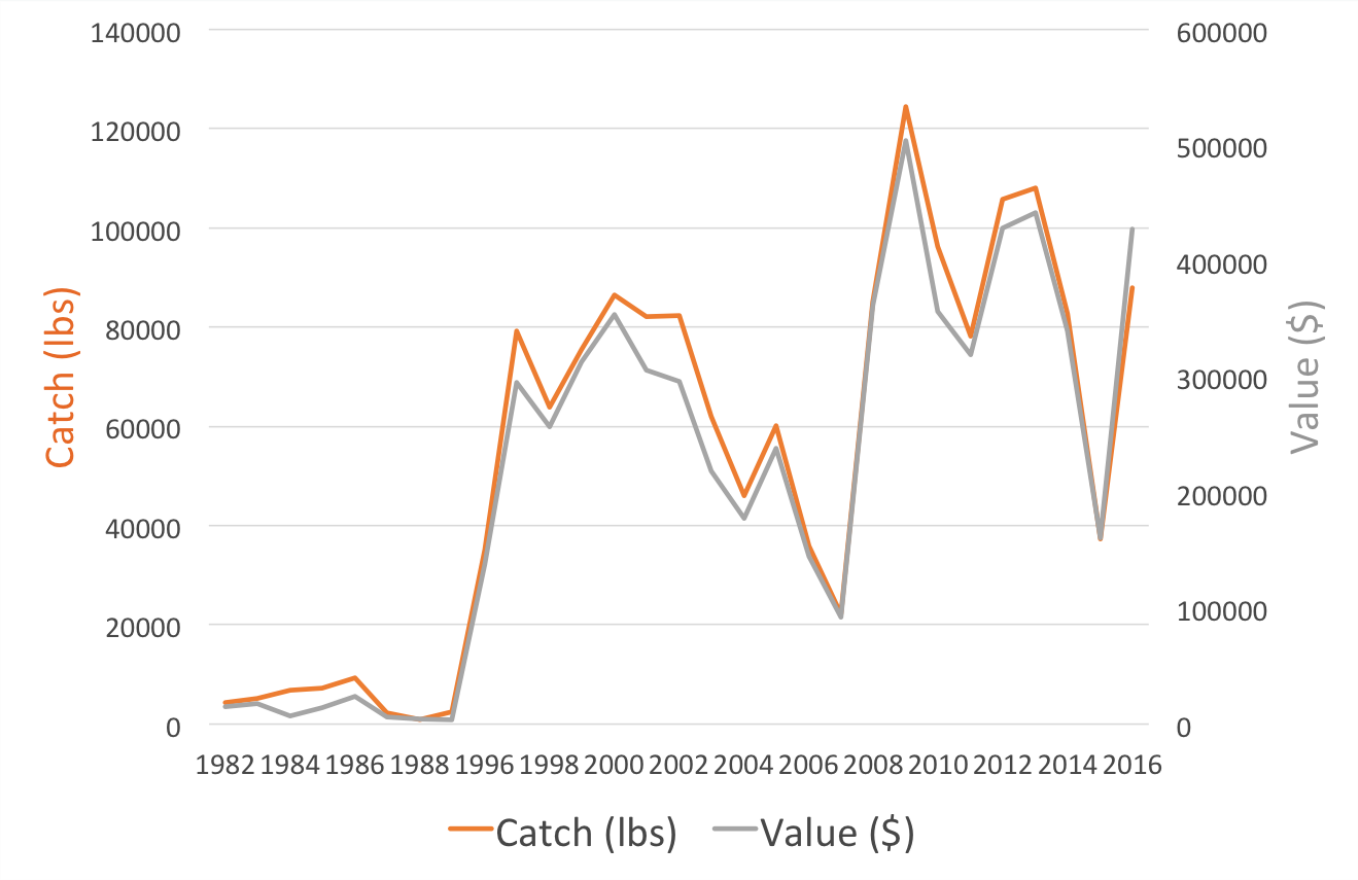

Figure 9: California coonstripe shrimp fishery catch (lbs, orange line) and value ($, grey line), 1982-2016. CDFW 2017.

Northern shrimp

Factor 1.1 - Abundance

Northeast Pacific | Beam trawls | United States | Alaska

Moderate Concern

Northern shrimp in Southeast Alaska (SEAK) are harvested with beam trawl fishing gear and are the secondary target in the sidestripe shrimp fishery. There is no stock assessment for northern shrimp in Alaska, and the stock status is considered unknown. Northern shrimp pounds per landing (as a proxy for abundance) declined in the late 2000s, but it has been relatively stable since 2011/2012 (Figure 12) (Smith et al. 2014). Northern shrimp receive a "moderate" concern for abundance.

Justification:

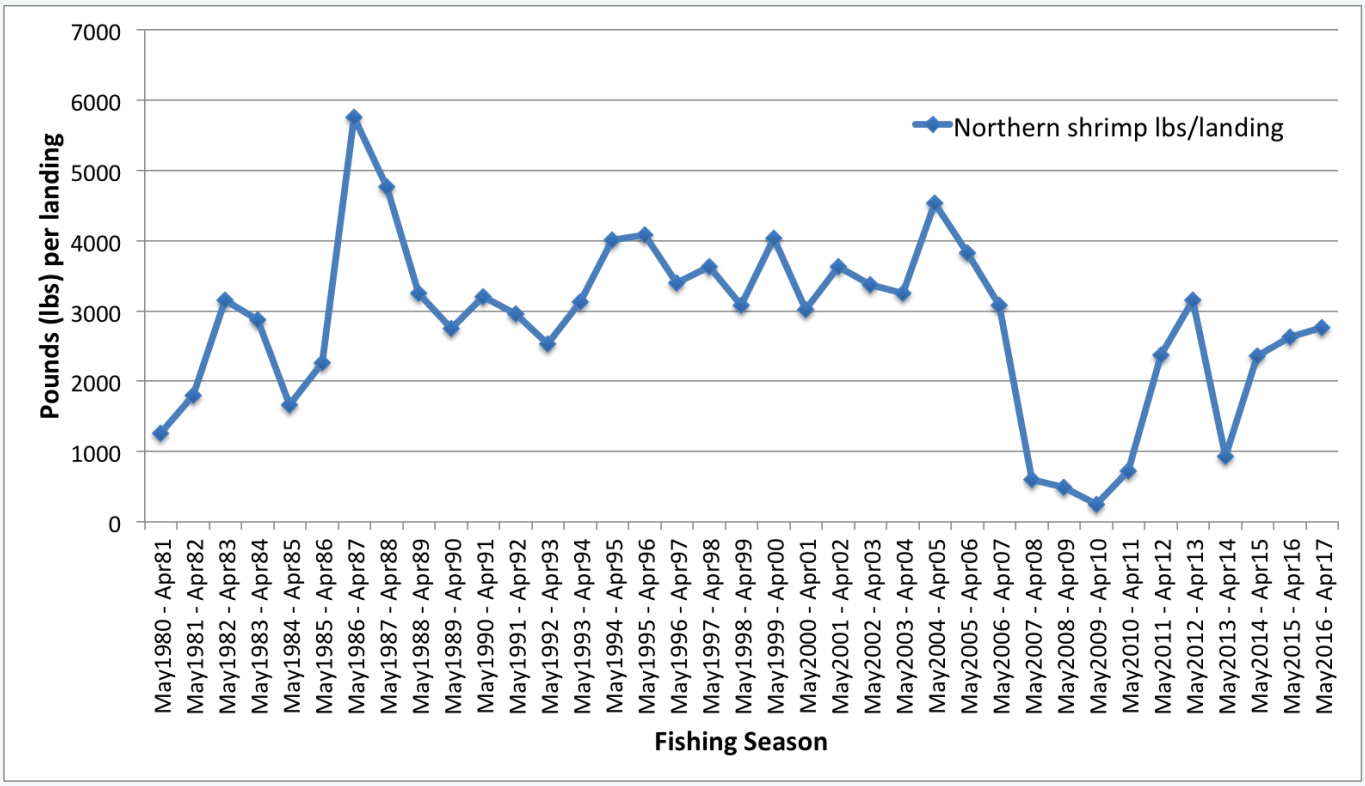

Figure 10: Southeast Alaska northern shrimp pounds per landing, 1980-2017.

Table 3. Northern shrimp, Alaska northern shrimp trawl

Productivity	Value	Score (1 = low risk, 2 = medium risk, 6 = high risk)	Reference		Susceptibility Attribute	Information	Score (1 = low risk, 2 = medium risk, 6 = high risk)	Reference
Average age at maturity (years)	1.5	1	Allen 1959, Butler 1964		**Areal overlap**	Unknown	3	
Average maximum age (years)	5	1	Allen 1959, Butler 1964		**Vertical overlap**	Target	3	
Fecundity (eggs/yr)	2,000	2	Allen 1959		**Selectivity of fishery**	Unknown	2	
Reproductive	Demersal egg layer or	2	Allen 1959, Cadrin et al.		**Post-capture**		3	

strategy	brooder		2004	**mortality**			
Trophic level	3.07	1	seaaroundus.org	**Susceptibility Subscore**	**2.325**		
Density dependence (invertebrates only)	Compensatory	1	Allen 1959, Butler 1964, Weiland 2005				
Quality of Habitat	Robust	1	Smith et al. 2014	**Productivity-Susceptibility Score**	**2.73**		
Productivity Subscore	**1.4285**			**Vulnerability Rating (high, medium, low)**	**MEDIUM**		

Factor 1.2 - Fishing Mortality

Northeast Pacific | Beam trawls | United States | Alaska

Moderate Concern

There are no reference points for Alaska northern shrimp; however, fishing mortality has declined in large part due to market conditions as opposed to declining stock status. It is unlikely that fishing mortality is negatively impacting the sustainability of the northern shrimp stock in the current state of the fishery. Overall Guideline Harvest Ranges (GHRs; based on fishery performance and size-class distribution data) vary in-season but cap at over approximately 3.5 million lb annually. GHLs were set for the first time since the early 2000s for the 2016/17 and 2017/18 seasons in SEAK due to renewed interest in the regional fishery (pers. comm., Smith, ADFG 2017). Harvests were well under the 2016 to 2017 GHLs in SEAK. The northern shrimp fishery receives a "moderate" concern for fishing mortality because F is unknown relative to appropriate reference points.

Justification:

Effort decreased from around 23 to 51 permits per year in the northern shrimp seasons pre-1999 to a low of just 4 permits fished during the 2014/2015 season (Figure 5). Landings decreased dramatically since the early 2000s (Figure 13), but have begun to increase in recent years {Smith and Gray 2018} This decrease in participation and harvest has been due in part to low market prices at the cannery and a reduction in local processing capabilities (Smith et al. 2014).

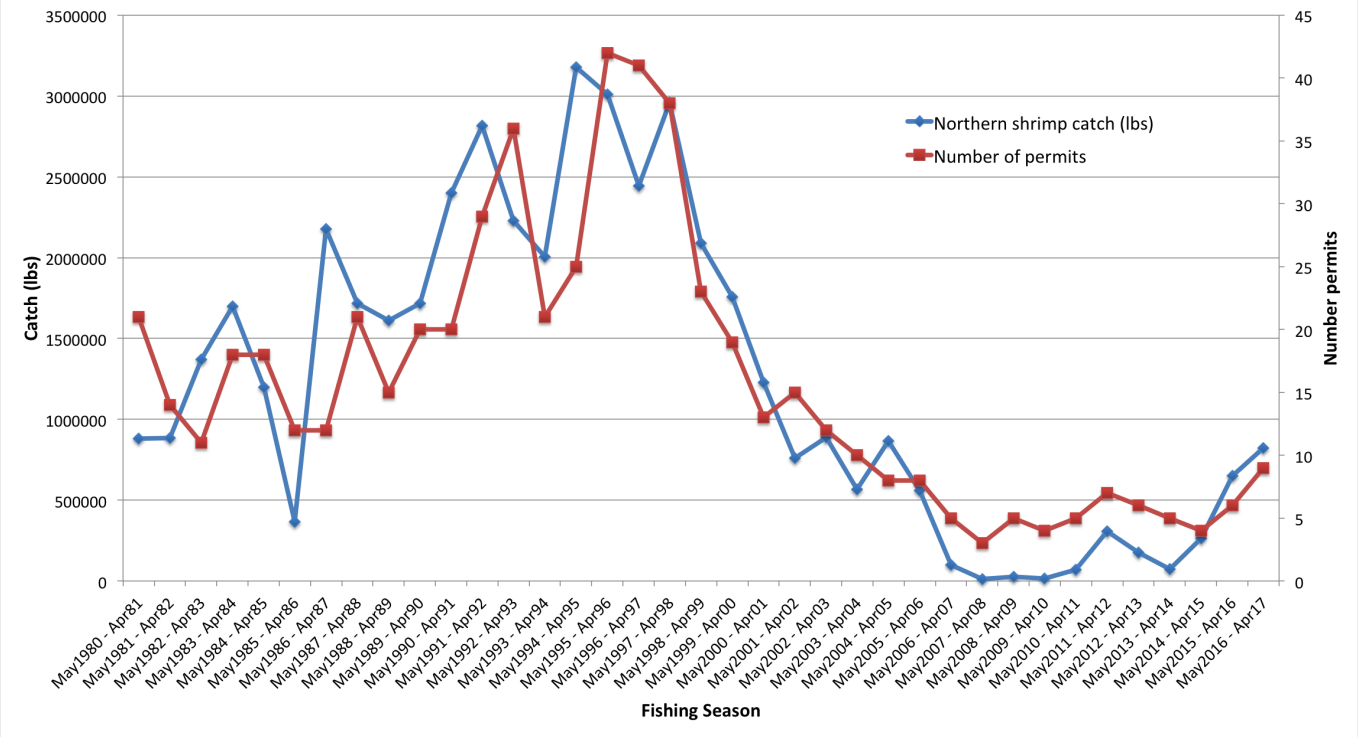

Figure 11: Southeast Alaska northern shrimp catch (lbs; blue line) and number of permits fished (red line), 1980-2017.

Ocean shrimp

Factor 1.1 - Abundance

Northeast Pacific | Bottom trawls | United States | California | Pink Shrimp Fishery

Low Concern

There is currently no stock assessment for pink shrimp caught in the California trawl fishery (pers. comm., Coates, CDFW 2017), but data-limited assessment methods can be used to assess the health of pink shrimp. Pink shrimp along the US west coast are generally considered one stock. Catch per unit effort (CPUE) in Oregon declined in recent years and 2019 had the lowest CPUE since 2004 (ODFW 2020), but improved in 2020 (ODFW 2021); trends in catch rates in Washington over the last three years (2018-2020) have been comparable to Oregon (WDFW 2021). Catch per trip in the California fishery generally increased from the 1980s--potentially because of increased trawler efficiency--but were lower in the last three seasons (data available through 2017) than the peak rates from 2009 to 2014 (CDFW 2019). The Oregon stock-recruitment index suggest stable pink shrimp stock abundance and environmental conditions in 2020 predict a strong recruitment class (ODFW 2020)(ODFW 2021).

Two data-limited assessment methods including stable-to-high CPUE from California, Oregon, and Washington fisheries (CDFW 2006) (ODFW 2021) (WDFW 2021), and the Oregon stock-recruitment index (ODFW 2021) suggest pink shrimp stock abundance in California is healthy. Therefore, pink shrimp abundance is rated “low" concern for abundance

Justification:

Large natural fluctuations in abundance and recruitment in short-lived invertebrates, such as pink shrimp (Frimodig et al. 2009) limit the reliability of traditional stock assessments and biomass estimates {CDFG 2006}. Research suggests environmental factors, as opposed to fishing effort, are the primary drivers of pink shrimp abundance {Frimodig 2009}. Catch per trip can be used as a proxy for pink shrimp abundance in California. Pink shrimp catch per trip in California has been relatively high since 2001 (Figure 26), when a number of regulatory changes required limited entry in the northern portion of the fishery and BRDs for the entire fleet.

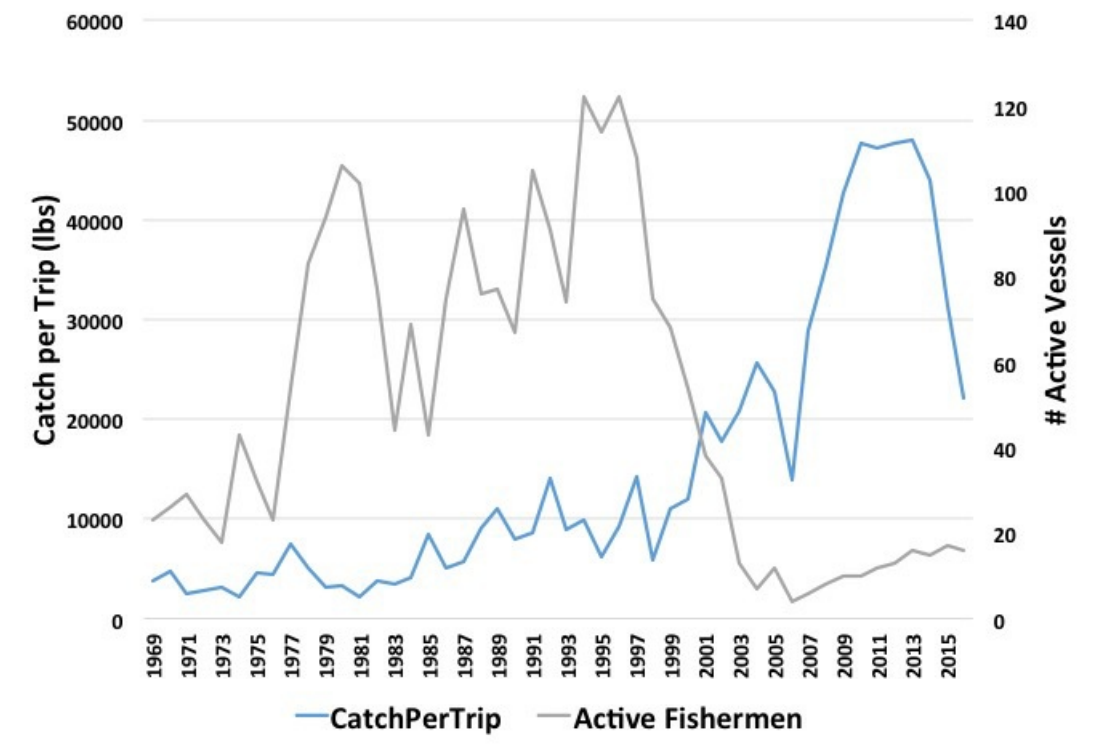

Figure 12: California pink shrimp fishery catch per trip (blue line) and number of active participants (grey line), 1969-2016. CDFW 2017.

Pink shrimp along the west coast of the United States likely originate from one genetic stock {CDFG 2006}; therefore, studies exploring the Oregon and Washington pink shrimp abundance and recruitment can be used as proxies for the status of the California pink shrimp. Specifically, average annual CPUE in the Oregon pink shrimp fishery has declined in recent years and was the lowest in 15 years in 2019, indicating a relatively low overall stock (ODFW 2020); however, the CPUE rebounded in 2020 to nearly double the 2019 rate (ODFW 2021)(Figure 17). Likewise, there were positive trend for pink shrimp in Washington; the CPUE in 2020 increased by 38% relative to 2019 (WDFW 2021). The stock recruitment model used by Oregon fishery managers (Figure 18) predicts excellent recruitment in 2020 (ODFW 2020). California fishery managers intended to develop a model similar to the Oregon recruitment index for California pink shrimp by 2019 (pers. comm., Coates, CDFW 2017). Stable-to-high CPUEs from Oregon, Washington, California, and results from the Oregon recruitment index indicate the pink shrimp stock along California is relatively robust despite lacking a stock assessment for the region.

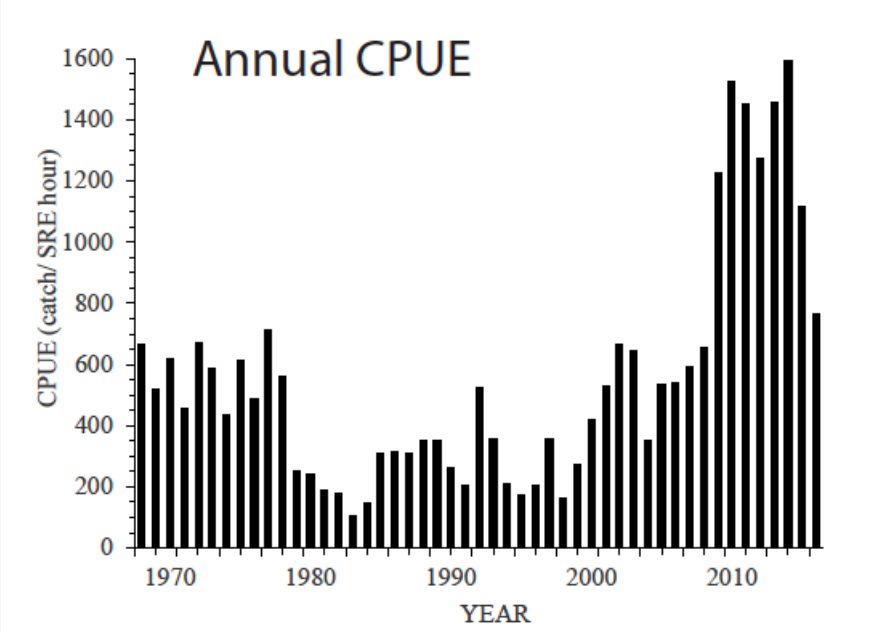

Figure 13: Annual average pounds of pink shrimp caught per hour (SRE) for vessels landing pink shrimp into Oregon; 1968-2016 (ODFW 2017).

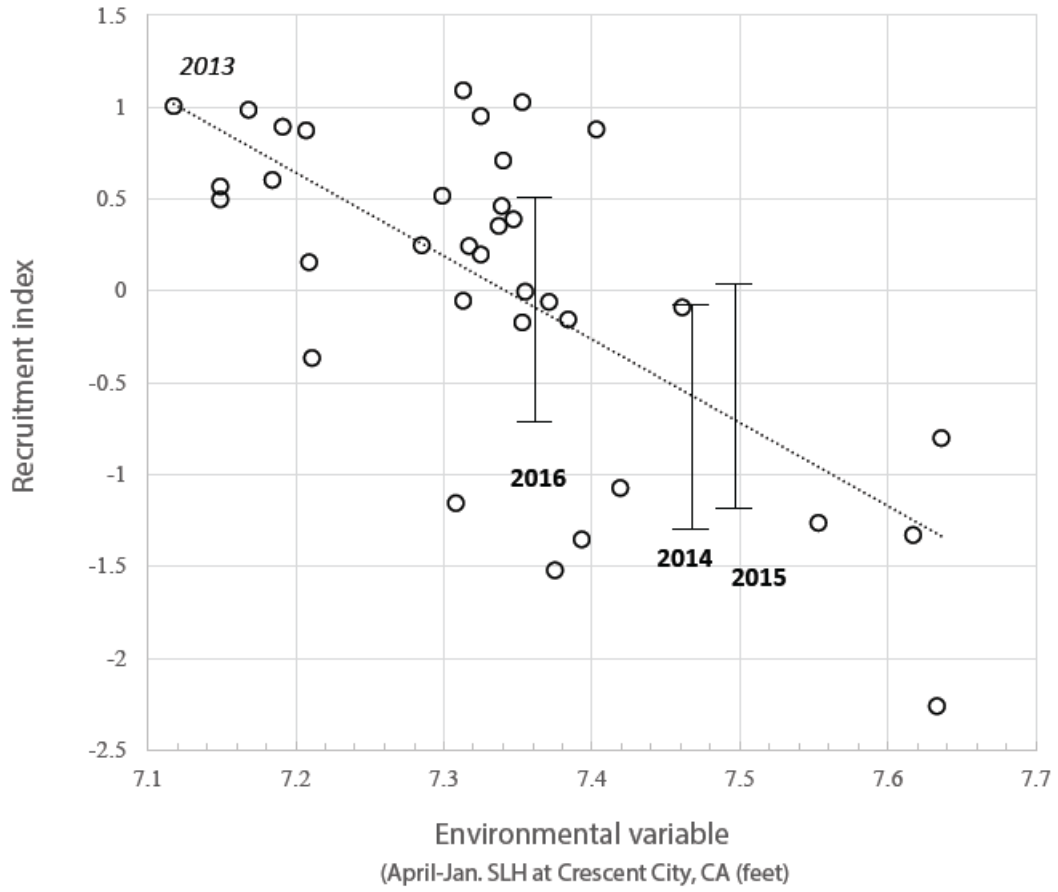

Figure 14: Pink shrimp recruitment model. A key environmental variable (mean April-January sea level height in Crescent City, CA) works as a predictive measure for total pink shrimp recruitment in each year. Each dot on this graph represents a year, dating back to 1979. Vertical lines labeled with year names represent the range of recruitment expected, given the environmental conditions in the year they are released as larvae. Sea level height varies by year and by month based on wind direction and intensity; these factors are known to affect the larval survival of newly hatched shrimp (ODFW 2017).

Productivity	**Value**	**Score (1 = low risk, 2 = medium risk, 6 = high risk)**	**Reference**	**Susceptibility Attribute**	**Information**	**Score (1 = low risk, 2 = medium risk, 6 = high risk)**	**Reference**
Average age at maturity (years)	2	1	Collier et al. 2006, Butler 1964	**Areal overlap**	Unknown	3	
Average maximum age (years)	4	1	Collier et al. 2006, Butler 1964	**Vertical overlap**	Target	3	
Fecundity (eggs/yr)	2,000	2	Collier et al. 2006	**Selectivity of fishery**	Unknown	2	
Reproductive strategy	Demersal egg layer or brooder	2	Cadrin et al. 2004	**Post-capture mortality**		3	
Trophic level	3.24	2	seaaroundus.org	**Susceptibility Subscore**	**2.325**		
Density							

dependence (invertebrates only)	Compensatory	1	Collier et al. 2006, Butler 1964				
Quality of Habitat	Robust	1	Collier et al. 2006	**Productivity-Susceptibility Score**	**2.73**		
Productivity Subscore	**1.4285**			**Vulnerability Rating**	**MEDIUM**		

Factor 1.2 - Fishing Mortality

Northeast Pacific | Bottom trawls | United States | California | Pink Shrimp Fishery

Moderate Concern

As noted above, there are no stock assessments or reference points specific to the California pink shrimp fishery (pers. comm., Coates, CDFW 2017). Data from multiple studies suggest that pink shrimp abundance is primarily driven by environmental factors, such as wind patterns and coastal currents, as opposed to fishing pressure (Frimodig et al. 2009) (Hannah 2011) (Anderson 2000). However, the effect of the fishery on the pink shrimp population in California is currently unknown; therefore, it is rated “moderate" concern.

Pacific rock shrimp

Factor 1.1 - Abundance

Eastern Central Pacific | Bottom trawls | United States | California | Ridgeback Shrimp Fishery

Moderate Concern

There is no population assessment for ridgeback shrimp in California (pers., comm., Coates, CDFW 2017). Fishing effort and ridgeback populations are concentrated in Southern California in the Santa Barbara Channel (Owens 2006) (pers. comm., Coates, CDFW 2017). Abundance of California ridgeback shrimp is unknown, and the stock is rated "moderate" concern.

Justification:

Historic trawl surveys conducted in the Santa Barbara Channel found ridgeback to be relatively abundant at both the middle and outer shelf in the region (Owens 2006). Ridgeback shrimp were also found to be the seventh most abundant megabenthic invertebrate during the Bight 08 research trawl studies conducted as part of the Southern California Coastal Water Research Project (Allen et al. 2011). Similar to other *pandalid* shrimp species, ridgeback shrimp recruitment appears to be largely influenced by environmental conditions, especially the El Niño Southern Oscillation. Ridgeback biological productivity is generally greater during warm water years (Owens 2006) (Allen et al. 2011). Future stock-recruitment indices may be able to predict ridgeback recruitment based on environmental parameters (pers. comm., Coates, CDFW 2017).

Table 4. Ridgeback prawn, California ridgeback prawn trawl

Productivity	Value	Score (1 = low risk, 2 = medium risk, 6 = high risk)	Reference		Susceptibility Attribute	Information	Score (1 = low risk, 2 = medium risk, 6 = high risk)	Reference
Average age at maturity (years)	1	1	Owens 2006, Butler 1964		**Areal overlap**	Unknown	3	
Average maximum age (years)	5	1	Owens 2006, Butler 1964		**Vertical overlap**	Target	3	
Fecundity (eggs/yr)	86,000	1	Owens 2006		**Selectivity of fishery**	Unknown	2	
Reproductive strategy	Broadcast spawner	1	Owens 2006		**Post-capture mortality**		3	
Trophic level	3.07	1	seaaroundus.org		**Susceptibility Subscore**	**2.325**		
Density dependence (invertebrates only)	Compensatory	1	Owens 2006					
Quality of Habitat	Robust	1	Owens 2006		**Productivity-Susceptibility Score**	**2.53**		
Productivity Subscore	**1**				**Vulnerability Rating (high, medium, low)**	**LOW**		

Factor 1.2 - Fishing Mortality

Eastern Central Pacific | Bottom trawls | United States | California | Ridgeback Shrimp Fishery

Moderate Concern

The ridgeback fishery is a limited entry fishery with gear restrictions and seasonal and area closures to minimize the risk of overharvest {Owens 2016}. The number of active fishery participants has remained relatively low since 2001, averaging 22 participants from 2001 to 2016. Landings of ridgeback shrimp are historically variable and have increased generally since 2004, with a peak in 2015 of 860,000 lb (Figure 14). The fishery is not fully prosecuted to date. In 2016, less than half of the ridgeback permits issued were actively fished (CDFW 2017) (Figure 15). Major biological reference points for ridgeback shrimp in the California trawl fishery are lacking, which means that F is unknown in relation to reference points. Fishing mortality for the California trawl fishery for ridgeback shrimp is rated "moderate" concern.

Justification:

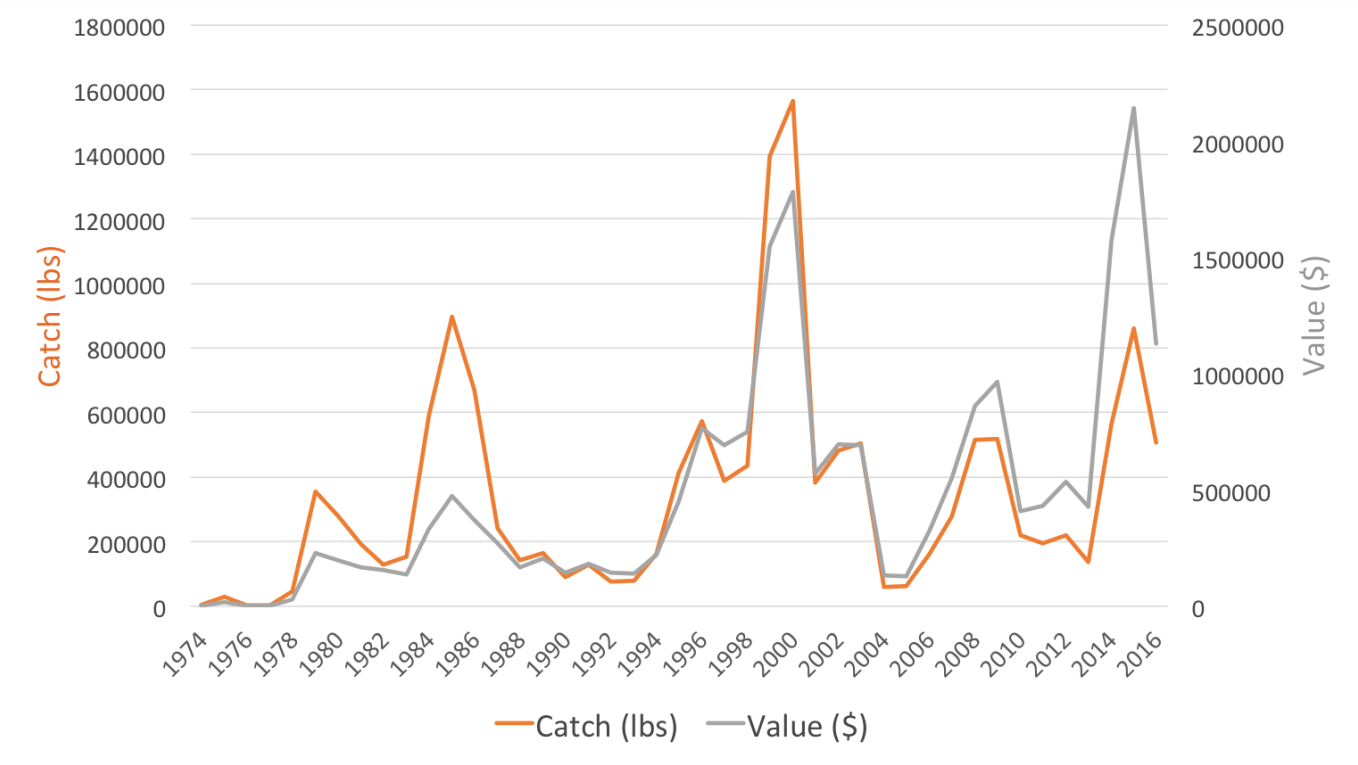

Figure 15: California ridgeback shrimp fishery landings (lbs, orange line) and value ($, grey line), 1974-2016. CDFW 2017.

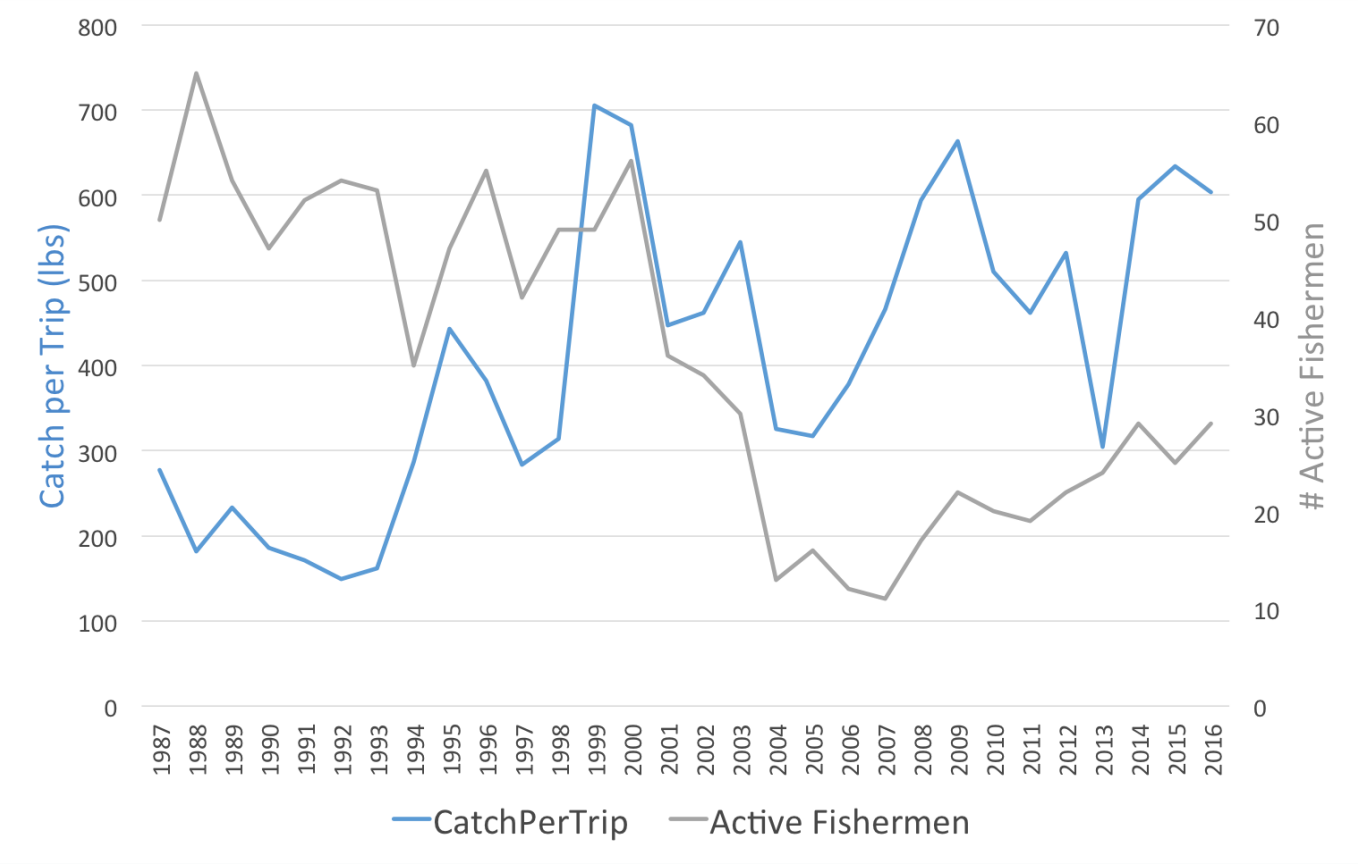

Figure 16: California ridgeback shrimp fishery catch per trip (blue line) and number of active fishermen (grey line), 1987-2016. CDFW 2017.

Sidestriped shrimp

Factor 1.1 - Abundance

Northeast Pacific | Beam trawls | United States | Alaska

Moderate Concern

Sidestripe shrimp are the primary target in the beam trawl fishery in Southeast Alaska. There is no stock assessment for sidestripe shrimp in Alaska, and the stock status is unknown. Pounds per landing (as a proxy for abundance) has been stable to increasing since the 1980s, with a big jump in the 2000s (Figure 19) (Smith et al. 2014). Sidestripe shrimp receive a "moderate" concern for abundance because the species is not highly vulnerable (see PSA) and there is no stock assessment, no reference points, and no evidence to suggest that stock is either above or below reference points.

Justification:

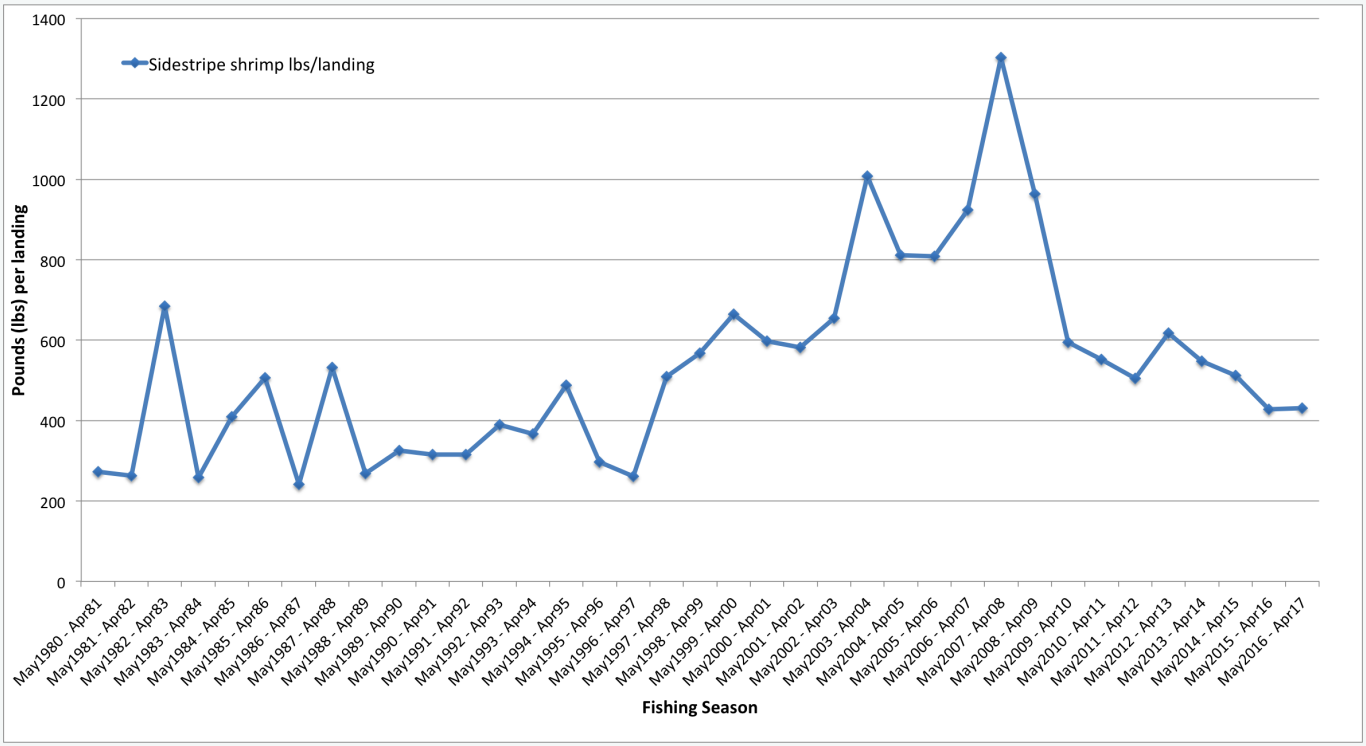

Figure 17: Southeast Alaska sidestripe shrimp pounds (lbs) per landing, 1980-2017.

Table 6. Sidestripe shrimp, Alaska sidestripe shrimp trawl

Productivity	Value	Score (1 = low risk, 2 = medium risk, 6 = high risk)	Reference		Susceptibility Attribute	Information	Score (1 = low risk, 2 = medium risk, 6 = high risk)	Reference
Average age at maturity (years)	2	1	DFO Canada 2017, Butler 1964		**Areal overlap**	Unknown	3	
Average maximum age (years)	4	1	DFO Canada 2017, Butler 1964		**Vertical overlap**	Target	3	
Fecundity (eggs/yr)	2,000	2	Allen 1959		**Selectivity of fishery**	Unknown	2	
	Demersal egg							

Reproductive strategy	layer or brooder	2	Cadrin et al. 2004	**Post-capture mortality**		3	
Trophic level	3.24	2	seaaroundus.org	**Susceptibility Subscore**	**2.325**		
Density dependence (invertebrates only)	Compensatory	1	Collier et al. 2006, Butler 1964				
Quality of Habitat	Robust	1	Smith et al. 2014	**Productivity-Susceptibility Score**	**2.66**		
Productivity Subscore	**1.285**			**Vulnerability Rating**	**MEDIUM**		

Factor 1.2 - Fishing Mortality

Northeast Pacific | Beam trawls | United States | Alaska

Moderate Concern

The number of sidestripe permits fished decreased from the mid-1990s to a low of just four permits fished during the 2014/2015 season. Sidestripe landings have increased moderately since 2005 (Figure 20) (Smith et al. 2014). Overall landings have been below the GHR of 50,000 lb by district/season. Area-specific harvest caps for sidestripe were set conservatively based on historic landings (Smith et al. 2014). Historically, the beam trawl fishery landed a great proportion of northern shrimp relative to sidestripe shrimp, but that has shifted in recent years; from 2008 to 2017 sidestripe have accounted for 55% of the harvest (up from 14% from 1997 to 2002 and 15% from 2003 to 2007) (Smith and Gray 2017). There are no reference points for Alaska sidestripe shrimp, and data on fishing mortality in relation to a reference point is therefore unavailable. The sidestripe shrimp fishery receives a "moderate" concern for fishing mortality.

Justification:

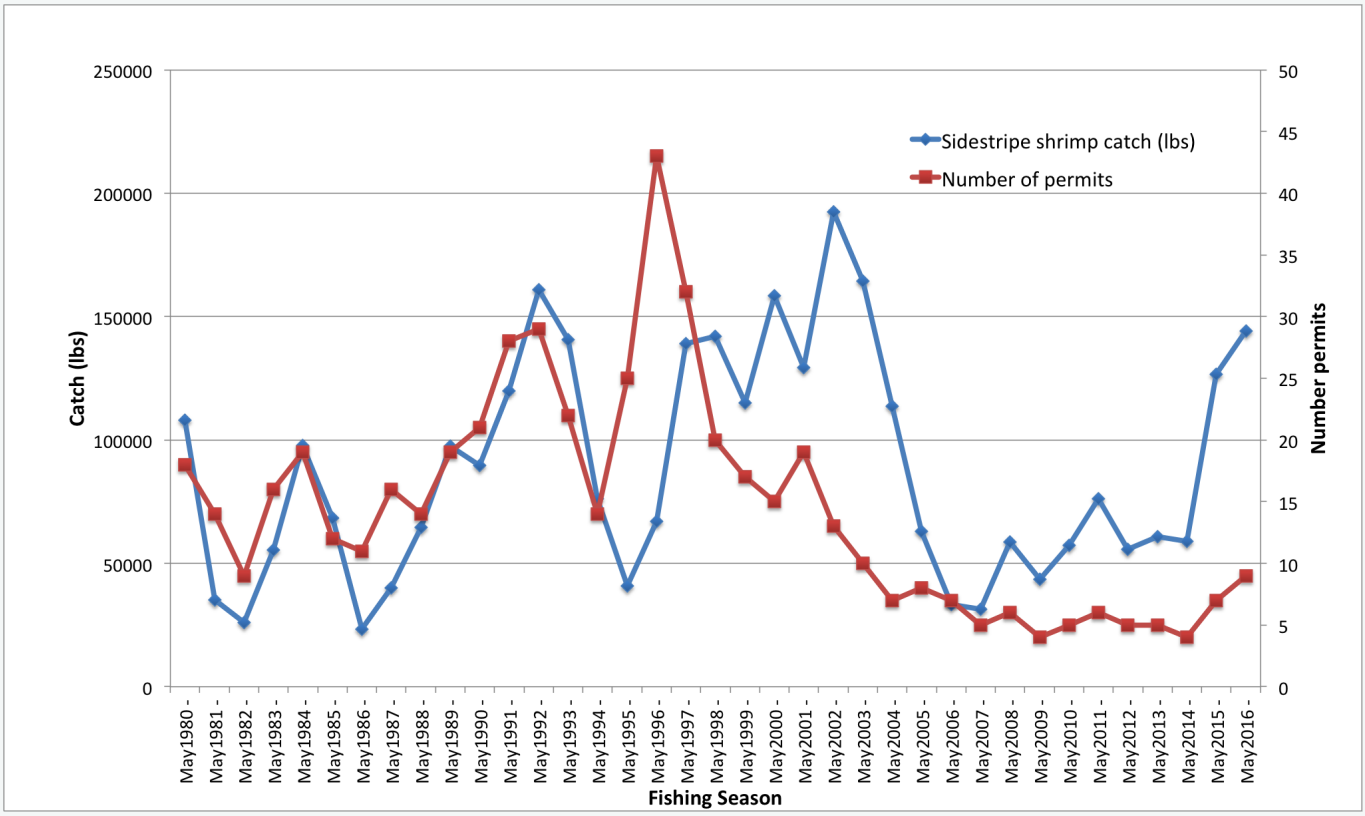

Figure 18: Southeast Alaska sidestripe shrimp catch (lbs; blue line) and number of permits fished (red line), 1980-2017

Spot shrimp

Factor 1.1 - Abundance

Northeast Pacific | Pots | United States | Alaska

Moderate Concern

There are two main spot prawn fisheries in Alaska: SEAK (Figure 21) and PWS (Figure 22). Data availability for spot shrimp stocks in SEAK is insufficient to estimate shrimp population size and appropriate harvest rates for sustainable yield to date. The PWS region utilizes a surplus production model informed by catches, CPUE, and survey data to estimate relative abundance of shrimp in PWS. Based on recent harvest and stock information, there is evidence that shrimp are moderately or steadily declining in most shrimp management areas in SEAK (Smith and Gray 2017)(Smith 2020). The spot prawn stock in Alaska receives a "moderate" concern for abundance because they are not highly vulnerable (based on the spot prawn PSA), and there is limited information on spot prawn stock size relative to reference points.

Justification:

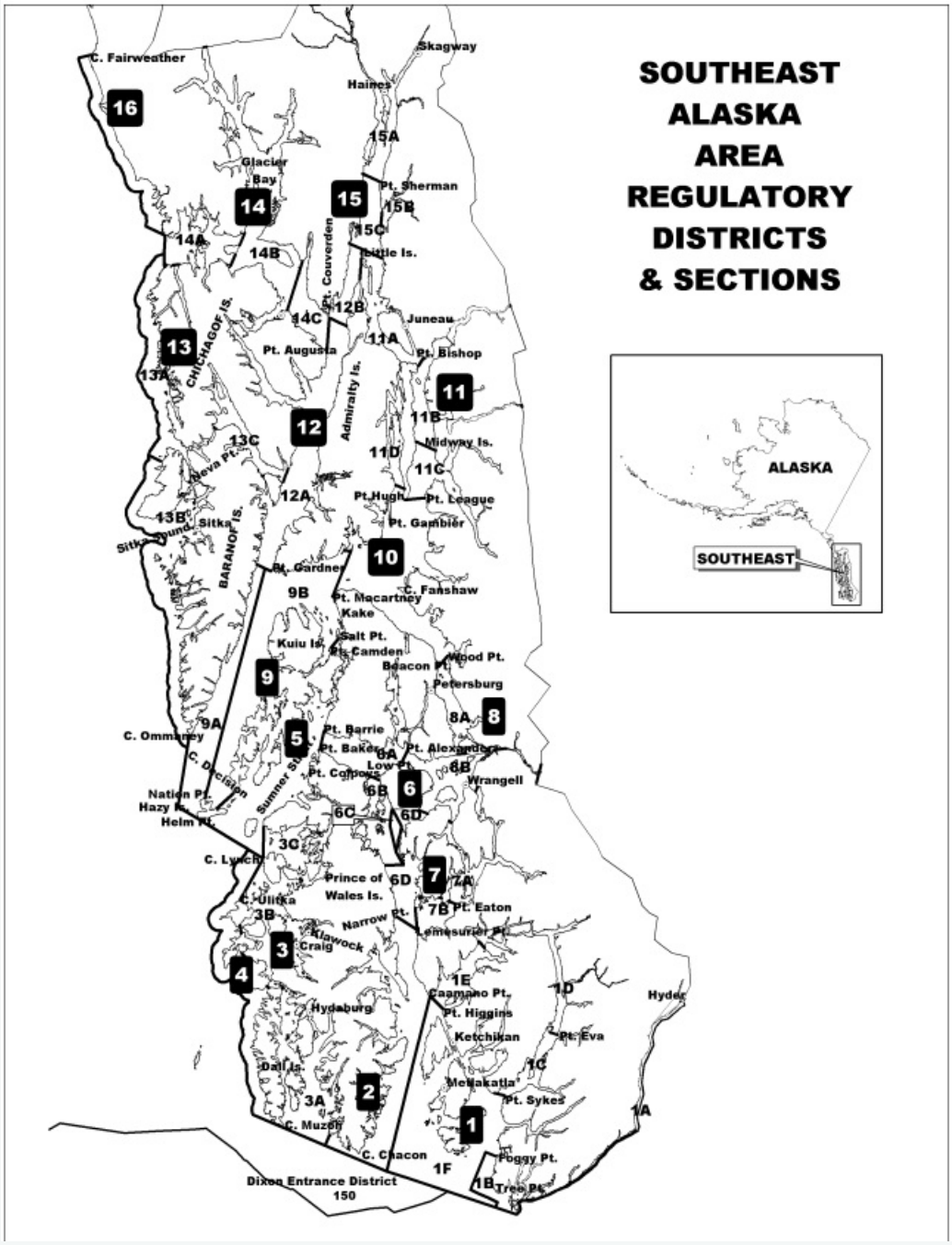

Figure 19: Spot prawn shrimp pot fishery management units in Registration Area A (Southeast Alaska) (Smith et al. 2014).

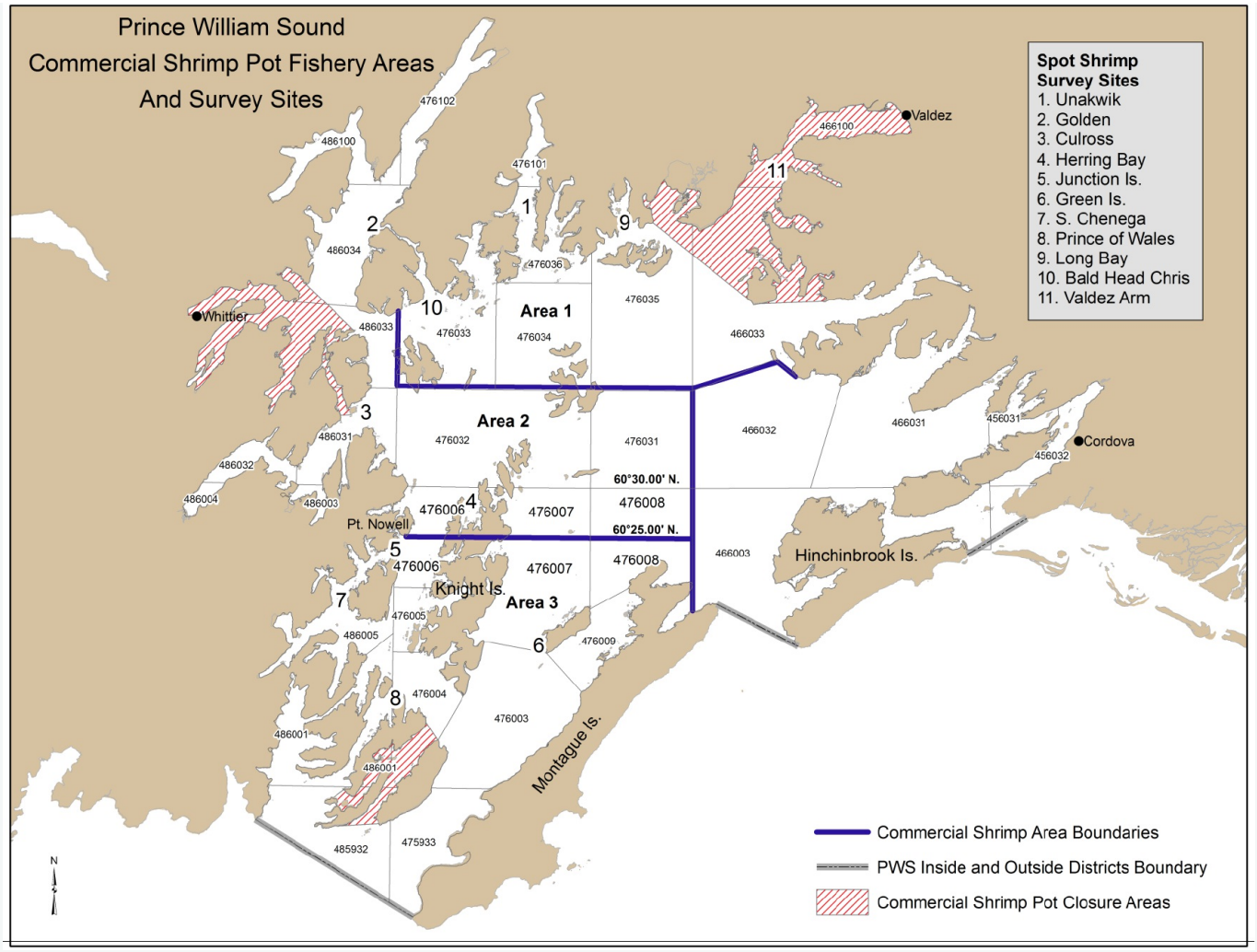

Figure 20: Prince William Sound management areas and index survey sites for spot shrimp.

A modified stock assessment is conducted annually in SEAK using fishery-dependent and fishery-independent data. 5 of 22 (23%) open districts in 2019/2020 in SEAK ranked "poor" or "below average" for spot prawn stock status, and there is evidence that a number of shrimp management areas have been moderately and steadily declining over the last few years (Smith 2020). 11 of 22 (50%) open districts were categorized as "moderate", 4 as "above average", and 1 in "good" for the 2019/20 season (ibid). The stock assessment covers 5 of the 22 management areas and accounts for 57% of the 10-year average total annual catch (ibid).

Conversely, in PWS stocks have been relatively stable based on results from the annual stock assessment and moderately increasing survey CPUE since 2011 (pers. comm., Rumble, ADFG 2017) (Wessel et al. 2015). CPUEs in the recreational PWS fishery also appear to be stable to increasing in most management areas (pers. comm., Baumer, ADFG 2017; Figure 23). Stock assessments for spot prawns are conducted annually in both management areas in Alaska, and although some subareas may be experiencing localized declines, GHLs are being adjusted accordingly to reduce harvests in these areas.

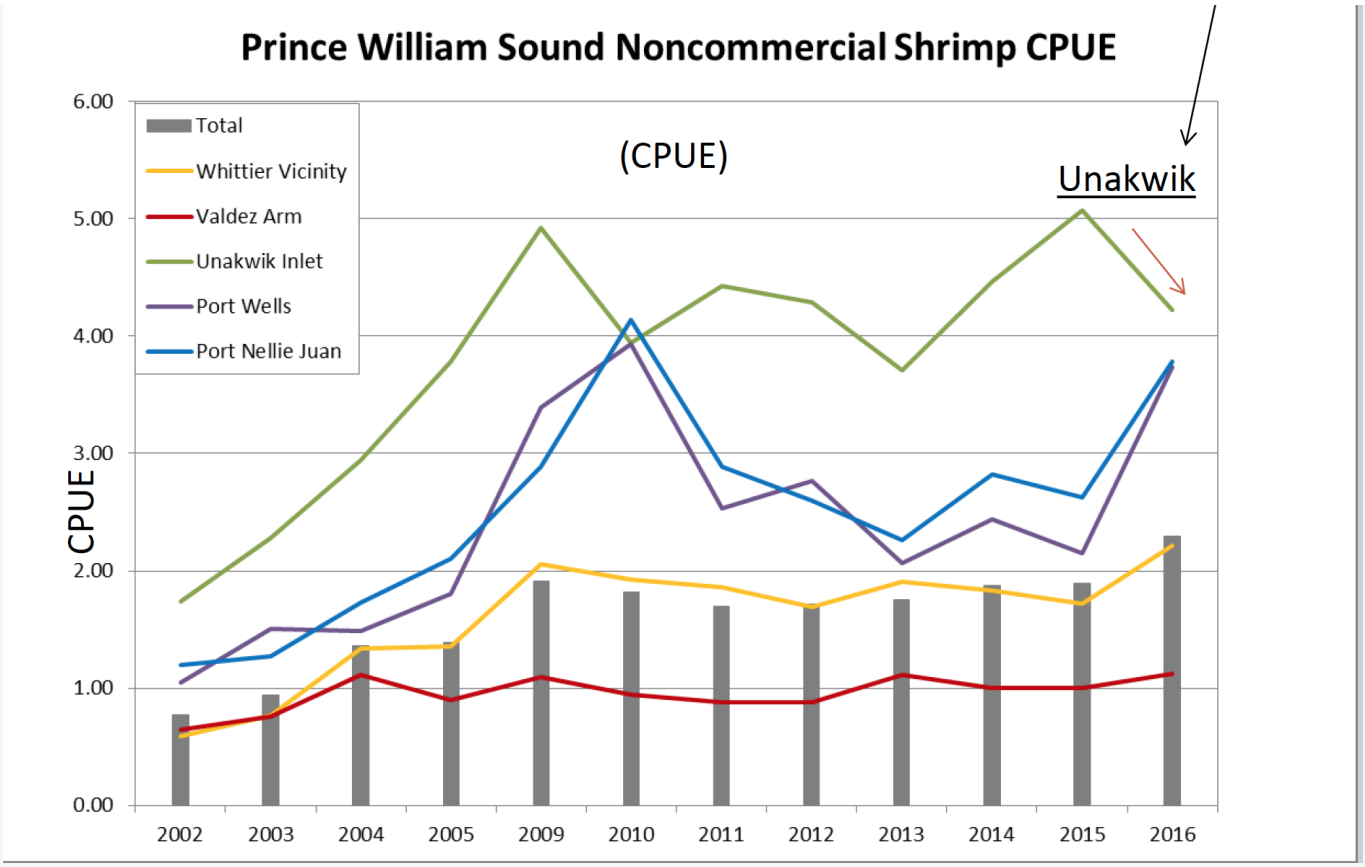

Figure 21: PWS spot prawn CPUE in the noncommercial (recreational) fishery by management area, 2002-2016.

Management Area	Score	Stock Status	2016/17 Std. Score	2017/18 Std. Score	2018/19 Std. Score	Confidence	Upper End GHR	2018/19 GHL	2018/19 Harvest	% GHL Taken
District 1	0.95	Moderate	0.21	-0.23	0.13	0.38	164,000	64,000	59,092	92%
District 2	-0.08	Moderate	0.12	0.57	-0.01	0.47	120,000	29,400	31,423	107%
Section 3A	0.63	Moderate	-0.10	-0.12	0.11	0.41	264,000	114,000	105,958	93%
Sections 3-B and C	-0.40	Moderate	0.00	-0.34	-0.18	0.24	70,000	30,000	21,733	72%
District 4	0.00	Moderate	-0.31	-0.16	0.00	0.20	28,000	20,000	14,313	72%
District 5	0.67	Above Average	0.00	0.23	0.31	0.16	20,000	12,000	1,713	14%
Northern Clarence	-1.47	Below Average	NA	0.91	-0.33	0.45	60,000	34,300	38,180	111%
District 7	2.16	Above Average	0.17	0.43	0.27	0.61	104,000	74,300	78,775	106%
Sumner Strait	1.80	Good	NA	0.34	0.83	0.19	25,000	15,000	17,017	113%
District 9	-0.87	Poor	-0.69	-0.60	-0.74	0.12	18,000	6,500	5,442	84%
Southern Frederick Sound	0.88	Above Average	NA	0.76	0.31	0.30	20,000	12,000	10,846	90%
Northern Frederick Sound	-1.88	Below Average	NA	-0.07	-0.43	0.42	50,000	35,000	39,984	114%
Seymour	0.33	Moderate	-0.44	0.38	0.11	0.33	30,000	12,000	11,456	95%
Remainder of District 11	0.67	Above Average	-1.00	0.46	0.31	0.07	15,000	4,000	*	*
Tenakee	-0.58	Moderate	0.61	0.02	-0.17	0.36	34,000	7,500	*	*
Remainder of District 12	0.00	CLOSED	NA	NA	NA	0.00	15,000	Closed	0	Closed
Sections 13-A/B	0.14	Moderate	-0.14	0.21	0.12	0.18	15,000	15,000	12,913	86%
Section 13-C	-0.13	Moderate	-0.68	-0.66	-0.04	0.33	50,000	16,000	14,316	89%
District 14	0.33	Moderate	NA	NA	0.33	0.09	20,000	7,500	5,039	67%
District 15 East	0.25	Moderate	-0.28	-0.27	0.12	0.16	20,000 (all 15)	3,500	3,882	111%
Remainder of District 15	-0.67	Below Average	0.00	NA	-0.40	0.18	20,000 (all 15)	7,500	*	*
District 16	-0.93	Poor	0.00	NA	-0.93	0.12	20,000	15,000	*	*
Mean	0.08	Moderate	-0.16	0.10	-0.01	0.26	1,162,000	534,500	487,510	91%

Note: * indicates confidential data with less than 3 permits participating.

Figure 22: Score, stock status, and confidence information summarized from Tables 4–47, and standardized (Std.) score. The standardized score is used to compare among districts and ranges from +1 to -1. The standardized score is calculated as the score divided by the total possible score for a given management area. A standardized score of ≥0.6 gives a stock status of Good, 0.2 to 0.59 is Above Average, -0.19 to 0.19 is Moderate, -0.2 to -0.59 is Below Average, and less than or equal to -0.6 is Poor (Smith 2020).

Productivity	Value	Score (1 = low risk, 2 = medium risk, 6 = high risk)	Reference	Susceptibility Attribute	Information	Score (1 = low risk, 2 = medium risk, 6 = high risk)	Reference
Average age at maturity (years)	3	1	Larson & Reilly 2006, Butler 1964	**Areal overlap**	Unknown	3	
Average maximum age (years)	3	1	Larson & Reilly 2006, Butler 1964	**Vertical overlap**	Target	3	
Fecundity (eggs/yr)	1,000	2	Larson & Reilly 2006	**Selectivity of fishery**	Unknown	2	
Reproductive strategy	Demersal egg layer or brooder	2	Cadrin et al. 2004	**Post-capture mortality**	Assumed they will not survive descent.	3	Wargo et al. 2013
Trophic level	2.6	1	seaaroundus.org	**Susceptibility Subscore**	**2.325**		
Density dependence (invertebrates only)	Compensatory	1	Larson & Reilly 2006, Butler 1964				
Quality of Habitat	Robust	1	Larson & Reilly 2006	**Productivity-Susceptibility Score**	**2.66**		
Productivity Subscore	**1.28571**			**Vulnerability Rating (high, medium, low**)	**MEDIUM**		

Northeast Pacific | Pots | United States | California

Moderate Concern

There is not enough quantitative data on recruitment and spot prawn stock status to support a stock assessment for spot prawn caught in the California pot fishery (pers. comm., Coates, CDFW 2017). The trawl fishery was closed in California in 2003, and since then (2004 to 2016) the landings, value of the fishery, and catch per trip have increased moderately while the number of active fishermen remained stable (Figure 25) (CDFW 2017). This suggests that the spot prawn stock is relatively robust at this stage; however, with no stock assessment in place the California spot prawn fishery receives a rating of "moderate" concern.

Justification:

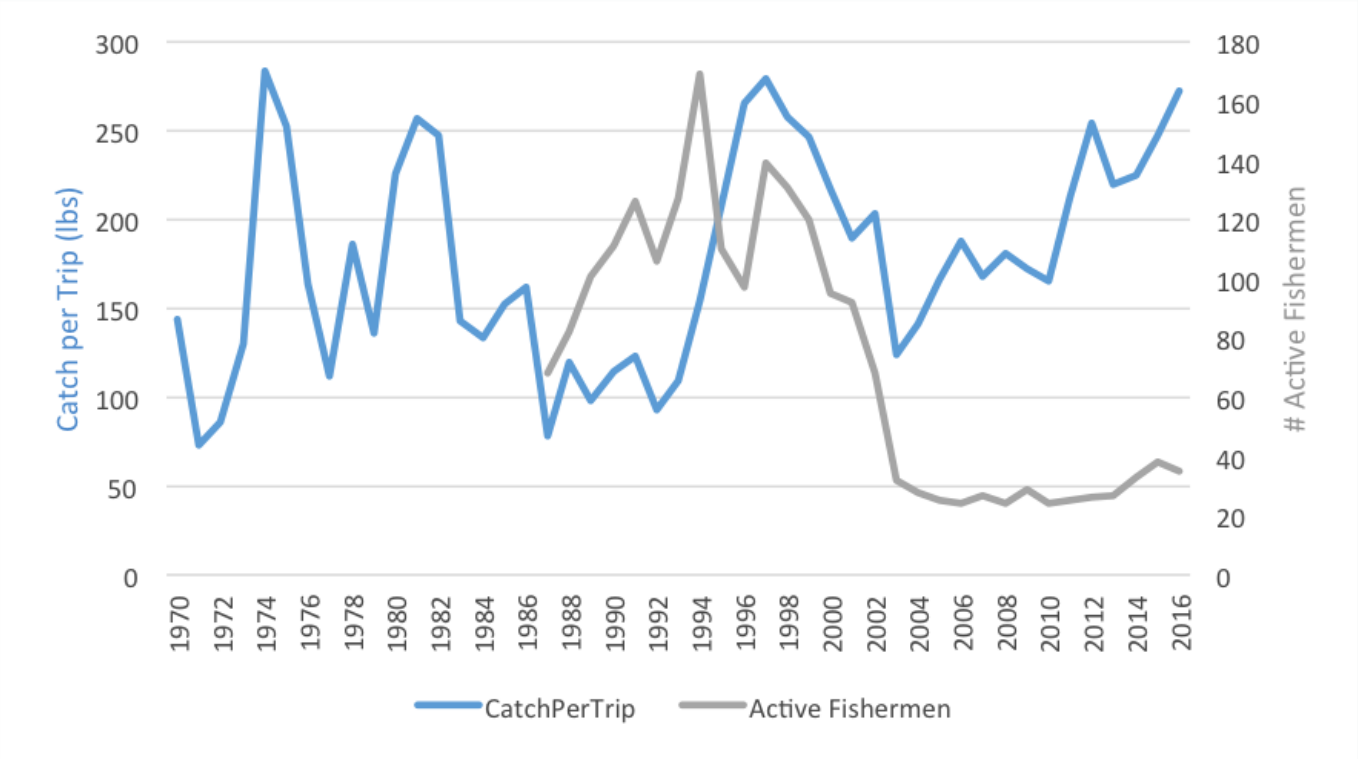

Figure 23: California spot prawn catch per trip (blue line) and number of active fishermen (grey line), 1970-2016 (CDFW 2017).

Northeast Pacific | Pots | United States | Washington

Moderate Concern

Spot prawns are primarily harvested in Puget Sound and along the coast in Washington. The regional fisheries are regulated separately. There is in-season monitoring of catches in Puget Sound, but no quantitative assessments have been conducted to determine prawn biomass or management reference points (Childers 2016). Coastal spot prawns in Washington are one of the few *pandalid* shrimps along the US west coast that are managed based on a modified stock assessment or surplus production model. Carapace length data suggest the coastal spot prawn shrimp stock in Washington is stable (Wargo et al. 2013). Spot prawn is not a highly vulnerable species (see spot prawn PSA above); landings and biological data suggest the Washington populations are relatively stable. However, current reference points are lacking for both regions. Therefore, the fishery receives a "moderate" concern for abundance.

Justification:

The coastal spot prawn population is assessed using a surplus production model that incorporates total catch and total fishing effort from 1997 to 2006 to estimate MSY (total of 200,000 lb), split evenly between the northern and southern regions of the Washington fishery. This stock assessment has not been updated since 2008. Based on dockside sampling, carapace length data suggest the spot prawn shrimp stock in Washington is stable (Wargo et al. 2013). Previous studies have found that the size at which shrimp transition from male to female decreases with low abundance, and carapace length data collected in Washington shows stable carapace lengths of transitioning shrimp in most coastal management areas from 2003 to 2009 (Figure 24) (Wargo et al. 2013).

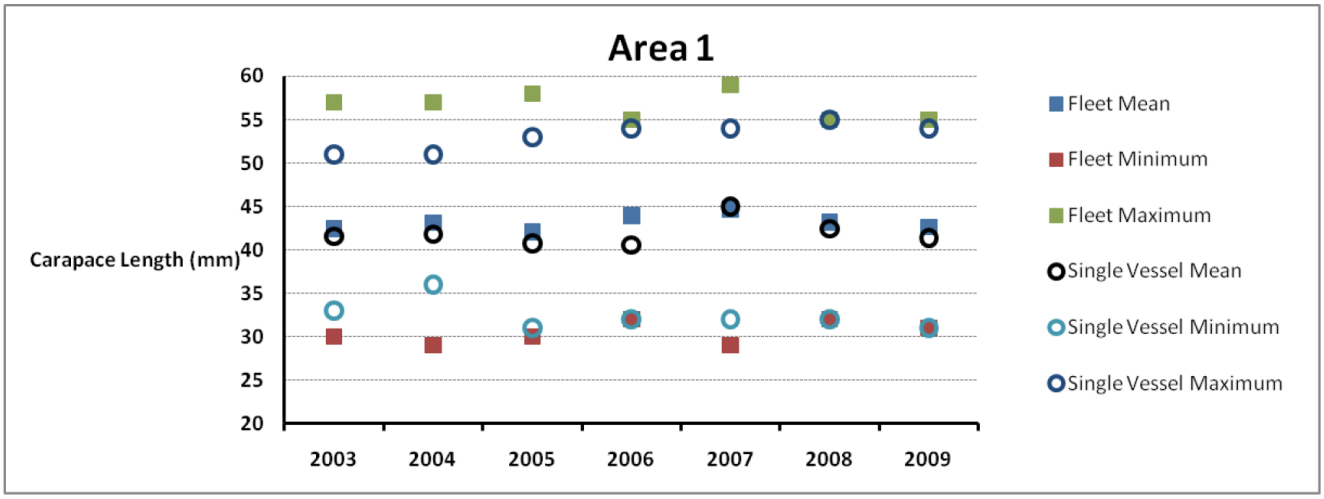

Figure 24: Washington Area 1 mean, minimum, and maximum carapace lengths (2003-2009) (Wargo et al. 2013).

Factor 1.2 - Fishing Mortality

Northeast Pacific | Pots | United States | Alaska

Moderate Concern

Fishing mortality in PWS and SEAK has been close to or exceeding GHLs regionally since 2009. GHLs are set based on stock status assessed from commercial fishery CPUE, dockside sampling, and fishery-independent surveys. Spot prawn stocks in SEAK appear to be declining (PWS stocks do not show a similar decline, but data for the PWS fishery is several years older than that from SEAK), and reductions in GHLs are in place to conservatively manage this stock. Based on

pandalid shrimp biology, it is likely that environmental factors are influencing declines in SEAK in addition to fishing pressure (Smith et al. 2014) {Anderson and Piatt 1999}. The fishery receives a "moderate" concern for fishing mortality because fishing mortality is unknown in relation to appropriate reference points in SEAK and has fluctuated above and below GHLs, depending on the location.

Justification:

There are reference points in the form of GHLs designed to manage shrimp catches while taking uncertainty into account in both PWS and SEAK. Spot prawn GHLs were established in 2009 in PWS; and from 2009 to 2012, total harvests (commercial and recreational) exceeded GHLs by a "substantial but unknown amount" (potentially up to 40%) (Wessel et al. 2015). The recreational PWS GHL was again exceeded in 2016 by over 30% (pers. comm., Baumer, ADFG 2017). Although the commercial spot prawn fishery (40% of overall GHL) is limited access, the recreational PWS spot prawn fishery (60% of overall GHL) is open access and generally accounts for the GHL overages (Figure 26). The total SEAK landings in 2016/17 and 2017/18 were 104% and 112% of the GHL (Smith and Gray 2017)(ADFG 2020). GHL levels change on a regular basis based on a conservative approach; a "Poor" designation is associated with a 40% reduction in GHL or district closure, "Above average" allows for a 0-20% increase, and "Healthy" results in a 0-40% increase (Smith and Gray 2017). The above designations and GHLs are determined from stock status, standardised stock health score, and confidence levels (ibid).

In light of evidence of stock declines in SEAK, area-specific closures have been implemented since 2005. GHLs and total landings were reduced from approximately 1 million lb in 2003/2004 to approximately 500,000 lb in 2010/2011. However, total annual GHLs in SEAKs were also exceeded by approximately 4% to 9% during the 2010 to 2014 seasons. It's important to note there is an open access spot prawn pot fishery in the Yakutat area, but harvests in this area are negligible (Smith et al. 2014). Across all districts in SEAK in the 2018/19 season, 91% of the GHL was taken, but the GHL was exceeded in 6 of the 21 management areas open to fishing (Smith 2020).

		GHL (lb)		Shrimp Harvest (lb)			% of
Year	TAH (lb)	Noncommercial	Commercial	Noncommercial	Commercial	Total	TAH
2010	137,500	82,500	55,000	142,146	45,349	187,495	139
2011	131,900	79,140	52,760	95,924	52,694	148,618	113
2012	128,100	76,860	51,240	90,385	21,561	111,946	87
2013	165,750	99,450	66,300	85,988	61,644	147,631	89
2014	166,500	99,900	66,600	89,155	68,464	157,619	95

Figure 25: Prince William Sound total allowable harvests (TAH), guideline harvest levels (GHL), and harvests in commercial and noncommercial shrimp pot fisheries, 2010–2014 (Wessel et al. 2015).

Management Area	Score	Stock Status	2016/17 Std. Score	2017/18 Std. Score	2018/19 Std. Score	Confidence	Upper End GHR	2018/19 GHL	2018/19 Harvest	% GHL Taken
District 1	0.95	Moderate	0.21	-0.23	0.13	0.38	164,000	64,000	59,092	92%
District 2	-0.08	Moderate	0.12	0.57	-0.01	0.47	120,000	29,400	31,423	107%
Section 3A	0.63	Moderate	-0.10	-0.12	0.11	0.41	264,000	114,000	105,958	93%
Sections 3-B and C	-0.40	Moderate	0.00	-0.34	-0.18	0.24	70,000	30,000	21,733	72%
District 4	0.00	Moderate	-0.31	-0.16	0.00	0.20	28,000	20,000	14,313	72%
District 5	0.67	Above Average	0.00	0.23	0.31	0.16	20,000	12,000	1,713	14%
Northern Clarence	-1.47	Below Average	NA	0.91	-0.33	0.45	60,000	34,300	38,180	111%
District 7	2.16	Above Average	0.17	0.43	0.27	0.61	104,000	74,300	78,775	106%
Sumner Strait	1.80	Good	NA	0.34	0.83	0.19	25,000	15,000	17,017	113%
District 9	-0.87	Poor	-0.69	-0.60	-0.74	0.12	18,000	6,500	5,442	84%
Southern Frederick Sound	0.88	Above Average	NA	0.76	0.31	0.30	20,000	12,000	10,846	90%
Northern Frederick Sound	-1.88	Below Average	NA	-0.07	-0.43	0.42	50,000	35,000	39,984	114%
Seymour	0.33	Moderate	-0.44	0.38	0.11	0.33	30,000	12,000	11,456	95%
Remainder of District 11	0.67	Above Average	-1.00	0.46	0.31	0.07	15,000	4,000	*	*
Tenakee	-0.58	Moderate	0.61	0.02	-0.17	0.36	34,000	7,500	*	*
Remainder of District 12	0.00	CLOSED	NA	NA	NA	0.00	15,000	Closed	0	Closed
Sections 13-A/B	0.14	Moderate	-0.14	0.21	0.12	0.18	15,000	15,000	12,913	86%
Section 13-C	-0.13	Moderate	-0.68	-0.66	-0.04	0.33	50,000	16,000	14,316	89%
District 14	0.33	Moderate	NA	NA	0.33	0.09	20,000	7,500	5,039	67%
District 15 East	0.25	Moderate	-0.28	-0.27	0.12	0.16	20,000 (all 15)	3,500	3,882	111%
Remainder of District 15	-0.67	Below Average	0.00	NA	-0.40	0.18	20,000 (all 15)	7,500	*	*
District 16	-0.93	Poor	0.00	NA	-0.93	0.12	20,000	15,000	*	*
Mean	0.08	Moderate	-0.16	0.10	-0.01	0.26	1,162,000	534,500	487,510	91%

Note: * indicates confidential data with less than 3 permits participating.

Figure 26: Score, stock status, and confidence information summarized from Tables 4–47, and standardized (Std.) score. The standardized score is used to compare among districts and ranges from +1 to -1. The standardized score is calculated as the score divided by the total possible score for a given management area. A standardized score of ≥0.6 gives a stock status of Good, 0.2 to 0.59 is Above Average, -0.19 to 0.19 is Moderate, -0.2 to -0.59 is Below Average, and less than or equal to -0.6 is Poor (Smith 2020).

Northeast Pacific | Pots | United States | California

Moderate Concern

As noted above, there are no stock assessments or reference points specific to the California spot prawn pot fishery (pers. comm., Coates, CDFW 2017). However, the fishery is limited entry and utilizes pot limits and minimum mesh size requirements. Landings and CPUE are tracked based on data collected from voluntary logbooks. Overall, the effects of fishing mortality on the spot prawn population is currently unknown; therefore, the fishery is rated "moderate" concern.

Northeast Pacific | Pots | United States | Washington

Moderate Concern

Landings from the Puget Sound and coastal fisheries are under the regional quotas or Total Allowable Catches (TACs). However, biological reference points are unavailable for the Puget Sound fishery and outdated for the coastal fishery. Therefore, the fishery receives a "moderate" concern for fishing mortality.

Justification:

Based on a 2006 stock assessment incorporating coastal spot prawn landings and fishing effort data, Maximum Sustainable Yield (MSY) was estimated to be 100,000 lb in the northern and southern regions. Spot prawn MSY is derived form the surplus production model curve (Wargo et al. 2013). TAC for each region was set at MSY in 2008. Although this estimate has not been updated to reflect more recent years, total landings of spot prawns have been well below TACs since 2003, with landings averaging 41,000 lb from 2011 to 2016 (Figure 27). Similar to other pandalids with relatively short life spans, spot prawn recruitment is heavily influenced by environmental parameters as opposed to

fishing effort (Wargo et al. 2013) (Hannah 2011) (Frimodig et al. 2009).

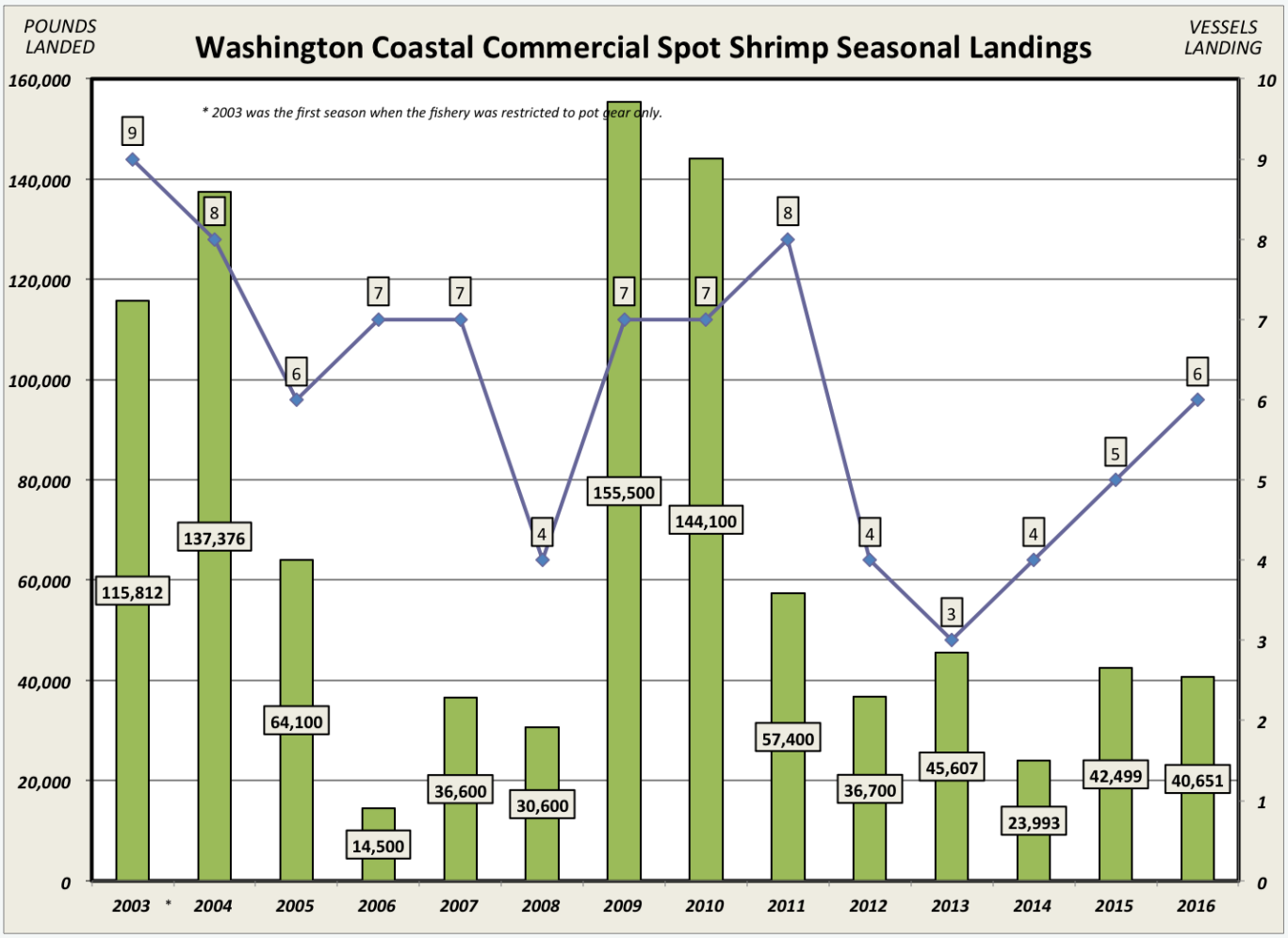

Figure 27: Washington spot prawn landings (green bars), $ value, and number of vessels, 2003-2016 (WDFW 2016).

In the Puget Sound fishery, the spot prawn fishery is carried out through a state-tribal management plan process. The original quotas were set based on historic landings from the late-1980s to the early-1990s. Managers currently meet annually to make catch limit/allocation adjustments by management area (Figure 28) according to recent logbook data and test fishery information (Childers 2012). Landings of spot prawns have increased moderately since 2003 in Puget Sound but are still below annual quotas (Figure 29).

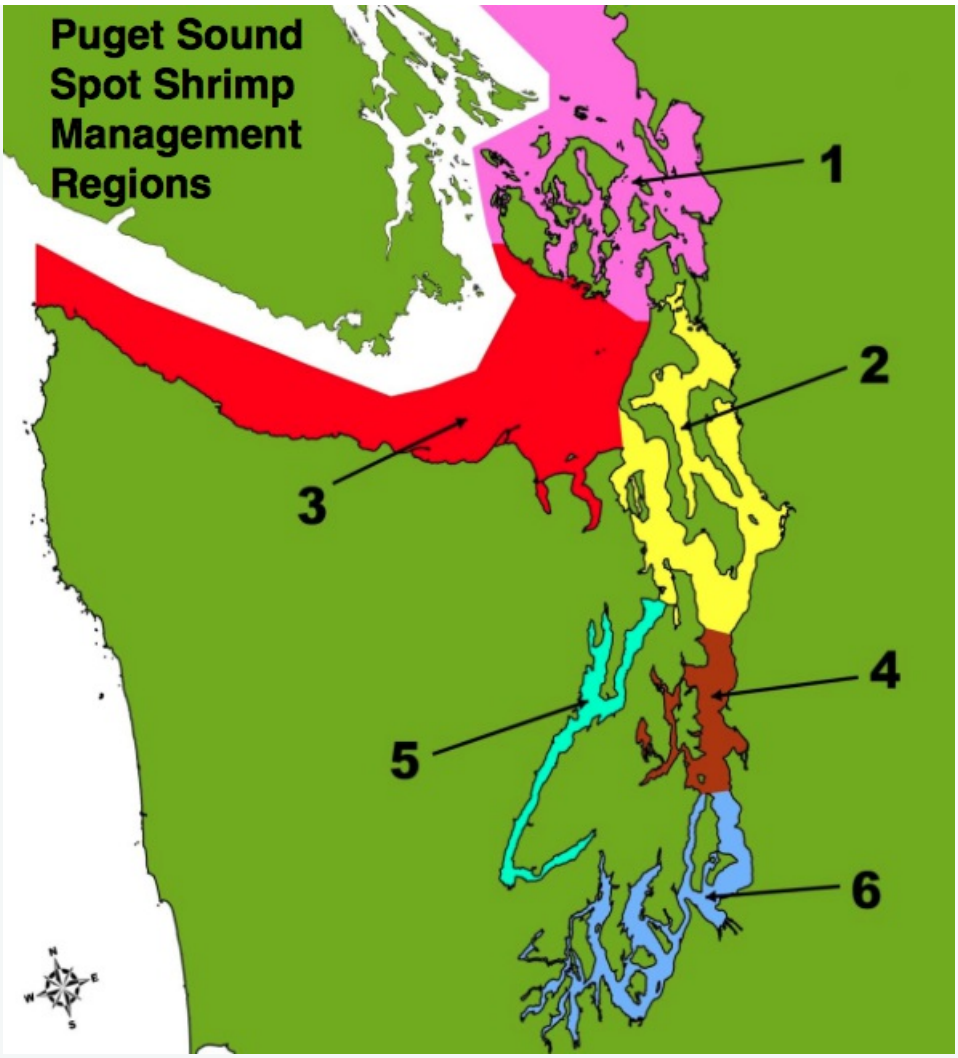

Figure 28: Puget Sound spot prawn management regions.

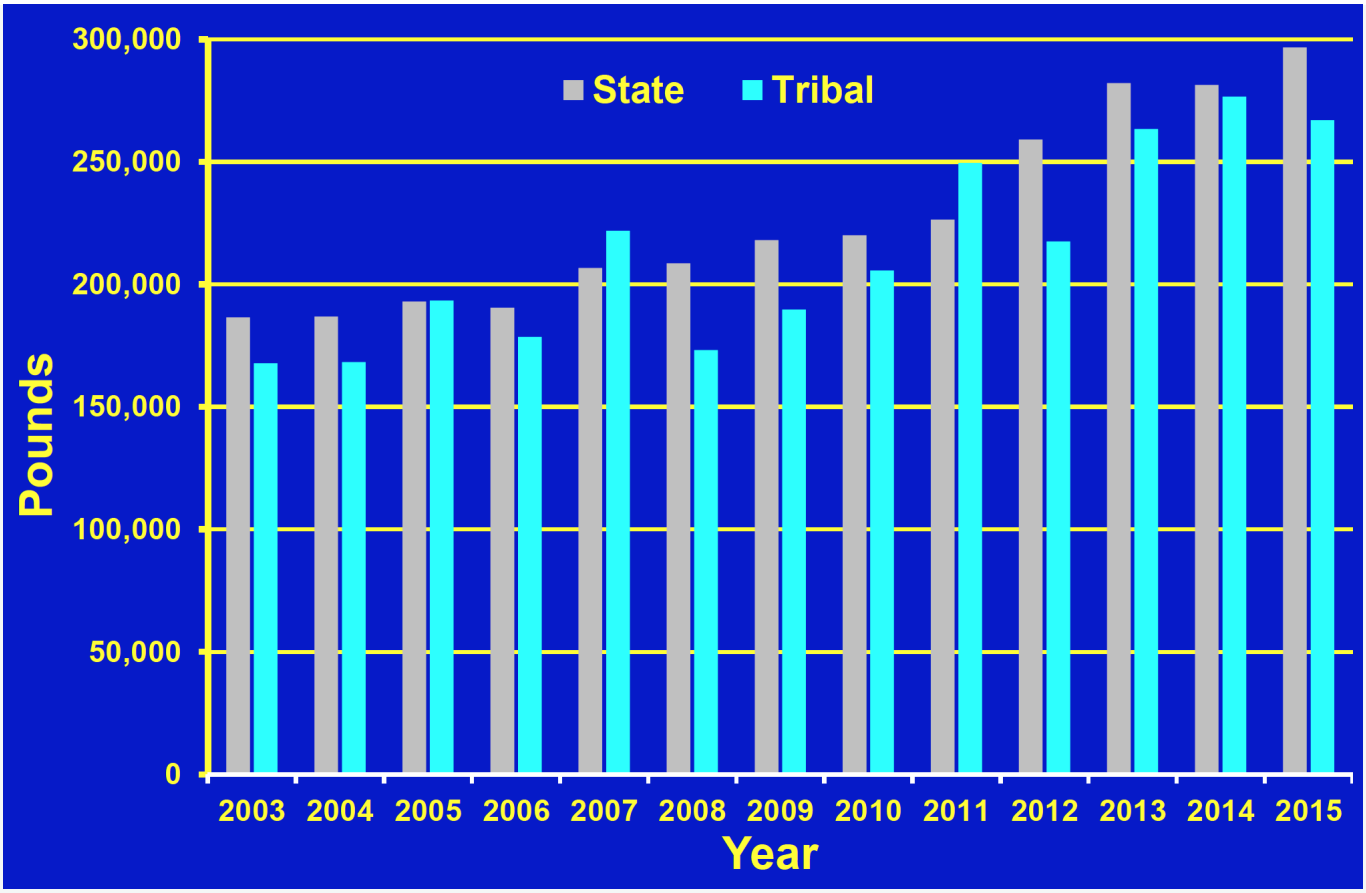

Figure 29: Washington State and Tribal spot shrimp harvest, 2003-2015.

Criterion 2: Impacts on Other Species

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

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

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

Guiding principles

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

Criterion 2 Summary

Criterion 2 score(s) overview

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

COONSTRIPED SHRIMP			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Northeast Pacific | Pots | United States | California	1.732	1.000: < 100%	Red (1.732)
Northeast Pacific | Pots | United States | Alaska	1.000	1.000: < 100%	Red (1.000)

NORTHERN SHRIMP			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Northeast Pacific | Beam trawls | United States | Alaska	1.000	1.000: < 100%	Red (1.000)

OCEAN SHRIMP			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Northeast Pacific | Bottom trawls | United States | California | Pink Shrimp Fishery	1.000	1.000: < 100%	Red (1.000)

PACIFIC ROCK SHRIMP			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Eastern Central Pacific | Bottom trawls | United States | California | Ridgeback Shrimp Fishery	1.526	1.000: < 100%	Red (1.526)

SIDESTRIPED SHRIMP			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Northeast Pacific | Beam trawls | United States | Alaska	1.000	1.000: < 100%	Red (1.000)

SPOT SHRIMP			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Northeast Pacific | Pots | United States | Washington	2.644	1.000: < 100%	Yellow (2.644)
Northeast Pacific | Pots | United States | California	1.732	1.000: < 100%	Red (1.732)
Northeast Pacific | Pots | United States | Alaska	1.000	1.000: < 100%	Red (1.000)

Criterion 2 main assessed species/stocks table(s)

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

EASTERN CENTRAL PACIFIC | BOTTOM TRAWLS | UNITED STATES | CALIFORNIA | RIDGEBACK SHRIMP FISHERY			
SUB SCORE: 1.526	DISCARD RATE: 1.000		**SCORE: 1.526**
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Benthic inverts	2.330: Moderate Concern	1.000: High Concern	Red (1.526)
Corals and other biogenic habitats	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Brandt's cormorant	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Finfish	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Pacific rock shrimp	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Pacific whiting	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)

NORTHEAST PACIFIC | BEAM TRAWLS | UNITED STATES | ALASKA			
SUB SCORE: 1.000	DISCARD RATE: 1.000		**SCORE: 1.000**
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Corals and other biogenic habitats	1.000: High Concern	1.000: High Concern	Red (1.000)
Benthic inverts	2.330: Moderate Concern	1.000: High Concern	Red (1.526)
Finfish	2.330: Moderate Concern	1.000: High Concern	Red (1.526)
Forage fish	2.330: Moderate Concern	1.000: High Concern	Red (1.526)
Seabirds	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Northern shrimp	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Sidestriped shrimp	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

NORTHEAST PACIFIC | BOTTOM TRAWLS | UNITED STATES | CALIFORNIA | PINK SHRIMP FISHERY			
SUB SCORE: 1.000	DISCARD RATE: 1.000		**SCORE: 1.000**
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Eulachon	1.000: High Concern	1.000: High Concern	Red (1.000)
Ocean shrimp	3.670: Low Concern	3.000: Moderate Concern	Green (3.318)

NORTHEAST PACIFIC | POTS | UNITED STATES | ALASKA			
SUB SCORE: 1.000	DISCARD RATE: 1.000	**SCORE: 1.000**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Mammals	1.000: High Concern	1.000: High Concern	Red (1.000)
Coonstriped shrimp	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Spot shrimp	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Benthic inverts	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)

NORTHEAST PACIFIC | POTS | UNITED STATES | CALIFORNIA			
SUB SCORE: 1.732	DISCARD RATE: 1.000	**SCORE: 1.732**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Humpback whale	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Coonstriped shrimp	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Spot shrimp	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Benthic inverts	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)
Lingcod	3.670: Low Concern	5.000: Low Concern	Green (4.284)

NORTHEAST PACIFIC | POTS | UNITED STATES | WASHINGTON			
SUB SCORE: 2.644	DISCARD RATE: 1.000	**SCORE: 2.644**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Spot shrimp	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Starfish	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Urchins (unspecified)	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Benthic inverts	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)
Hagfish	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)

Main species added to the US coldwater shrimp assessment were determined based on the 2017 Seafood Watch standard; 1) species that constitute over 5% of the catch, or 2) are categorized as overfished, undergoing overfishing, endangered, threatened, or otherwise a species of concern caught regularly in the target fishery.

Bycatch data were not available for the following fisheries: Alaska northern shrimp and sidestripe shrimp trawl and spot prawn and coonstripe shrimp pot, California coonstripe shrimp pot, California ridgeback shrimp (some limited data available). Therefore, the unknown bycatch matrix for the northeast Pacific region was used to identify and evaluate bycatch

species for those fisheries. For the unobserved pot fisheries, marine mammals typically limited the Criterion 2 scores due to their high vulnerability and potential to interact with the gear. For the unobserved trawl fisheries, corals and other biogenic habitats limited the Criterion 2 scores due to their vulnerability, potential to interact with the gear, and/or unknown stock status.

Pink shrimp trawl fisheries along the US west coast (including California) have been partially observed as part of the West Coast Groundfish Observer Program (WCGOP) since 2004 (Somers et al. 2016). WCGOP data were used to determine main species to include for the California pink shrimp trawl fishery. Overall bycatch rates are negligible (<5%) in the pink shrimp trawl fishery in California (Somers et al. 2016) due to a number of gear requirements to minimize bycatch. However, eulachon are regularly caught in the fishery and currently listed as a threatened species under the ESA (Wargo et al. 2016); it was included as a main species for the California pink shrimp trawl fishery. Eulachon limited the Criterion 2 score for the California pink shrimp fishery due to their threatened status.

Data on bycatch in the California spot prawn pot and ridgeback shrimp trawl fishery are limited. However, 4 trawl tows in 1999 and 262 pot string pulls in 2000 and 2001 were monitored to assess bycatch in these fisheries {Reilly & Geibel 2002}; these data were used to determine main species as part of this assessment. Observer data for the ridgeback shrimp fishery in 2017 and 2018 were used for the interim update of this report. Also, based on marine mammal stranding/injury data from NOAA fisheries, the California spot prawn fishery is known to have entangled one humpback whale in 2006, and average annual serious injury/mortality in this fishery between 2010 and 2014 was calculated as 0.75. In addition, US west coast pot fisheries in general (sablefish, Dungeness crab, and spot prawn only) are known to have entangled other humpback whales, though which specific fishery is not always known (NMFS 2017). Therefore, humpback whales were included as a main species for the California spot prawn fishery since some portions of the humpback whale population in the northeast Pacific are listed as threatened or endangered under the Endangered Species Act (ESA). Humpback whales limited the Criterion 2 score for the California spot prawn pot fishery due to their high vulnerability and potential to interact with the gear. Benthic invertebrates and corals and other biogenic habitats limit the score of the ridgeback shrimp trawl fishery.

A more recent observer-based study was conducted in the Washington spot prawn fishery, where a total of 3,059 pot-lifts over six fishing trips from 2003 to 2007 were observed (Wargo et al. 2013). The Washington data-informed main species determinations for the Washington spot prawn fishery as a number of species groupings constituted over 5% of the catch. Urchins and starfish limited the Criterion 2 score for the Washington spot prawn fishery due to their moderate vulnerability and unknown stock status.

Bycatch data in the California ridgeback shrimp fishery from 2017 and 2018 are now available (NWFSC 2020). For the purposes of the interim update, we analyzed observer data to determine what would be considered a main species based on the Seafood Watch criteria. While several species meet that criteria, none were recorded that would change the overall score for C2. Therefore, those species were not individually added to this report. However, for reference they include: English sole, Pacific sanddab, Pacific angel shark, white croaker, halfbanded rockfish, longspine combfish, Pacific electric ray, plainfin midshipman, hornyhead turbot, longfin sanddab, bigmouth sole, shortspine combfish, and specklefin midshipman (NWFSC 2020). Likewise, there is more data on bycatch of benthic invertebrates in the rideback shrimp fishery, but many organisms are not recorded to the species level; therefore the UBM is still used to score these taxa. Invertebrates that meet the main species criteria include: sea star (unidentified), urchin (unidentified), nudibranch (unidentified), brown box crab, California sea cucumber, squat lobster (unidentified), sheep crab, sea snail (unidentified), California king crab, bivalve (unidentified), and armed box crab (NWFSC 2020). Because benthic invertebrates are not identified to the species level, fishing mortality is still scored using the UBM.

Criterion 2 Assessment

SCORING GUIDELINES

Factor 2.1 - Abundance
(same as Factor 1.1 above)

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

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

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

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

Benthic inverts

Factor 2.1 - Abundance

Northeast Pacific | Beam trawls | United States | Alaska
Eastern Central Pacific | Bottom trawls | United States | California | Ridgeback Shrimp Fishery
Northeast Pacific | Pots | United States | Alaska
Northeast Pacific | Pots | United States | Washington
Northeast Pacific | Pots | United States | California

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

Factor 2.2 - Fishing Mortality

Eastern Central Pacific | Bottom trawls | United States | California | Ridgeback Shrimp Fishery

High Concern
Removals of benthic invertebrates in the ridgeback shrimp trawl fishery are unknown due to limited observer coverage and landing data. Benthic invertebrate abundance in the region is also unknown. More data may become available following the implementation of partial observer coverage in this fishery for the 2017 fishing season (pers. comm., Coates, CDFW 2017). Per Seafood Watch 2017 Criteria and research from Chuenpagdee et al. (2003) and Fuller et al. (2008), benthic invertebrates receive a "high" concern rating for fishing mortality in the California ridgeback shrimp trawl fishery.

Northeast Pacific | Beam trawls | United States | Alaska

High Concern
Removals of benthic invertebrates in the Alaska shrimp trawl fishery are unknown due to limited observer coverage and landing data. Benthic invertebrate abundance in the region is also unknown. The majority of benthic invertebrate bycatch in this fishery is discarded at sea, but the mortality rate of releases is unknown (pers. comm., Smith, ADFG 2017). Based on Seafood Watch 2017 Criteria and research from Chuenpagdee et al. (2003) and Fuller et al. (2008), benthic invertebrates receive a "high" concern for fishing mortality in the Alaska shrimp trawl fisheries.

Northeast Pacific | Pots | United States | Alaska
Northeast Pacific | Pots | United States | Washington
Northeast Pacific | Pots | United States | California

Low Concern
Benthic invertebrates are regularly caught in shrimp pot fisheries in the northeast Pacific. The ratio of benthic invertebrate to target shrimp catch ratios varies widely by region and fishery, but can approach 0.5/1 based on a study from the Washington spot prawn fishery (Wargo et al. 2013). Nonetheless, most benthic invertebrates are returned to the water, and survival is presumed to be high {Reilly and Geibel 2002}. Shrimp pot fisheries are not observed along the US west coast, so overall removals of benthic invertebrates in the pot fisheries are unknown. In summary, the effect of fishing mortality on benthic invertebrates is unknown; however, research suggests this taxon is not highly susceptible to pot fishing, and benthic invertebrates receive a "low" concern rating for fishing mortality {Chuenpagdee et al. 2003} (Fuller et al. 2008){Seafood Watch Criteria 2017}.

Brandt's cormorant

Factor 2.1 - Abundance

Eastern Central Pacific | Bottom trawls | United States | California | Ridgeback Shrimp Fishery

Moderate Concern

Brandt's cormorant (*Urile penicillatus,* Brandt 1837) is assessed by the IUCN as a species of Least Concern (BirdLife International 2018). The species inhabits the Pacific coast of North America and has an estimated population of 230,000 individuals (ibid). Climate change is considered a threat to the species, while human disturbances from recreational activities also have a negative impact (ibid). In addition to climate, prey availability has as strong influence on recruitment: Brandt's cormorants are a "boom-or-bust" species and have responded positively to conservative management of forage fish stocks and reduced disturbance at breeding sites (Ainley et al. 2018). We score abundance as "moderate" concern based on the 2018 IUCN assessment.

Factor 2.2 - Fishing Mortality

Eastern Central Pacific | Bottom trawls | United States | California | Ridgeback Shrimp Fishery

Moderate Concern

The California ridgeback prawn fishery was first observed in 2017 and is recorded to have high bycatch of Brandt's cormorant, relative to other fisheries (Jannot et al. 2021). Prior to observer data from the ridgeback prawn fishery, an estimated 13 to 18 birds were caught per year from 2012 to 2016; mortality estimates increased increased to 53 birds in 2017 and 91 in 2018 (ibid). Because of the low observer coverage in this fishery and a lack of historical observations, mortality estimates from the rideback prawn fishery--and variance around those estimates--are high: 35 in 2017 (LCI = 12, UCI = 70) and 61 in 2018 (LCI = 23, UCI = 125) (ibid). Sustainable levels of fishing mortality are not available for this species, F is considered unknown, and a "moderate" concern score is given.

Corals and other biogenic habitats

Factor 2.1 - Abundance

Northeast Pacific | Beam trawls | United States | Alaska
Eastern Central Pacific | Bottom trawls | United States | California | Ridgeback Shrimp Fishery

High Concern
Stock status and abundance of corals and other biogenic habitats is unknown in the northeast Pacific. Due to basic life history characteristics and based on the Seafood Watch Unknown Byatch Matrix, corals and other biogenic habitats receive a "high" concern rating for abundance.

Factor 2.2 - Fishing Mortality

Eastern Central Pacific | Bottom trawls | United States | California | Ridgeback Shrimp Fishery

Moderate Concern
The ridgeback prawn trawl fishery was observed for the first time in 2017 as part of the West Coast Groundfish Observer Program (WCGOP); coral and sponge bycatch data is available for 2017-2019 (Somers et al. 2020). Across all three seasons, 35.4 kg of unidentified sponges were caught as bycatch, while 5.7 kg of black coral were reported for 2017 only (NWFSC 2020). Although sustainable levels of fishing mortality for corals and sponges in California cannot be determined, there is other available information to override the unknown bycatch matrix used in other parts of this report. Because sponge and coral mortality is unknown and the fishery is managed in a way that reduces impact, a score of "moderate" concern is awarded.

Justification:
The ridgeback prawn fishery occurs exclusively within California and mainly occurs at depths of 15 to 200 m in the Santa Barbara Channel (CDFW 2020), which is within the Southern Bioregion off the U.S. West Coast (Shester et al. 2021). Under Amendment 28 to the Pacific Coast Groundfish Management Plan, large areas of essential fish habitat (EFH) were closed to bottom trawling for prawn, California halibut, sea cucumbers, and groundfish (NOAA 2019).

Amendment 28 resulted in a net increase of 44,498 km^2 of EFH conservation areas at fishable depths (<1,280 m); approximately 73% of known coral and sponge locations at shelf depths (0 - 200 m) in the Southern Bioregion are now closed to bottom trawling and 96% of coral and sponge occurrences in the upper slope (200 - 1,280 m) are closed to bottom trawling (Shester et al. 2021). While some corals and sponges have been reported in recent WCGOP data, the area closures under Amendment 28 reduces the susceptibility of these vulnerable species. Since there are measures in place to reduce the impact of the fishery, the UBM is overridden and the fishery score "moderate" rather than "high" concern.

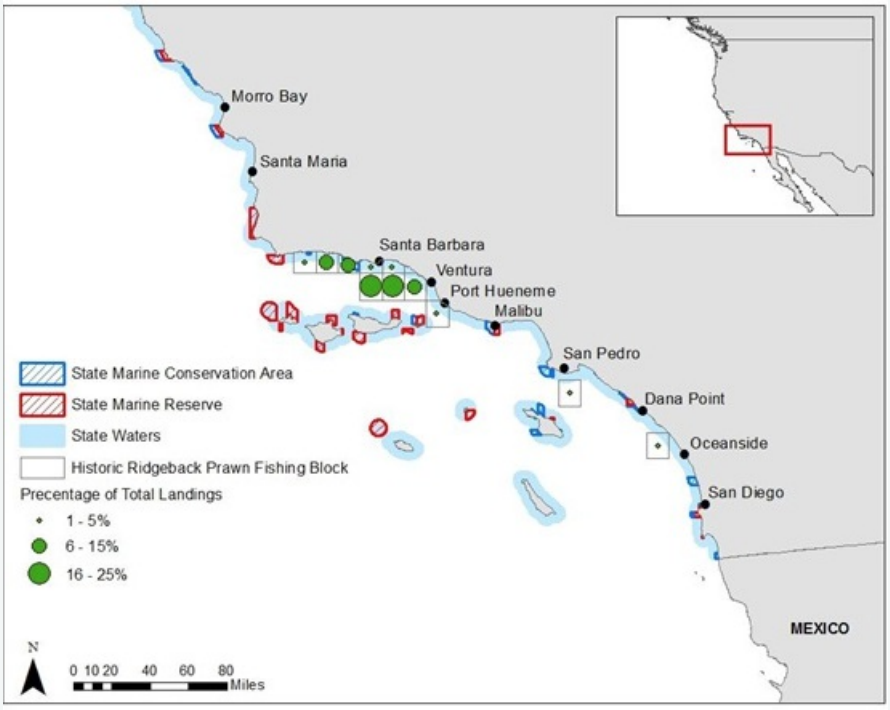

Figure 30: Ridgeback prawn trawl locations by CDFW fishing blocks and the percentage of total landing by fishing block from 1974 to 2019. Each fishing block is 10 by 10 nautical miles (CDFW 2020).

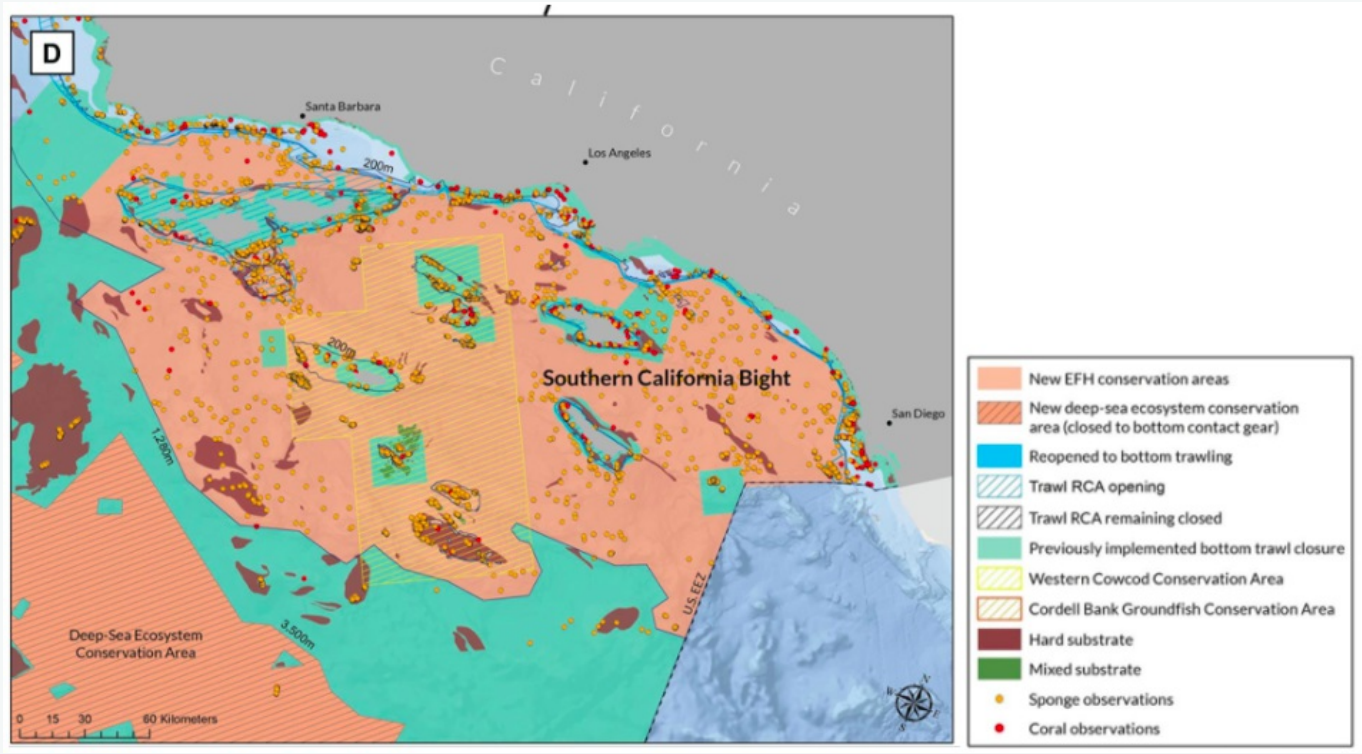

Figure 31: Map of a portion of the West Coast EEZ showing changes to bottom contact fishing regulations resulting from Amendment 28 final action for Southern California Bite. Adopted from Shester et al. (2021).

Northeast Pacific | Beam trawls | United States | Alaska

High Concern

Removals of corals and other biogenic habitats due to shrimp trawling in unobserved fisheries is unknown. Due to the high susceptibility of corals and other biogenic habitats to gears that touch the bottom, and the likely high mortality of corals damaged in trawl gear (Seafood Watch 2017 Criteria), the taxon is rated "high" concern for fishing mortality according to the Seafood Watch Unknown Bycatch Matrix.

Eulachon

Factor 2.1 - Abundance

Northeast Pacific | Bottom trawls | United States | California | Pink Shrimp Fishery

High Concern

Eulachon are listed as threatened under the ESA in the range of the California shrimp trawl fishery and receive a "high" concern score for abundance as described in the 2017 Seafood Watch Criteria 2017.

Justification:

Due to fairly dramatic declines in abundance and fishery catches of eulachon in the late 1990s and 2000s along the US West Coast, in March 2010 the National Marine Fisheries Service (NMFS) listed the southern distinct population segment (DPS) of eulachon as threatened under the ESA (Gustafson et al. 2016) Listed threats to eulachon recovery include changing oceanic conditions and bycatch in trawl fisheries {NFMS 2016} (Figure 31).

Threat	Klamath	Columbia	Fraser	Mainland BC
Climate change impacts on ocean conditions	high	high	high	high
Dams /water diversions	moderate	moderate	very low	very low
Eulachon by-catch	moderate	high	moderate	high
Climate change impacts on freshwater habitat	moderate	moderate	moderate	moderate
Predation	moderate	moderate	moderate	moderate
Water quality	moderate	moderate	moderate	low
Catastrophic events	very low	low	very low	low
Disease	very low	very low	very low	very low
Competition	low	low	low	low
Shoreline construction	very low	moderate	moderate	low
Tribal/First Nations fisheries	very low	very low	very low	low
Non-indigenous species	very low	very low	very low	very low
Recreational harvest	very low	low	very low	very low
Dredging	very low	moderate	low	very low
Commercial harvest	very low	low	low	very low
Scientific monitoring	very low	very low	very low	very low
Qualitative threat level	**Color code**			
very low				
low				
moderate				
high				
very high				

Figure 32: Qualitative threat level and numerical and color coding. The level of threat severity is based on the 2010 modal score for each threat in each subpopulation (Gustafson et al. 2016).

Adult spawning abundance of the southern DPS of eulachon along the US West Coast has increased since the listing occurred in 2010. A number of data sources suggest eulachon abundance in some subpopulations within the southern DPS were substantially higher from 2011 to 2015 compared to indications of very low abundance from 2005 to 2010 (Figure 32, 33). Although eulachon abundance in monitored populations has generally improved, especially in the 2013 to 2015 return years, recent ocean condition trends and the likelihood that these conditions will persist into the near future suggest that population declines may be widespread in the upcoming return years (Gustafson et al. 2016).

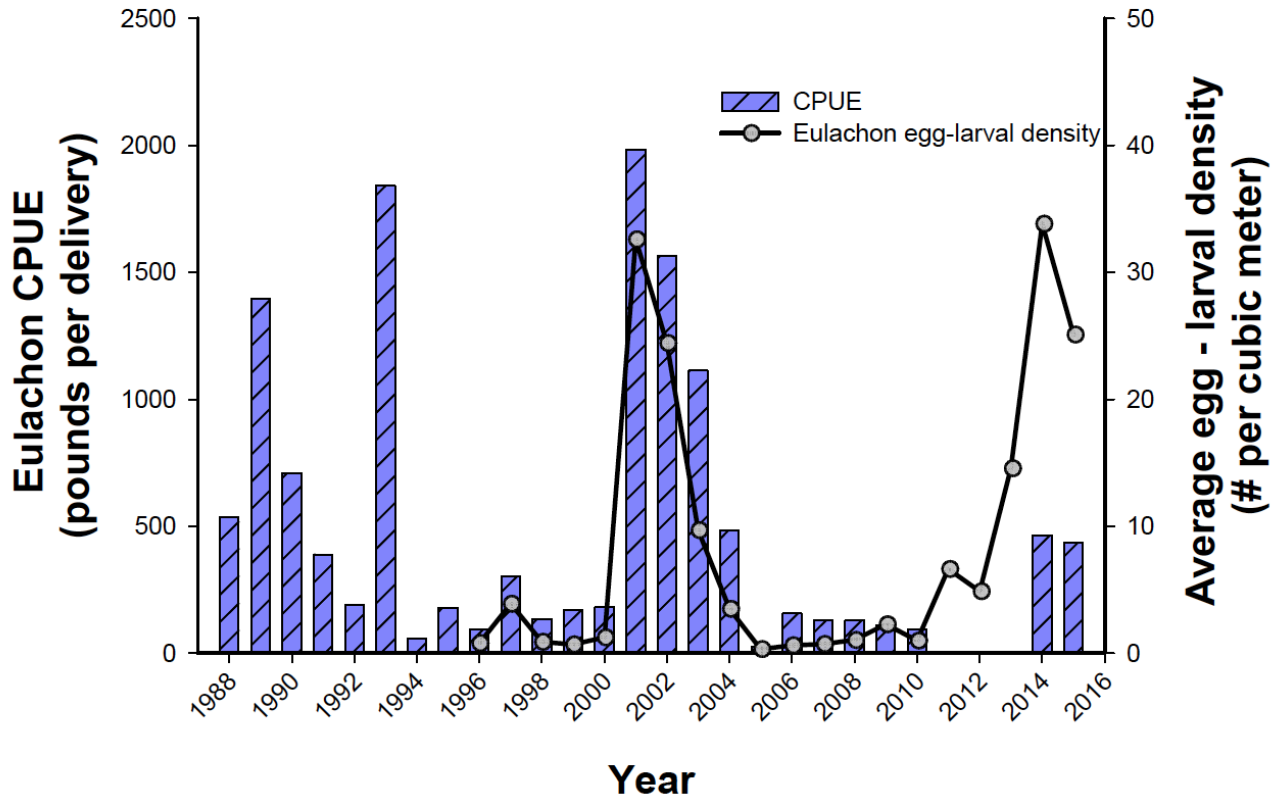

Figure 33: Historical trends in CPUE (pounds per delivery) and average larval density in the mainstem Columbia River (1996–2015). CPUE is lacking for 2011–2013 due to closure of the commercial fishery. Adjusted density in the mainstem Columbia River from 2011–2014 represents average density during February-April for consistency with previous years (Gustafson et al. 2016).

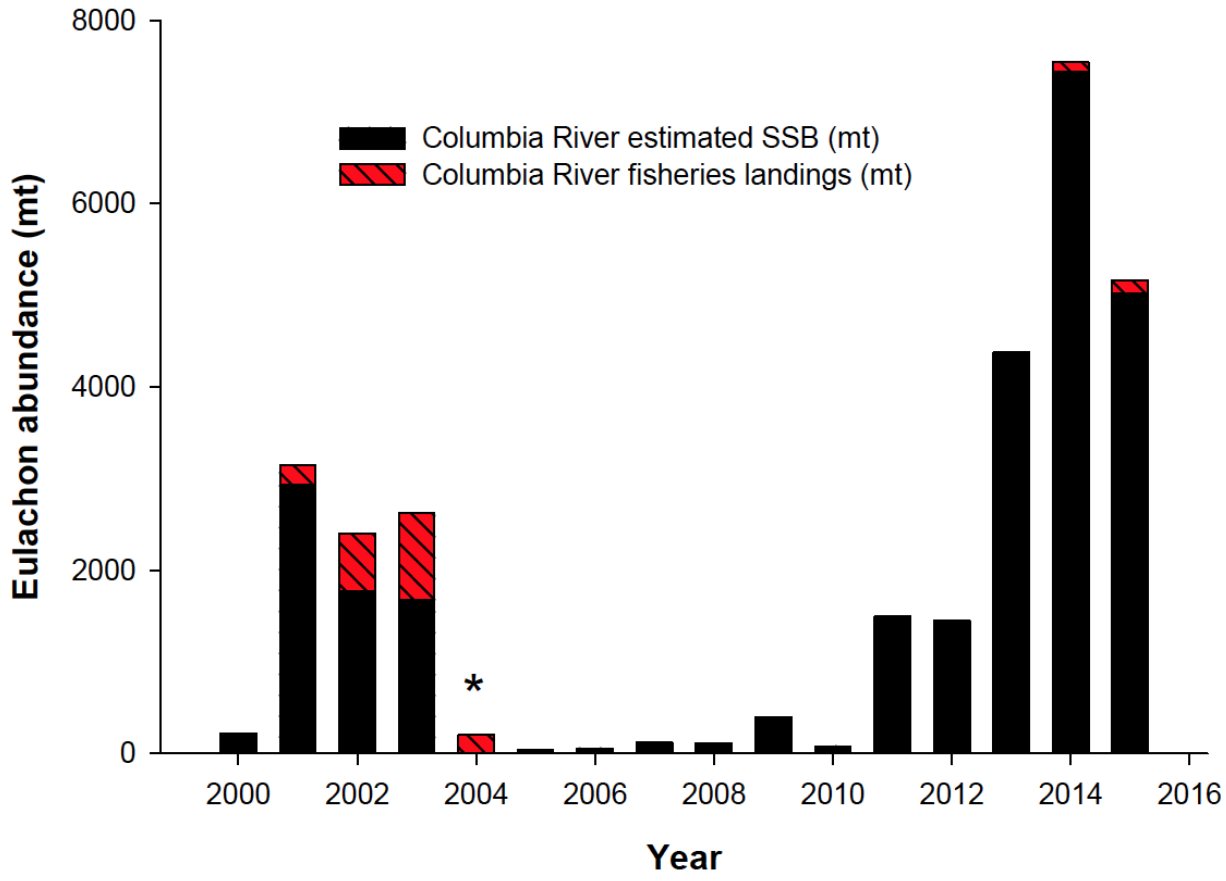

Figure 34: Estimated Columbia River eulachon spawning stock biomass and fisheries landings from 2000–2015. Pre-2011 adjusted SSB estimates are based on historical Columbia River water discharge rates and expansions of historical larval densities adjusted for the shorter duration of the pre-2011 surveys. Asterisk indicates that a survey was conducted in 2004; however, detailed daily larval density data for that year are unavailable and only harvest data for that year is displayed (Gustafson et al. 2016).

Factor 2.2 - Fishing Mortality

Northeast Pacific | Bottom trawls | United States | California | Pink Shrimp Fishery

High Concern

Eulachon are listed as threatened under the ESA. Bycatch in shrimp trawl fisheries is ranked as a "moderate" to "high" threat to eulachon recovery. Overall removals of eulachon (eulachon bycatch/shrimp catch ratio) are relatively low in the California region based on observer data (Figure 34, 35) (Gustafson et al. 2017). Research conducted in Oregon and Washington have shown LED lights to be effective at reducing eulachon bycatch in trawl gear {ODFW 2016} (WDFW 2017) {Hannah et al. 2011}. CDFW is set to propose new legislation requiring LED lights in the next year (pers. comm., Coates, CDFW 2017). Lomeli et al. (2018) report that Washington state is in the process of creating LED requirements, but it is unknown if California will pursue similar actions (Lomeli et al. 2018). Based on the threatened status of eulachon in the fishery area, there is a probable chance that fishing mortality is above a sustainable level; therefore, eulachon receive a "high" concern rating for fishing mortality.

Justification:

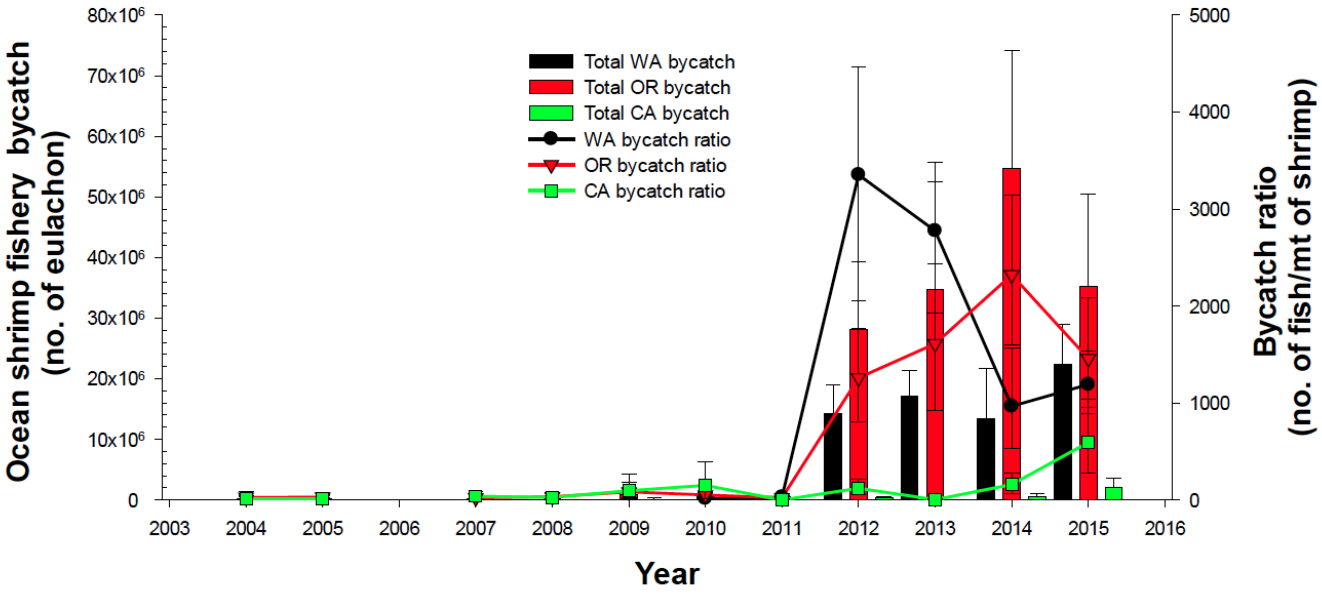

Figure 35: Estimated total bycatch and bycatch ratios of eulachon in the California, Oregon (2004–2015), and Washington (2010–2015) ocean shrimp trawl fisheries. Ocean shrimp fisheries were not observed in 2006 (Gustafson et al. 2017).

	State observed								State fleetwide				
Year	Bycatch (kg of eulachon)	Bycatch (no. of eulachon)	Observed ocean shrimp catch (mt)	Bycatch ratio (kg per mt of ocean shrimp)	95% CI	Bycatch ratio (no. per mt of ocean shrimp)	95% CI	Percent landings observed	Fleet ocean shrimp landings (mt)	Bycatch estimate (kg eulachon)	95% CI	Bycatch estimate (no. of eulachon)	95% CI
2004	*	*	*	0.3	0.1 0.7	11.5	0.0 40.6	*	996.8	311.1	108.9 711.6	11,442	351 40,431
2005	*	*	*	0.3	0.0 0.5	11.4	0.0 40.7	*	860.6	225.9	25.1 404.7	9,848	0 35,051
2006	--	--	--	--	-- --	--	-- --	--	63.6	--	-- --	--	-- --
2007	*	*	*	0.6	0.3 0.9	39.6	0.0 86.3	*	289.1	168.4	86.8 272.0	11,450	978 24,943
2008	*	*	*	0.3	0.0 0.5	26.2	0.0 66.0	*	945.5	251.5	82.9 517.8	24,793	5,908 62,402
2009	*	*	*	0.6	0.3 1.2	96.2	16.0 270.3	*	1,183.5	740.6	405.2 1,399.5	113,815	18,953 319,844
2010	367.9	40,040	265.5	1.4	0.4 2.2	150.8	16.0 396.7	15.0	1,771.0	2,454.0	718.6 3,927.1	267,057	40,040 702,623
2011	3.7	59	420.6	0.0	0.0 0.0	0.1	0.1 0.2	12.6	3,333.0	29.6	15.2 33.0	471	198 827
2012	857.2	42,018	347.6	2.5	1.4 5.3	120.9	53.3 217.2	12.5	2,790.7	6,882.0	4,023.3 14,793.4	337,344	148,647 606,034
2013	65.8	1,533	359.8	0.2	0.1 0.3	4.3	1.0 8.7	9.2	3,915.4	715.9	221.5 1,295.2	16,684	3,816 33,998
2014	1,020.2	94,976	597.5	1.7	0.8 2.4	158.9	62.8 276.7	15.5	3,845.0	6,564.9	2,901.4 9,327.7	611,152	241,491 1,063,825
2015	3,134.5	198,759	334.7	9.4	5.9 14.7	593.9	278.0 1,033.0	9.7	3,453.0	32,341.9	20,503.8 50,622.0	2,050,791	960,061 3,567,063

Figure 36: Numbers and weight of eulachon observed and bycatch ratios from ocean shrimp trawl vessels that landed their catch in California (2010–2015). Bycatch ratios were calculated for each year by dividing the observed catch of eulachon (in numbers of eulachon and in kg of eulachon) by the observed weight (in mt) of retained ocean shrimp. A fleet-wide bycatch estimate (in both weight and number of fish) was obtained by multiplying the bycatch ratios by fleet-wide ocean shrimp landings. 95% bootstrapped confidence intervals (CI) are provided for the estimates. Asterisks (*) signify strata with fewer than three observed vessels (Gustafson et al. 2017).

Finfish

Factor 2.1 - Abundance

Northeast Pacific | Beam trawls | United States | Alaska
Eastern Central Pacific | Bottom trawls | United States | California | Ridgeback Shrimp Fishery

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

Factor 2.2 - Fishing Mortality

Eastern Central Pacific | Bottom trawls | United States | California | Ridgeback Shrimp Fishery

Moderate Concern
There is sufficient information to override the UBM score of "high" concern for finfish caught in the ridgeback shrimp trawl fishery. The finfish bycatch composition for this fishery is known and none of the species are of conservation concern or known to be undergoing overfishing; however, it is unknown whether the current levels of fishing mortality for these species is sustainable. Therefore, a "moderate" concern score is given.

Northeast Pacific | Beam trawls | United States | Alaska

High Concern
Finfish are highly susceptible to interactions with trawl fisheries and score as a "high" concern as described in the Seafood Watch Unknown Bycatch Matrix .

Forage fish

Factor 2.1 - Abundance

Northeast Pacific | Beam trawls | United States | Alaska

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

Factor 2.2 - Fishing Mortality

Northeast Pacific | Beam trawls | United States | Alaska

High Concern
Forage fish are highly susceptible to interactions with trawl fisheries; therefore, it received a "high" concern score using the Seafood Watch Unknown Bycatch Matrix.

Hagfish

Factor 2.1 - Abundance

Northeast Pacific | Pots | United States | Washington

Moderate Concern

Abundance of hagfish species (*Myxinidae spp.*) is unknown in the northeast Pacific (Figure 54). Based on landings from the first surge of fishing activity from 1989 to present, the biomass is thought to be quite large (Tanaka 2008). Data from a tagging study performed by Nakamura (1991) and recent CDFG fishery sampling suggest that the Pacific hagfish population density could range from approximately 48 to 89 ST of hagfish per mi^2 in suitable habitats (soft bottom less than 1200 feet). In summary, abundance is unknown, and hagfish receive a "moderate" concern score for abundance.

Justification:

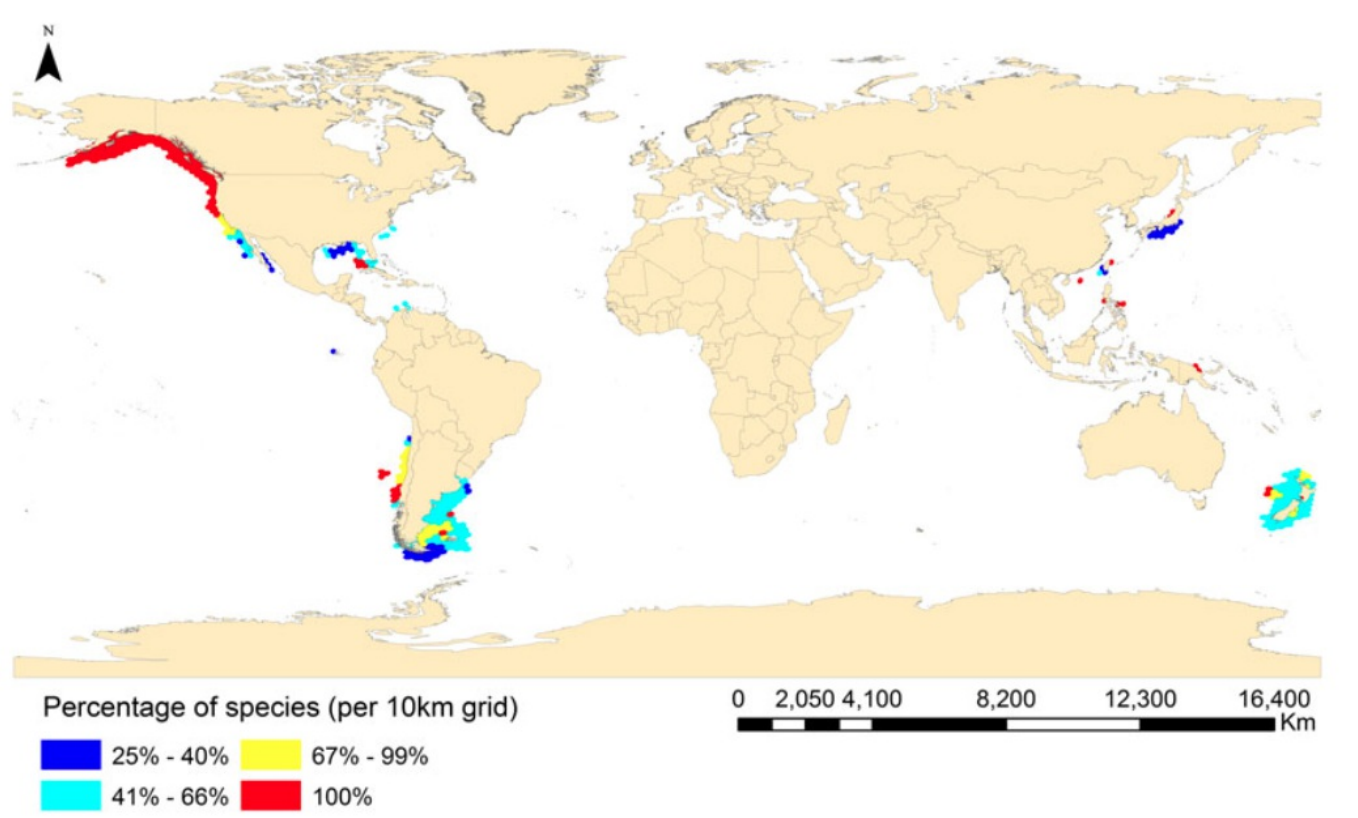

Figure 37: Proportion of Data Deficient (DD) species of hagfishes occurring in major regions of the World {Knapp et al. 2011}.

Table 12. Hagfish, Washington spot prawn pot

Productivity Attributes	Value	Score (1 = low risk; 2 = medium risk; 6 = high risk)	Reference	Susceptibility Attribute	Information	Score (1 = low risk; 2 = medium risk; 6 = high risk)	Reference
Average age at maturity (years)	10	2	Tanaka 2008	**Areal overlap**	Data limited. Default.	3	

Average maximum age (years)	12	2	Tanaka 2008	**Vertical overlap**	Data limited. Default.	3	
Fecundity (eggs/yr)	25	3	Tanaka 2008, Powell et al. 2005	**Selectivity of fishery**	Species targeted and incidentally encountered.	2	Tanaka 2008
Average maximum size (cm) (not to be used when scoring invertebrate species)	63	1	Animal Diversity Web	**Post-capture mortality**	Default.	3	
Average size at maturity (cm) (not to be used when scoring invertebrate species)	42	2	Univ. of Michigan Animal Diversity Web	**Susceptibility Subscore**		**2.325**	
Reproductive strategy	Demersal egg layer or brooder	2	Tanaka 2008, Powell et al. 2005				
Trophic level	5	3	Fishbase.org	**Productivity-Susceptibility Score**	**3.07**		
Density dependence (invertebrates only)	NA			**Vulnerability Rating (high, medium or low)**	**MEDIUM**		
Quality of Habitat	Robust	1	Tanaka 2008				
Productivity Subscore		2					

Factor 2.2 - Fishing Mortality

Northeast Pacific | Pots | United States | Washington

Low Concern

There is no stock assessment or reference points available for hagfish in the northeast Pacific. Removals in the target hagfish fishery were variable for 1982 to 2008, and changes in target harvest typically occurred due to market conditions as opposed to hagfish stock status (Tanaka 2008) (Figure 55). Data on hagfish fishing mortality in pot fisheries is generally unknown due to limited observer coverage; however, one study from Washington state for 2003 to 2007 confirmed that the hagfish bycatch to target spot prawn ratio was approximately 0.08/1 (Wargo et al. 2013). In summary, biomass is expected to be quite high for hagfish (Tanaka 2008), and the spot prawn fishery is unlikely to be a substantial contributor to a fishing mortality level that would aversely affect the hagfish population. Therefore, the spot prawn fishery receives a "low" concern for hagfish fishing mortality.

Justification:

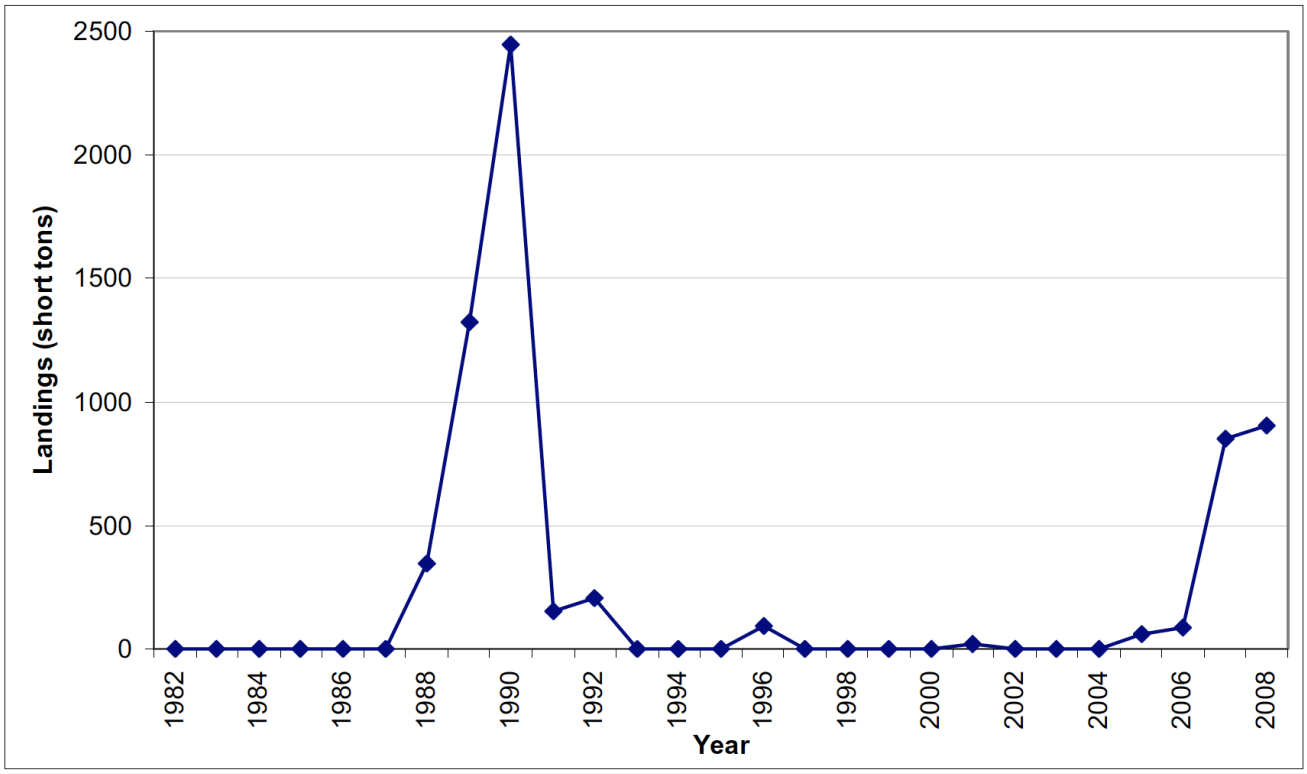

Figure 38: Pacific hagfish commercial landings, 1982-2008. Data source: CFIS data, all gear types combined.

Humpback whale

Factor 2.1 - Abundance

Northeast Pacific | Pots | United States | California

High Concern

Humpback whale populations are highly vulnerable to interactions with fishing gear. Therefore, they receive a score of "high" concern for abundance.

Justification:

Humpback whales were listed as endangered under the US ESA until 2016 when 14 Distinct Population Segments (DPSs) with unique stock status designations were established in legislation. Based on extant data, the Mexico (threatened), Central America (endangered), and Hawaii (not at risk) DPSs may all feed along the US west coast at various times of the year (NOAA 2017) (Figure 36). Stock delineation under the Marine Mammal Protection Act (MMPA) has yet to be finalized to align with the US DPS ESA delineations. Thus, management measures are still in development for the California/Oregon/Washington humpback whale stock under the MMPA. Because feeding aggregations that include endangered and threatened humpback DPSs occur along the US west coast, humpback whales should conservatively be considered endangered in this area at this time.

The estimated population size of the California/Oregon/Washington humpback whale stock is approximately 2,900 individuals, and the population growth rate is estimated at 6% to 7% {NOAA SAR 2020}.

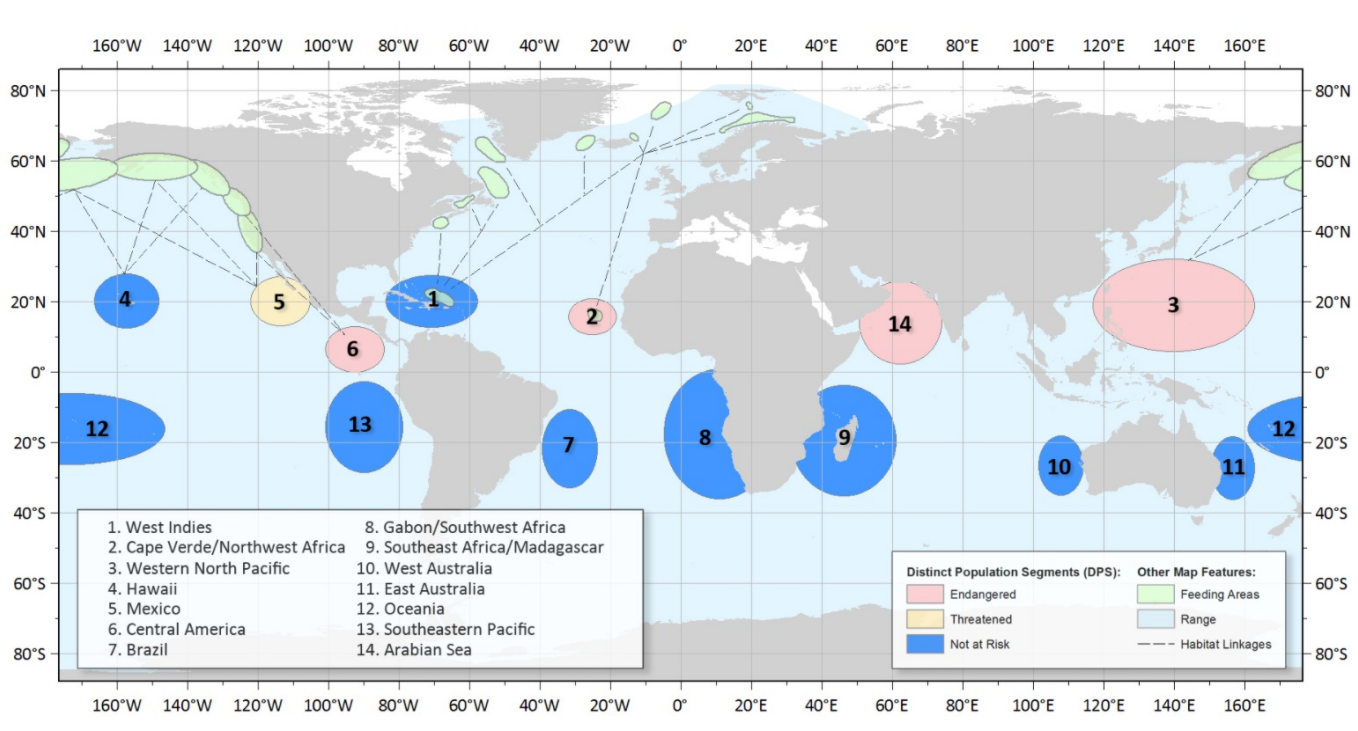

Figure 39: Humpback whale Distinct Population Status (DPS), feeding areas, and conservation status (NOAA 2017).

Factor 2.2 - Fishing Mortality

Northeast Pacific | Pots | United States | California

Moderate Concern

The spot prawn fishery is listed as a Category II fishery under the MMPA. When averaged over the five year period 2013 to 2017, the relative contribution of the spot prawn fishery to total humpback whale mortality was less than 10% of the annual potential biological removal (PBR), but there are takes from fisheries in which gear type is unknown (NMFS SAR 2020). The estimated mean annual mortality and serious injury of humpback whales was ≥ 0.5 (California spot prawn fishery), ≥ 1.4 (unspecified pot and trap fisheries), and ≥ 8.85 (unidentified fisheries); cumulative fishing mortality from 2013 to 2017 (approximately 17.3 takes per year) exceeded the PBR of 16.7 (NMFS SAR 2020). More recent entanglement data (not yet included in the published NMFS Stock Assessment Report [SAR] for US west coast humpback whales) confirms numerous entanglements in 2018 (34 confirmed, 5 unconfirmed), 2019 (17 confirmed, 2 unconfirmed) and 2020 (10 confirmed, 2 unconfirmed) (NOAA 2021).

In light of updated fishing mortality exceeding PBR, a conservative scoring approach was used to score humpback whale fishing mortality for two reasons: 1) the relative contribution of the spot prawn fishery to humpback whale mortality may exceed 10% of the PBR, and 2) the cumulative fishing mortality does exceed the PBR. Therefore, humpback whales score a "moderate" concern for fishing mortality.

Justification:

As a Category II fishery in the MMPA List of Fisheries, spot prawn pot fishery is known to cause occasional incidental, serious injury/mortality to marine mammals. Specifically, the spot prawn fishery is known to have entangled one humpback whale in 2006, three more humpbacks in 2016, and one in 2020 and US west coast pot fisheries in general (sablefish, Dungeness crab, and spot prawn) are known to have entangled other humpback whales, though the specific fishery is not always known (NMFS 2017) (NMFS SAR 2014) (NOAA 2017a)(NOAA 2021b).

The PBR for the California/Oregon/Washington population of humpback whales is estimated at 16.7 individuals per year across the region (NMFS SAR 2020). From 2013 to 2017, there were 62 documented interactions associated with pot fisheries (the specific fishery is not always known). The minimum level of annual mortality and serious injury attributed to the California pot fishery from 2013 to 2018 was 2.5 (prorated to include takes in unidentified fisheries). The minimum average annual serious injury and mortality of California/Oregon/Washington humpback whales in all pot fisheries was 8.45 from 2013 to 2017 (NMFS SAR 2020).

Although entanglements do not always equate "one to one" as a take in the sense of the PBR, a recent uptick in entanglements is noteworthy in this case and influenced the fishing mortality score. Overall, the spot prawn pot fishery has less of an impact on humpback whales than the Dungeness crab commercial fishery; however, the US west coast humpback whale grouping represents an intermixing of stocks, which could include DPS threatened or endangered under the ESA.

Lingcod

Factor 2.1 - Abundance

Northeast Pacific | Pots | United States | California

Low Concern

Pacific lingcod was assessed with a Stock Synthesis model in 2017. The southern stock (California waters) is currently considered in the "precautionary zone" (spawning biomass 25-40% of estimated unfishing biomass) with SSB_{2017}/SSB_0 = 0.321 (Haltuch et al. 2017). The stock is above the limit reference point, less than the target reference point ($0.40SSB_0$). Therefore, a "low" concern is awarded.

Justification:

Lingcod are managed as two distinct stocks along the US west coast: the Washington and Oregon stock (north) and the California stock (south). This assessment will focus on the southern stock (California), which has been caught incidentally in the California spot prawn fishery {Reilley & Geibel 2002}. The most recent assessment of southern stock lingcod was conducted in 2017 (Haltuch et al. 2017) and considered commercial and recreational CPUE and other biological parameters to estimate current and future lingcod biomass. Biomass estimates suggest that the southern stock was overfished in the 1990s but had rebuilt by 2007 to levels above the management target (Haltuch et al. 2017).

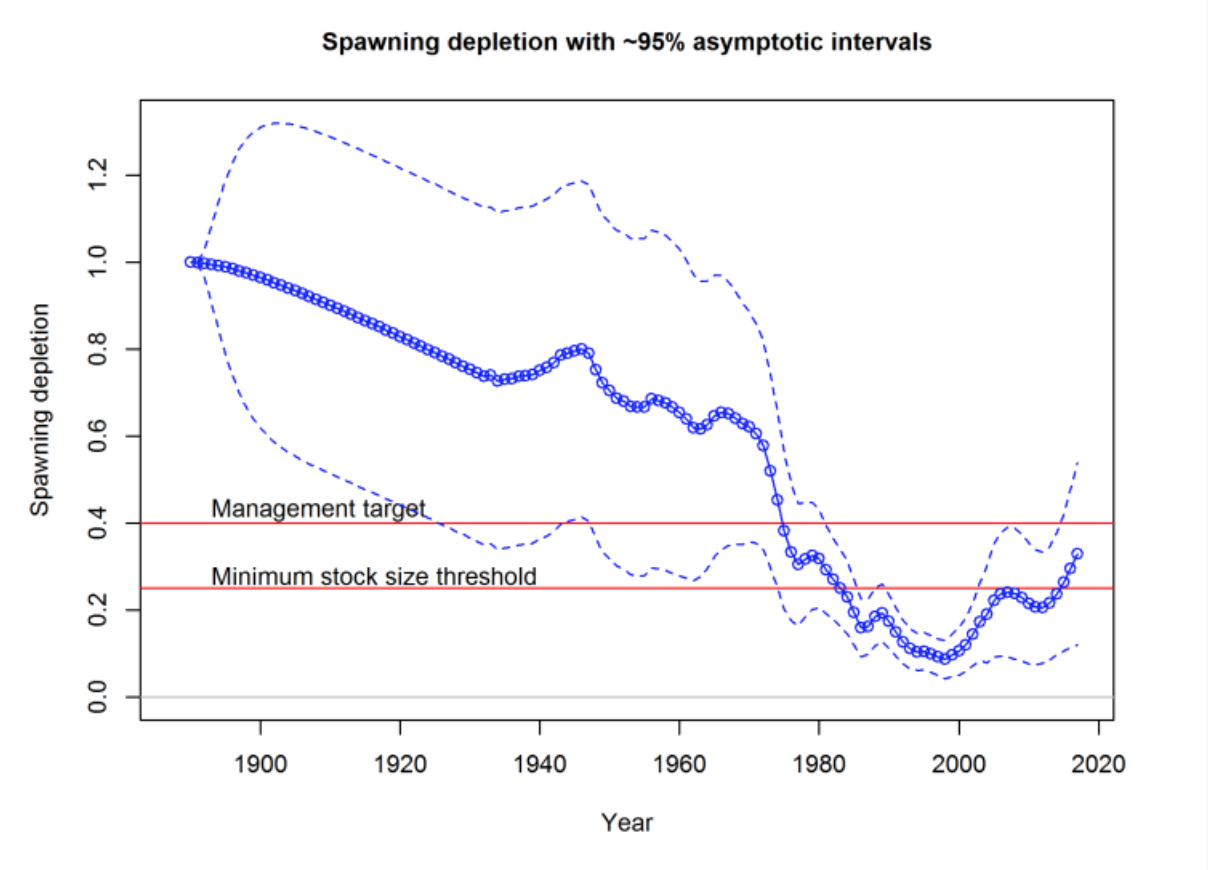

Figure 40: Time series of stock depletion for the south stock of lingcod. Haltuch et al. 2017.

Factor 2.2 - Fishing Mortality

Northeast Pacific | Pots | United States | California

Low Concern

Historically lingcod harvest rates exceeded management target levels; however, harvest rates have been below targets since the early 2000s (Haltuch et al. 2017). The estimated exploitation rate for the most recent year is below target levels (F_{2016} < 1). Overfishing is not occurring and a score of "low" concern is awarded.

Justification:

Lingcod are targeted in commercial and recreational fisheries in California. Lingcod are also taken in the IFQ trawl, longline, and pot fisheries. In the target lingcod fishery in California, ABCs are determined annually based on catch data and biomass estimates. Lingcod catch has historically been well below coastwide ABCs (Hamel et al. 2009) (Figure 59). Fishing mortality reference points are based on an MSY proxy ($SPR_{45\%}$), where the stock is undergoing overfishing when (1-SPR)/(s-$SPR_{45\%}$) > 1. The exploitation rate in 2016 is below the target value ((1-SPR)/(s-$SPR_{45\%}$) = 0.61).

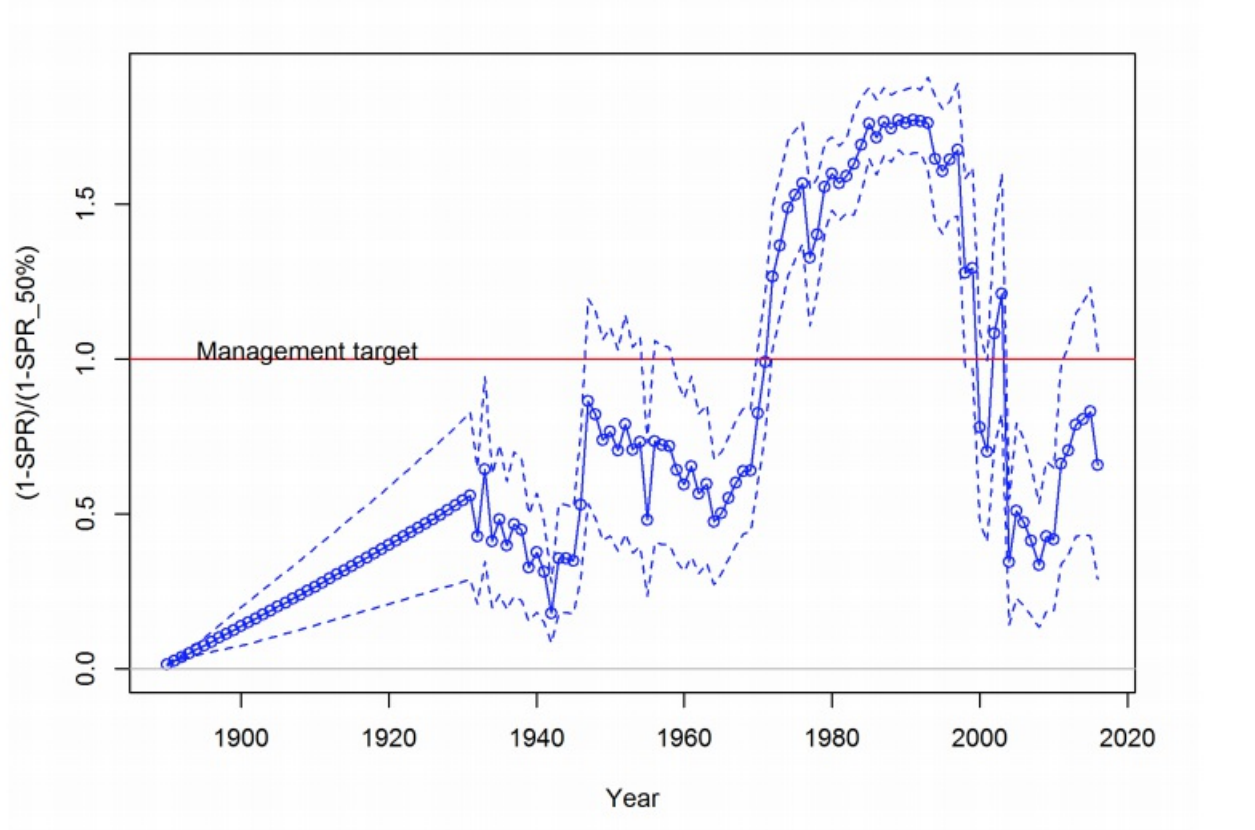

Figure 41: Estimated spawning potential ratio (SPR) of the southern lingcod stock. One minus SPR is plotted so that higher exploitation rates occur in the upper portion of the y-axis. Haltuch et al. 2017.

Mammals

Factor 2.1 - Abundance

Northeast Pacific | Pots | United States | Alaska

High Concern
Marine mammal populations have high inherent vulnerability to interactions with fishing gear, and therefore receive a score of “high" concern for abundance.

Factor 2.2 - Fishing Mortality

Northeast Pacific | Pots | United States | Alaska

High Concern
Marine mammals are highly susceptible to interactions with trawls and pot fisheries in the Northeast Pacific and score "high" concern for fishing mortality in the Seafood Watch Unknown Bycatch matrix.

Pacific whiting

Factor 2.1 - Abundance

Eastern Central Pacific | Bottom trawls | United States | California | Ridgeback Shrimp Fishery

Very Low Concern

The median estimate of 2020 relative spawning biomass for Pacific hake (spawning biomass at the start of 2020 divided by that at unfished equilibrium, B_{ZERO} is 65%, which is well above the target reference point $B_{40\%}$. (Grandin et al. 2020)(Figure 56). The Pacific hake stock is robust, above target reference points, and is MSC certified. The stock receives a score of "very low" concern for abundance.

Justification:

The Pacific hake stock is assessed annually using a model fit to acoustic survey abundance data, commercial catch data, and age composition data from survey and commercial catches {Berger et al. 2017}. The stock is estimated to be at its highest biomass level since the 1980s as a result of estimated large 2010 and 2014 cohorts.

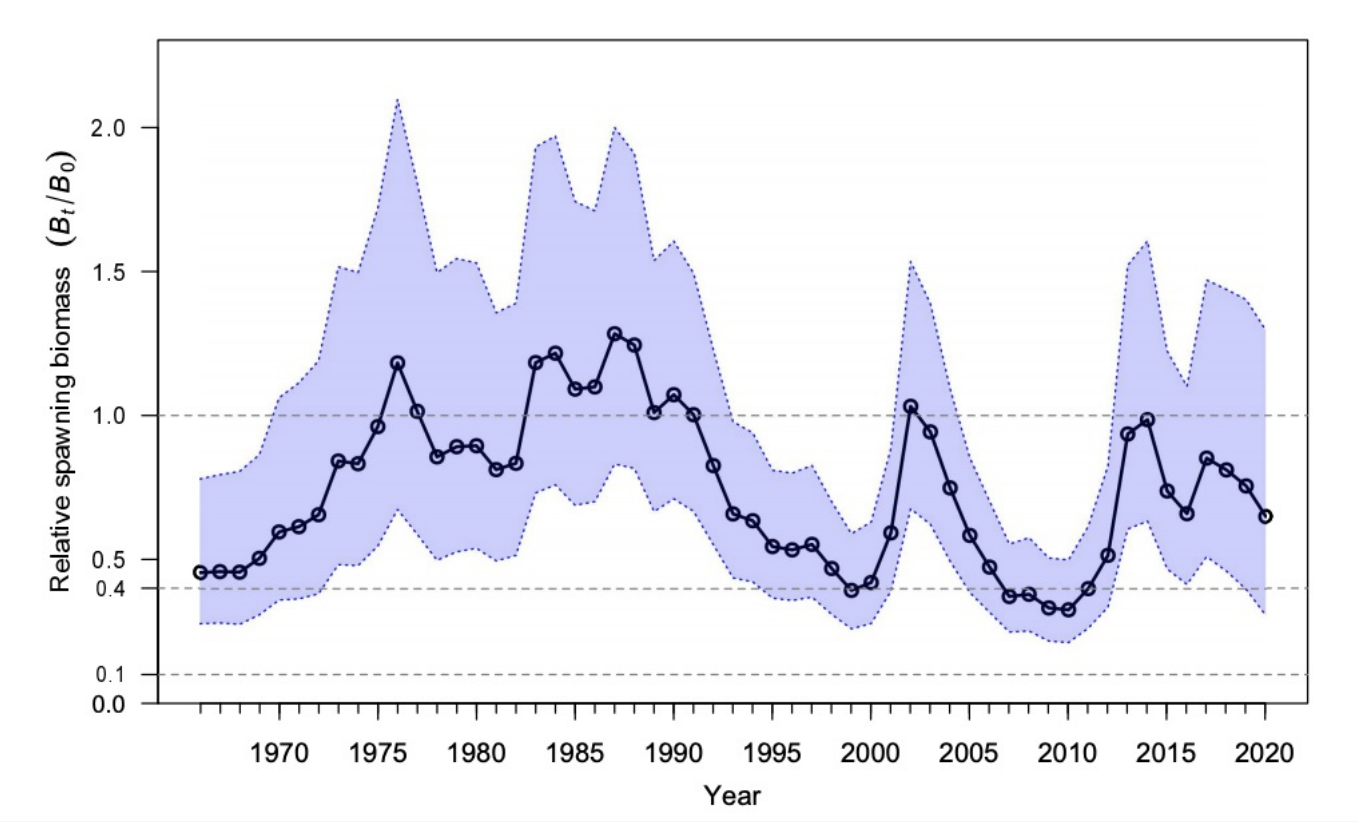

Figure 42: Median (solid line) of the posterior distribution for relative spawning biomass (Bt/B0) through 2017 with 95% posterior credibility intervals (shaded area). Dashed horizontal lines show 10%, 40% and 100% levels (Grandin et al. 2020).

Factor 2.2 - Fishing Mortality

Eastern Central Pacific | Bottom trawls | United States | California | Ridgeback Shrimp Fishery

Low Concern

Overall removals of Pacific Hake from all groundfish fisheries in 2019 was 71.8% of the US TAC and well below the management reference point (Grandin et al. 2020) . Pacific hake fishing mortality is well below target reference points and receives a "low" concern for fishing mortality.

Justification:

The default harvest policy for Pacific Hake prescribes the maximum fishing mortality to equal FSPR=40%. This rate gives a spawning potential ratio (SPR) of 40%, meaning that the spawning biomass per recruit is 40% of that without fishing. If the spawning biomass is below $B_{40\%}$, the policy reduces the TAC linearly until it equals zero at $B_{10\%}$. Median relative fishing mortality on the stock is estimated to have been below the $SPR_{40\%}$ target except in 1999 when spawning biomass was low {Berger et al. 2017} (Figure 57).

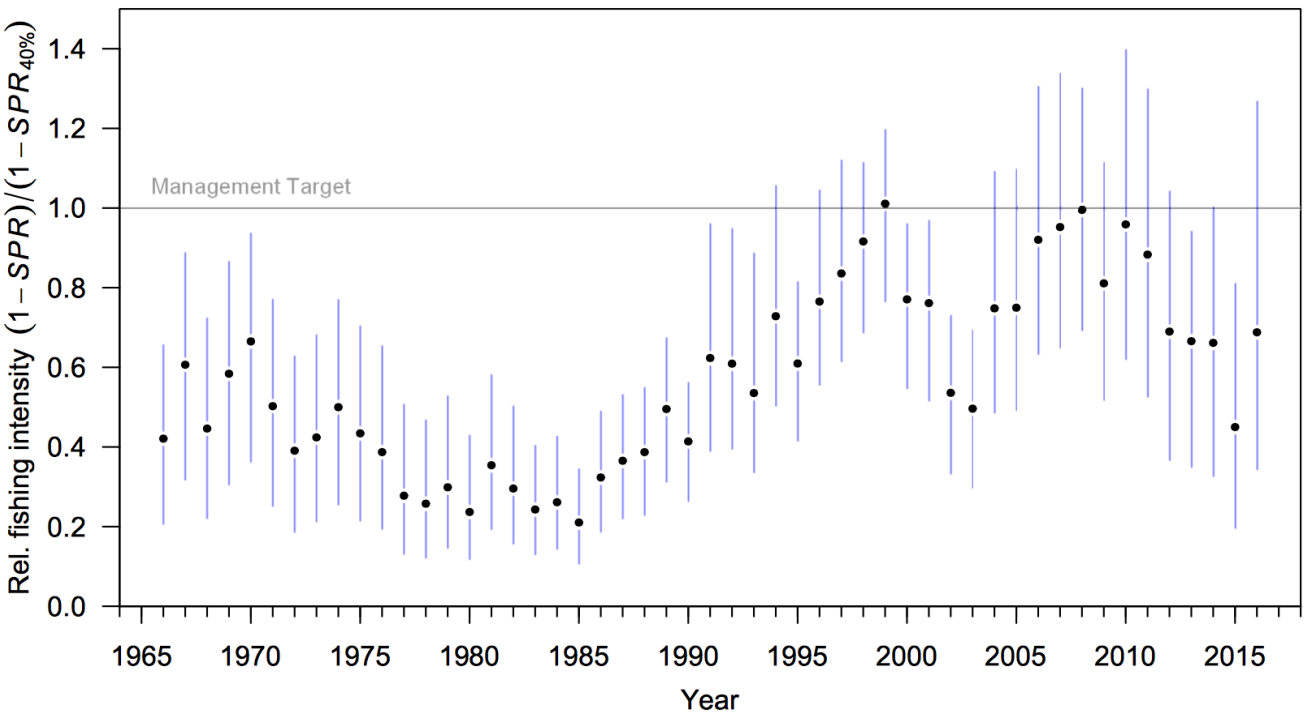

Figure 43: Trend in median fishing intensity (relative to the SPR management target) through 2016 with 95% posterior credibility intervals. The management target defined in the Agreement is shown as a horizontal line at 1.0 {Berger et al. 2017}.

Seabirds

Factor 2.1 - Abundance

Northeast Pacific | Beam trawls | United States | Alaska

High Concern
Seabird populations have high inherent vulnerability to interactions with fishing gear, and therefore receive a score of "high" concern for abundance.

Factor 2.2 - Fishing Mortality

Northeast Pacific | Beam trawls | United States | Alaska

Moderate Concern
Seabirds have a moderate susceptibility to interactions with trawl fisheries in the northeast Pacific and score a "moderate" concern for fishing mortality as described in the Seafood Watch Unknown Bycatch Matrix.

Starfish

Factor 2.1 - Abundance

Northeast Pacific | Pots | United States | Washington

Moderate Concern
Abundance of sea urchins and sea stars is unknown. There is no evidence that sea urchins and sea stars caught in this fishery are endangered, threatened, or depleted, and they score medium inherent vulnerability in the PSA above (Table 8); therefore, they are rated "moderate" concern for abundance.

Factor 2.2 - Fishing Mortality

Northeast Pacific | Pots | United States | Washington

Moderate Concern
Removals of sea urchins and sea stars in US west coast pot fisheries are unknown due to limited observer coverage and landings data. Sea stars and sea urchins are not highly vulnerable species (see PSA above), and there are no reference points available for fishing mortality. Therefore, sea urchins and sea stars receive a "moderate" concern for fishing mortality.
Justification:
Small-scale fisheries for sea urchins do exist, but are likely minimal in comparison to urchin abundance {Kalvass & Rogers-Bennet 2002}. The majority of sea urchins and sea stars caught as bycatch are discarded at sea, and survival is presumed to be high, but is unknown (Wilson et al. 2014) (Wargo et al. 2013}.

Urchins (unspecified)

Factor 2.1 - Abundance

Northeast Pacific | Pots | United States | Washington

Moderate Concern

Abundance of sea urchins and sea stars is unknown. There is no evidence that sea urchins and sea stars caught in this fishery are endangered, threatened, or depleted, and they score medium inherent vulnerability in the PSA below (Table 8); therefore, they are rated "moderate" concern for abundance.

Justification:

Table 8. Starfish and Urchins, Washington spot prawn pot

Productivity	Value	Score (1 = low risk, 2 = medium risk, 6 = high risk)	Reference		Susceptibility Attribute	Information	Score (1 = low risk, 2 = medium risk, 6 = high risk)	Reference
Average age at maturity (years)	NA	3			**Areal overlap**	Default. Data limited.	3	
Average maximum age (years)	5	1	Barnes 1987		**Vertical overlap**	Default. Data limited.	3	
Fecundity (eggs/yr)	1,000,000	1	Levitan et al. 1992, Kalvass & Rogers-Bennet 2002		**Selectivity of fishery**	Default. Data limited.	2	
Reproductive strategy	Broadcast spawner	1	Levitan et al. 1992, Kalvass & Rogers-Bennet 2002		**Post-capture mortality**	Default. Data limited.	3	
Trophic level	2.51	1	seaaroundus.org		**Susceptibility Subscore**	**2.325**		
Density dependence (invertebrates only)	Compensatory	1	Levitan et al. 1992					
Quality of Habitat	Robust	1	Kalvass & Rogers-Bennet 2002		**Productivity-Susceptibility Score**	**2.66**		
Productivity Subscore	**1.28571**				**Vulnerability Rating (high, medium, low)**	**MEDIUM**		

Factor 2.2 - Fishing Mortality

Northeast Pacific | Pots | United States | Washington

Moderate Concern
Removals of sea urchins and sea stars in US west coast pot fisheries are unknown due to limited observer coverage and landings data. Sea stars and sea urchins are not highly vulnerable species (see PSA above), and there are no reference points available for fishing mortality. Therefore, sea urchins and sea stars receive a "moderate" concern for fishing mortality.
Justification:
Small-scale fisheries for sea urchins do exist, but are likely minimal in comparison to urchin abundance {Kalvass & Rogers-Bennet 2002}. The majority of sea urchins and sea stars caught as bycatch are discarded at sea, and survival is presumed to be high, but is unknown (Wilson et al. 2014) (Wargo et al. 2013}.

Factor 2.3 - Discard Rate/Landings

Eastern Central Pacific | Bottom trawls | United States | California | Ridgeback Shrimp Fishery

< 100%
Data from 4 trawl tows in 1999 indicated a minimum discard to landings ratio of 0.41 (512 lb discards / 1247 lb total landings). This is a minimum estimate, since it is unclear whether invertebrate discards were included in the study {Reilly & Geibel 2002}.

Northeast Pacific | Beam trawls | United States | Alaska

< 100%
Based on a review conducted by Alverson (1994), the ratio of discards to target catch for shrimp fisheries in the US Gulf shrimp fishery was approximately 10/1. However, this estimate is outdated and likely not applicable to the SEAK shrimp trawl fisheries. A comprehensive study estimated a discard to landings ratio of 4% to 10% for the Gulf of Alaska (GOA) trawl-caught pollock and 52% to 72% for GOA deepwater flatfish (Queriolo et al. 1995). More recent research suggests lower discard ratios for trawl fisheries in the region {Somers et al. 2016a}. Mortality of discards in the trawl fisheries for all species is assumed to be 100% {Somers et al. 2016a}. Data are limited specific to shrimp trawl fisheries in SEAK; however, it is likely that the discard to total landings ratio is <1 based on data from other bottom trawl fisheries in the GOA and the extremely low bycatch and discard rates in the pink shrimp trawl fisheries in California, Oregon, and Washington (Somers et al. 2016).

Northeast Pacific | Bottom trawls | United States | California | Pink Shrimp Fishery

< 100%
WCGOP observer data for 2004 to 2015 were used to estimate the discards/total landings ratio of 0.057 (175 MT discards /3074 MT total landings) (Somers et al. 2016).

Northeast Pacific | Pots | United States | Alaska

< 100%

Data on bycatch and discards for the Alaska shrimp trawl and pot fisheries are unavailable (pers. comm., Smith & Rumble, ADFG 2017). Catch composition in the SEAK pot fishery was evaluated in a research survey for 1996 to 2003. A wide array of species were caught, including invertebrates and fish, but spot shrimp and coonstripe shrimp were the two species caught in the greatest number at 90% and 8% of the catch by number. This study was not used to estimate discards versus landings in this report because it only assessed species numbers (not weight), and only surveyed a few management where shrimp catches are highest {Love & Bishop 2005}. Based on results from the Washington spot prawn analysis (Wargo et al. 2013), the applied estimated ratio of discards + bait/ total landings is approximately 0.5 for the Alaska spot prawn and coonstripe shrimp pot fisheries. It is important to note that pots used in the Alaska spot prawn fishery are generally larger than Washington spot prawn pots, and they may use less bait relative to pot size (pers. comm., Smith, ADFG 2017). Undoubtedly, regional and target fishery variations could influence this estimate; however, with limited data, extending the Washington estimate serves as the best conservative indicator to date.

Northeast Pacific | Pots | United States | California

< 100%

Based on results from the Washington spot prawn study using observers to monitor bycatch (Wargo et al. 2013), the applied estimated ratio of discards + bait/ total landings is approximately 0.5 for the California spot prawn and coonstripe shrimp pot fisheries. Undoubtedly, regional and target fishery variations could influence this estimate; however, with limited data, extending the Washington estimate serves as the best indicator to date.

Northeast Pacific | Pots | United States | Washington

< 100%

Observers monitored 3,059 pot-lifts over six fishing trips from 2003 to 2007 in the Washington spot prawn fishery (Wargo et al. 2013). Invertebrates composed a majority of the bycatch (Figure 30); the post-capture mortality rate for invertebrates is conservatively assumed to be 50% based on research from the Alaska Fisheries Science Center and additional studies suggesting discard mortality rates are relatively low for invertebrates caught in pot gear (AFSC 2017a)(Suuronen 2005). The estimated bait/catch ratio in the pot fisheries was approximately 0.45 based on fishermen reports and logbook data (pers. comm., Ayres, WDFW 2017). The actual bait used varies and includes: fish pellets, cat food, and various small bait fish (pers. comm., Ayres, WDFW 2017) (pers. comm Coates, CDFW 2017). The estimated discard + bait/ total landings ratio for the Washington spot prawn fishery (with invertebrate discard mortality adjusted to 50%) was 0.5 (1559 lb total discards|bycatch + ~2236 lb bait) / 7548 lb total landings).

Justification:

Observed Trip Number - pot gear	1	2	3	4	5	6
Month-Year	April-03	June-03	April-04	June-06	April-07	August-07
No. of Pot lifts observed	804	279	300	178	1248	250
Total Spot Shrimp catch (pounds)	1245	445	295	137	2620	227
Total Bycatch (pounds)	978	173	381	5	971	71
Fish	42	30	46	0	15	3
Invertebrates	818	128	325	5	706	59
Percent spot shrimp (total spot shrimp/total catch)	56%	72%	44%	97%	73%	76%
Bycatch by species/species group (pounds)						
Canary Rockfish	-	-	-	-	-	0.1
Crab sp.	5.9	17.3	24.1	1.5	26.6	1.5
Hagfish sp.	18.2	23.4	42.1	-	15.0	-
Jellyfish sp.	-	0.2	-	-	-	-
Kelp Greenling	-	5.0	0.6	-	-	-
Lingcod	-	-	-	-	-	2.4
Octopus sp.	30.7	0.7	5.0	0.0	1.5	1.5
Pacific Cod	3.1	-	-	-	-	-
Poacher sp.	0.2	-	0.3	-	-	-
Rat fish	2.0					
Red banded Rockfish	0.5	0.2	0.7	-	0.2	0.2
Rockfish sp.	0.2	0.4	1.6	-	-	-
Rosethorn Rockfish	1.3	0.8	0.5	0.1	-	0.4
Sablefish	16.5	-	-	-	-	-
Sculpin sp.	11.7	11.7	32.5	0.0	4.7	0.8
Sea Stars sp.	130.3	75.0	201.0	3.2	323.4	34.7
Snail sp.	117.7	14.9	10.4	-	250.5	8.2
Urchin sp.	639.4	23.3	62.6		349.6	20.7
Bycatch of fish by species/species group (count)						
Canary Rockfish	-	-	-	-	-	1
Hagfish sp.	46	59	105	-	38	
Kelp greenling	-	10	1	-	-	-
Lingcod	-	-	-	-	-	1
Pacific cod	1	-	-	-	-	-
Poacher sp.	1		1			
Rat fish	2					
Red banded Rockfish	5		8		2	2
Rockfish sp.	1	4	4		0	0
Rosethorn Rockfish	10	6	4	1	0	3
Sablefish	6	-				
Sculpin sp.	37	34	79		11	4
Splitnose Rockfish	-	-	4	-	-	-

Figure 44: At-sea observations of the coastal spot shrimp pot fishery, 2003-2007 (Wargo et al. 2013).

Criterion 3: Management Effectiveness

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

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

The Criterion 3 rating is determined as follows:

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

Rating is Critical if Management Strategy and Implementation is Critical.

Guiding principle

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

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

Criterion 3 Summary

FISHERY	MANAGEMENT STRATEGY	BYCATCH STRATEGY	RESEARCH AND MONITORING	ENFORCEMENT	INCLUSION	SCORE
Eastern Central Pacific | Bottom trawls | United States | California | Ridgeback Shrimp Fishery	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Highly effective	**Yellow (3.000)**
Northeast Pacific | Beam trawls | United States | Alaska	Moderately Effective	Moderately Effective	Moderately Effective	Highly effective	Highly effective	**Yellow (3.000)**
Northeast Pacific | Bottom trawls | United States | California | Pink Shrimp Fishery	Moderately Effective	Highly effective	Moderately Effective	Highly effective	Highly effective	**Yellow (3.000)**
Northeast Pacific | Pots | United States | Alaska	Moderately Effective	Moderately Effective	Moderately Effective	Highly effective	Highly effective	**Yellow (3.000)**
Northeast Pacific | Pots | United States | California	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Highly effective	**Yellow (3.000)**
Northeast Pacific | Pots | United States | Washington	Highly effective	Moderately Effective	Moderately Effective	Highly effective	Highly effective	**Green (4.000)**

Criterion 3 Assessment

SCORING GUIDELINES

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

Factor 3.2 - Bycatch Strategy
Considerations: What type of management strategy/measures are in place to reduce the impacts of the fishery on bycatch species and when applicable, to minimize ghost fishing? How successful are these management measures? To achieve a Highly Effective rating, the fishery must have no or low bycatch, or if there are bycatch or ghost fishing concerns, there must be effective measures in place to minimize impacts.

Factor 3.3 - Scientific Research and Monitoring
Considerations: How much and what types of data are collected to evaluate the fishery's impact on the species? Is there adequate monitoring of bycatch? To achieve a Highly Effective rating, regular, robust population assessments must be conducted for target or retained species, and an adequate bycatch data collection program must be in place to ensure bycatch management goals are met.

Factor 3.4 - Enforcement of Management Regulations
Considerations: Do fishermen comply with regulations, and how is this monitored? To achieve a Highly Effective rating, there must be regular enforcement of regulations and verification of compliance.

Factor 3.5 - Stakeholder Inclusion
Considerations: Are stakeholders involved/included in the decision-making process? Stakeholders are individuals/groups/organizations that have an interest in the fishery or that may be affected by the management of the fishery (e.g., fishermen, conservation groups, etc.). A Highly Effective rating is given if the management process is transparent, if high participation by all stakeholders is encouraged, and if there a mechanism to effectively address user conflicts.

Factor 3.1 - Management Strategy And Implementation

Eastern Central Pacific | Bottom trawls | United States | California | Ridgeback Shrimp Fishery

Moderately Effective
The California ridgeback shrimp fishery is managed by the California Department of Fish and Wildlife in cooperation with the California Fish and Game Commission. A number of management measures are in place to regulate the fishery including the following: limited entry, seasonal and area closures, voluntary groundfish catch limits, and gear restrictions. The California ridgeback shrimp fishery is closed June 1 to September 30 to protect ridgeback shrimp females during their peak spawning months, and the fishery is closed in state waters (0 to 3 NM from shore) (Owens 2006). Management measures are effectively implemented in the California ridgeback fishery; however, data are lacking for ridgeback stock assessment and there is no cap on total commercial landings. The ridgeback fishery, therefore, receives a "moderately effective" rating.

Northeast Pacific | Beam trawls | United States | Alaska

Moderately Effective

There are a number of measures in the Alaska shrimp trawl fishery to manage regional shrimp stocks, but additional measures may be necessary (Smith and Gray 2017). The fishery is limited entry, and there are gear restrictions including minimum mesh and webbing sizes. There is a minimal allowable average size for shrimp that can be sold and a minimum count of 150 shrimp per pound (Smith et al. 2014). An overall GHR, based on fishery performance and size-class distribution data collected via dockside sampling, varies in-season and annually but caps at 3.5 million lb for northern shrimp (Smith et al. 2014), but the GHR is not based on population estimates (Smith and Gray 2017). Because of weak market conditions, northern shrimp harvests have not approached this cap in recent years (pers. comm., Smith, ADFG 2017) and sidestripe shrimp has become the preferred shrimp species (Smith and Gray 2017). The beam trawl fishery in the Southeast region does not have a management plan or stock assessment programs and regulations may be needed to assure conservative management (Smith and Gray 2017).

The directed sidestripe fishery was established in 1997, and a limit of 50,000 lb of shrimp may be taken from any district or section during the directed sidestripe season; however sidestripe shrimp taken in the traditional northern shrimp fishery are not subject to the 50,000 lb limit (Smith and Gray 2017). Logbooks are required for all participants in the pot fishery, but not in the beam trawl fishery (Smith and Gray 2017). Northern shrimp GHRs are determined annually based on average historical harvest levels, but there is a need for a management plan to ensure sustainable harvest goals are achievable (Smith and Gray 2017). Data-limited management measures are in place, but effectiveness is unknown and more active management and research programs are needed (Smith and Gray 2017). Therefore, the northern and sidestripe shrimp fisheries receive "moderately effective" for management strategy and implementation.

Justification:

Northern shrimp and sidestripe shrimp are targeted by several different fisheries. Each fishery has GHRs by district.

- **Traditional Northern Shrimp Fisheries**
  - GHRs are distributed by district in the following Districts: a portion of District 6 (Duncan Canal); a portion of District 7 (Eastern Channel); a portion of District 10 (Thomas and Farragut Bays); a portion of District 8 (Stikine Flats). The total allowed season harvest is 1.2 million lb.
- **Nontraditional Northern Shrimp Fisheries**
  - GHRs are distributed by district in the following Districts: 3, 5, 9, 11; the remaining portions of Districts 6 (South Zarembo and Sumner Strait), 7 (Blake Channel), 10 (Upper Frederick Sound); 11-A, 11-B, 11-C and 11-D.
- **Directed Sidestripe Shrimp Fisheries**
  - Limit of 50,000 lb may be taken from any district, but participants cannot concurrently participate in a northern shrimp fishery.

Landings and Guideline Harvest Ranges (GHRs) of northern and sidestripe shrimp (combined) in Alaska by region; only Districts 3 and 11 were fished by nontraditional sector in the last three seasons with available data (Smith and Gray 2017).

Fishery	Region	GHR (lb)	Landings (lb) 2014/15	Landings (lb) 2015/16	Landings (lb) 2016/17	Average Annual Landings (lb) (2014 - 2017)
Traditional	Duncan Channel (District 6)	80,000 - 400,000	confidential	303,100	562,000	343,400
	Eastern Channel (District 7)	15,000 - 50,000	0	confidential	confidential	11,000 combined
	Thomas and Farragut Bays (District 10)	5,000 - 75,000	confidential	confidential	confidential	
	Stikine Flats (District 8)	25,000 - 250,000	165,400	481,900	395,000	347,400
Nontraditional	District 3	25,000 - 100,000	0	confidential	0	
	District 11	125,000 - 375,000	0	confidential	confidential	
Directed Sidestripe	Any district	50,000	0	0	0	No directed sidestripe fishery since 2002/03

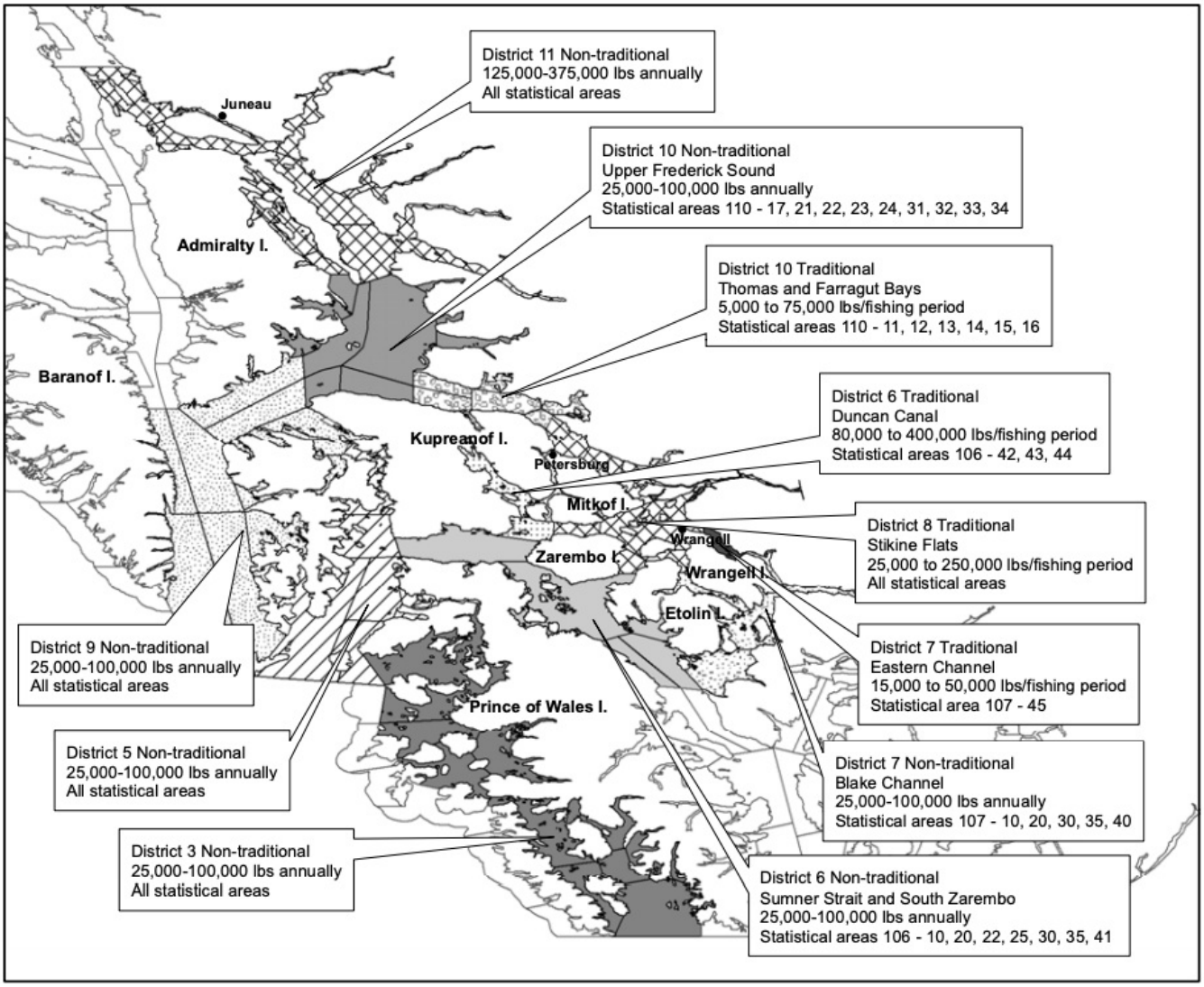

Figure 45: Beam trawl shrimp fishery areas and fishing period GHRs for Southeast Alaska (Smith and Gray 2017).

Northeast Pacific | Bottom trawls | United States | California | Pink Shrimp Fishery

Moderately Effective

The California pink shrimp fishery is state-managed, and a number of management measures are in place to regulate the fishery including the following: seasonal closures to protect egg-bearing females, area closures, maximum shrimp counts per pound, limited entry in the northern region, and gear requirements {Frimodig 2009} {Collier et al. 2006}. ? There is no cap on commercial landings of pink shrimp in California and no stock assessment currently.

Since 2004, the California pink shrimp fishery has experienced partial observer coverage (4% to 14% of catch) through the West Coast Groundfish Observer Program on (WCGOP) (Gustafson et al. 2017). WCGOP observer data from 2004 to 2015 confirm that pink shrimp retention in the fishery is essentially 100% (Somers et al. 2016). California state managers are working to develop a recruitment-based index of pink shrimp abundance which could enable reference point-based management in the next few years (pers. comm., Coates 2017). Although numerous regulations ensure effective management of the California pink shrimp fishery, lack of reference points and a stock assessment result in a "moderately effective" rating for management strategy and implementation.

Justification:

The CA pink shrimp fishing season extends from April 1 to October 31. There is a maximum count per lb of 160 to incentivize avoidance of small shrimp, a minimum mesh size of $1^{3/8}$ in, and a minimum catch rate of 350 lb per hour to protect shrimp when the populations are low {Collier et al. 2006}. A number of management measures were implemented in the early 2000s to improve regulation of the pink shrimp fishery in California. In 2001, the pink shrimp trawl fishery was divided into northern (California-Oregon border to Point Conception) and southern regions (Point Conception to the California-Mexico border). The northern region (where the majority of landings occur) is managed as a limited entry fishery. Over 99% of the pink shrimp catch occurred in the northern region from 2001 to 2006, and no landings have been recorded in ports south of Morro Bay since 2003 {Collier et al. 2006}. In 2004, trawling in state waters between 2 to 3 NM from the mainland in northern California was banned despite high regional productivity {Collier et al. 2006}.

Northeast Pacific | Pots | United States | Alaska

Moderately Effective

SEAK and PWS spot prawn and coonstripe commercial fisheries are both limited access fisheries with seasonal closures to protect shrimp during the egg hatch period, pot limits of 150, annual GHLs, and fishery dependent and fishery-independent data collection to evaluate management efficacy. Pot gear used in the spot prawn and coonstripe fisheries must be configured with a large enough mesh size to allow for escape of juvenile shrimp not yet recruited to the fishery. Therefore, retention is relatively high and bycatch is mostly composed of invertebrates and other shrimp species (pers. comm., Bush, ADFG 2017). The Alaska pot fishery employs a number of crucial management measures to regulate the fishery. However, GHLs have been exceeded in both PWS and SEAK in a number of years since 2009. The Alaska pot fishery receives a "moderately effective" rating for management strategy and implementation.

Justification:

Spot prawn and coonstripe shrimp management is based on data collected via fishery landings, dockside sampling, voluntary logbooks, and number of fishery-independent surveys that are conducted annually. In SEAK, recommendations for annual changes in Guideline Harvest Limits (GHLs) of spot prawns are made based on stock status, standardized score and confidence levels, and stock status is rated "poor," "below average," "moderate," or "above average (Smith and Gray 2017) (Table 9)."

Management Unit	Stock Status	Confidence	Std. Score
District 1	Above Average	0.32	0.21
District 2	Above Average	0.36	0.22
Section 3-A	Moderate	0.33	-0.15
Sections 3-B/C	Moderate	0.18	0.00
District 4	Below Average	0.24	-0.46
District 5	Moderate	0.13	0.00
District 6	Above Average	0.42	0.44
District 7	Moderate	0.65	0.16
District 8	Moderate	0.22	0.11
District 9	Poor	0.17	-0.60
District 10	Moderate	0.33	-0.13
Seymour	Below Average	0.18	-0.29
Remainder of District 11	Poor	0.06	-1.00
Tenakee	Above Average	0.32	0.59
Remainder of District 12	CLOSED	0.00	NA
Sections 13-A/B	Moderate	0.18	-0.18
Section 13-C	Poor	0.20	-0.62
District 14	Moderate	0.09	0.00
District 15 East	Moderate	0.15	-0.05
Remainder of District 15	Moderate	0.18	0.00
District 16	Moderate	0.18	0.15

Figure 46: Stock status, confidence information, and standardized scores for the 2016/17 season of the Registration Area A (Southeast Alaska) commercial pot shrimp fishery. Standardized scores are used to compare among districts and range from +1 to -1. The standardized score is calculated as the raw score divided by the total possible score for a given management unit.

In PWS, a stock surplus production model, informed by fishery and survey CPUE data, is used to estimate MSY for spot prawns in the region.

Aside from the Yakutat area (negligible harvests) and the recreational PWS fishery, the Alaska spot prawn and coonstripe fishery is managed as a limited access fishery. The spot prawn fishery has averaged 181 permits, landing 719,631 lb/year from 2003 to 2013 (Smith et al. 2014). Each year there are a number of latent permits in SEAK (~158 in 2013), and these permits are transferable. Should market demand increase for spot prawns, effort may increase in turn. The Yakutat spot prawn fishery is open-access, and additional management measures may be needed should interest in this small fishery increase.

Northeast Pacific | Pots | United States | California

Moderately Effective

The California Department of Fish and Wildlife (CDFW) and California Fish and Game Commission currently manage spot prawn and coonstripe (dock) fisheries in California. The spot prawn fishery is a limited-access fishery with a number of gear requirements and seasonal closures. Retention is high in the spot prawn fishery, since smaller males and juveniles can generally escape the pot gear {Larson and Reilly 2006} {Reilly and Geibel 2002}. Nonetheless, data are lacking in the fishery, and there is no cap on total commercial landings of spot prawns for Tier-1 permit holders and no stock assessment currently.

The coonstripe shrimp fishery in California is a relatively new fishery that developed in 1995 and is small in scale with a relatively high price per pound. The fishery primarily operates out of Crescent City in northern California. The fishery is open access with no pot or catch limits, and there is no logbook requirement. The open season (May 1 to October 31) complements the Dungeness crab season, and the majority of coonstripe landings occur on vessels that target Dungeness crab as well {McVeigh 2008}.

While the spot prawn fishery is limited access, logbooks are not required. Should landings continue to increase it may be necessary to identify a clear reference point for spot prawn stock management and/or evaluate an overall cap on landings. Conversely, management measures are more limited in the open-access coonstripe fishery. Therefore, the spot prawn and coonstripe fisheries in California receive a "moderately effective" rating.

Justification:

The spot prawn fishery has a longstanding history in California, and harvests began in the 1930s in Monterey when spot prawns were caught incidentally in octopus pots {Larson and Reilly 2006}. In response to increasing market demand and fishing effort in the late 1990s, followed by a 21% decline landings in 1999 and studies confirming that bycatch of groundfish was problematic in the trawl fishery, the trawl fishery was closed in 2003. Concurrently, the pot fishery became a limited access fishery with 3 Tiers. Tier-1 permits are transferable and there is no limit on annual landings (500 pot max). Tier-2 permits are non-transferable and there is a limit on annual landings and maximum number of pots used (150 pot max). Tier-3 was developed in 2004 to assist trawl fishermen that had lost fishery access, but it has not been utilized significantly due to the high capital investment needed to buy into the pot fishery {Larson and Reilly 2006}. The spot prawn fishery operates from Central California southward to the Mexico border. North of Point Arguello, the season is open from August 1 to April 30. South of Point Arguello, the season runs from February 1 to October 30. The minimum mesh size for all pots is 7/8 $inch^2$.

While management in the California coonstripe fishery is limited by all standards, a control date of November 1, 2001 has been determined in regulation should interest in the fishery increase {McVeigh 2008}. The number of permits issued for the coonstripe fishery has declined steadily from 59 in 2011 to 34 in 2016. The number of active fishery participants has declined during the same time period as well and averaged 9 participants from 2011 to 2016 (CDFW 2017). Coonstripe shrimp yield a relatively high price per lb, and the open access nature of the fishery could jeopardize localized coonstripe populations should the fishery expand.

Northeast Pacific | Pots | United States | Washington

Highly effective

Washington's spot prawn fishery occurs in two primary regions: Puget Sound and on the coast. Commercial harvests for spot prawn began in Washington in 1992, and a number of regulations are in place to manage both fisheries including the following: seasonal closures, area apportionments, total allowable catch limits, vessel length limitations, and gear and logbook requirements (Wargo et al. 2013) (Childers 2012) (Childers 2016). Management measures are in place to effectively manage the Washington spot prawn stock, and the fishery is rated "highly effective" for management strategy and implementation.

Justification:

The coastal spot prawn season is open March 15 to September 15. It is relatively small in scale and is limited entry. Within season, the total allowable catch (TAC) is 100,000 pounds to each area south and north of 47° N latitude. In 2011, legislation established the spot prawn fishery as a limited entry fishery with eight non-native permits maximum (more permits can be issued if the number of permits issued drops below eight); a vessel length cap to each license; and ownership requirements to prevent further consolidation in the fishery (Wargo et al. 2013). Spot prawns in coastal Washington are managed based on a modified stock assessment in the form of a surplus production model. This model used total catch and total fishing effort from 1997 to 2006 to estimate MSY with standard errors, and is validated by a length structure model analysis by Lowry (2007). Model results suggested TACs in the southern and northern regions close to 100,000 lb, and this was set as the annual TAC in 2008 (Wargo et al. 2013).

The Puget Sound fishery is limited entry and is open June to September each year. Fishers are required to report harvest information daily during the season. The region is divided into 19 sub-regions, and quotas are evaluated annually using logbook and test fishery data. Quotas are fully utilized by the state and Tribal fisheries (Childers 2012). Mesh size requirements are designated such that the pot gear is selective for larger, older shrimp so retention of the target spot prawn is presumably high. ?All pots must include an escape mechanism. Each year landings and CPUE are monitored via required logbooks. The stability of the prawn stock, based on carapace length and consistent landings by year, suggests that research and monitoring have been sufficient to manage this stock despite the lack of updated reference points.

Factor 3.2 - Bycatch Strategy

Eastern Central Pacific | Bottom trawls | United States | California | Ridgeback Shrimp Fishery

Moderately Effective

In the California ridgeback fishery, management measures in place to minimize bycatch include bycatch limits of no more than 1000 lb per trip of any non-groundfish, with no more than 300 lb of any groundfish. Rigid grate fish-excluder devices or bycatch reduction devices (BRDs) are also required for all ridgeback fishery participants to reduce catch of unwanted finfish and ray-finned fish, including north Pacific Hake, groundfish species as well as vulnerable taxa such as shark species, and marine mammals species. Although bycatch of sea turtles and seabirds is presumably low (pers. comm., Coates, CDFW 2017), shrimp trawl gear does not currently include turtle excluder devices (TEDs) or devices specifically designed to reduce seabird bycatch. Additional area/depth closures are in place to protect overfished groundfish stocks (Owens 2006). Bycatch reduction measures do exist; however, data are limited on the efficacy of these measures. The ridgeback trawl fishery receives a "moderately effective" rating.

Justification:

Anecdotal evidence suggests that recent groundfish retention in the ridgeback shrimp trawl fishery may be higher than reported in logbooks and may exceed regulatory limits (pers. comm., Coates, CDFW 2017). There are no historic observer data available for the ridgeback shrimp fishery in southern California, and in response to bycatch and BRD compliance concerns, fishery managers implemented a partial observer program in the fishery for the 2017 season (pers. comm., Coates, CDFW 2017).

Northeast Pacific | Beam trawls | United States | Alaska

Moderately Effective

Bycatch data in the northern and sidestripe shrimp trawl fisheries are limited due to the fact there is no observer coverage for the fleet and almost all bycatch species are discarded at sea, based on landings data (pers. comm., Smith, ADFG 2017). There are mesh size requirements to allow escape of smaller/undesired shrimp species (Smith et al. 2014), and in 2003, bycatch limits for spot prawns and coonstripe shrimp were determined based on historic harvests in the beam trawl fishery. Overall, some measures including gear requirements and bycatch limits for spot and coonstripe shrimp are in place to limit bycatch rates. The efficacy of gear-associated bycatch reduction measures is unknown because of limited catch-at-sea data. Therefore, the shrimp trawl fisheries receive a "moderately effective" rating for bycatch strategy.

Justification:

There are no BRD requirements in the Alaska beam trawl fishery; however, some fishermen do voluntarily place a larger mesh net in front of the cod-end in order to deter debris and vulnerable taxa from interacting with the gear (pers. comm., Smith, ADFG 2017).

Northeast Pacific | Bottom trawls | United States | California | Pink Shrimp Fishery

Highly effective

In 2001, BRDs in the California pink shrimp trawl fishery were required to reduce unwanted bycatch of groundfish {Collier et al. 2006}. BRDs have significantly reduced bycatch of groundfish in the California pink shrimp trawl fishery, and ongoing observer coverage through the WCGOP confirms that bycatch remains low in the fishery. Overall, the use of BRDs has fundamentally shifted bycatch composition from commercially important large fish to smaller fish and invertebrates with little commercial value {Frimodig et al. 2006} (Hannah and Jones 2007). Observer data confirm that bycatch of vulnerable taxa such as sharks, marine mammals, seabirds, and turtles is negligible in the pink shrimp fishery {Somers et al. 2017}. Overall, bycatch levels from 2010 to 2015 averaged 4.9% of total catch on observed sets {Somers et al. 2017}. Ongoing monitoring and research (and collaboration with ODFW and WDFW) towards improving BRD efficacy, coupled with low bycatch rates in California, yield a rating of "highly effective" for bycatch strategy.

Justification:

BRDs have proven highly effective at reducing groundfish bycatch in pink shrimp trawl fisheries along the entire US west coast. In Oregon, BRDs reduced fish bycatch by 66% to 88% with minimal shrimp loss (Hannah and Jones 2007). And in California, incidental groundfish landed in the California pink shrimp trawl fishery declined from 11.5 t in 1998 to less than 0.3 t in 2002, with no marketable groundfish landed in subsequent years (Frimodig et al. 2009). As a percentage of target, bycatch percentages ranged from 32% to 61% of total catch prior to BRDs versus 8% when BRDs were used (Frimodig et al. 2009). Current observer data parallels this downward trend in bycatch, and in 2014 and 2015, bycatch comprised approximately 3% to 4% of total catch in the California pink trawl fishery on observed sets (Somers et al. 2016) (Figure 38).

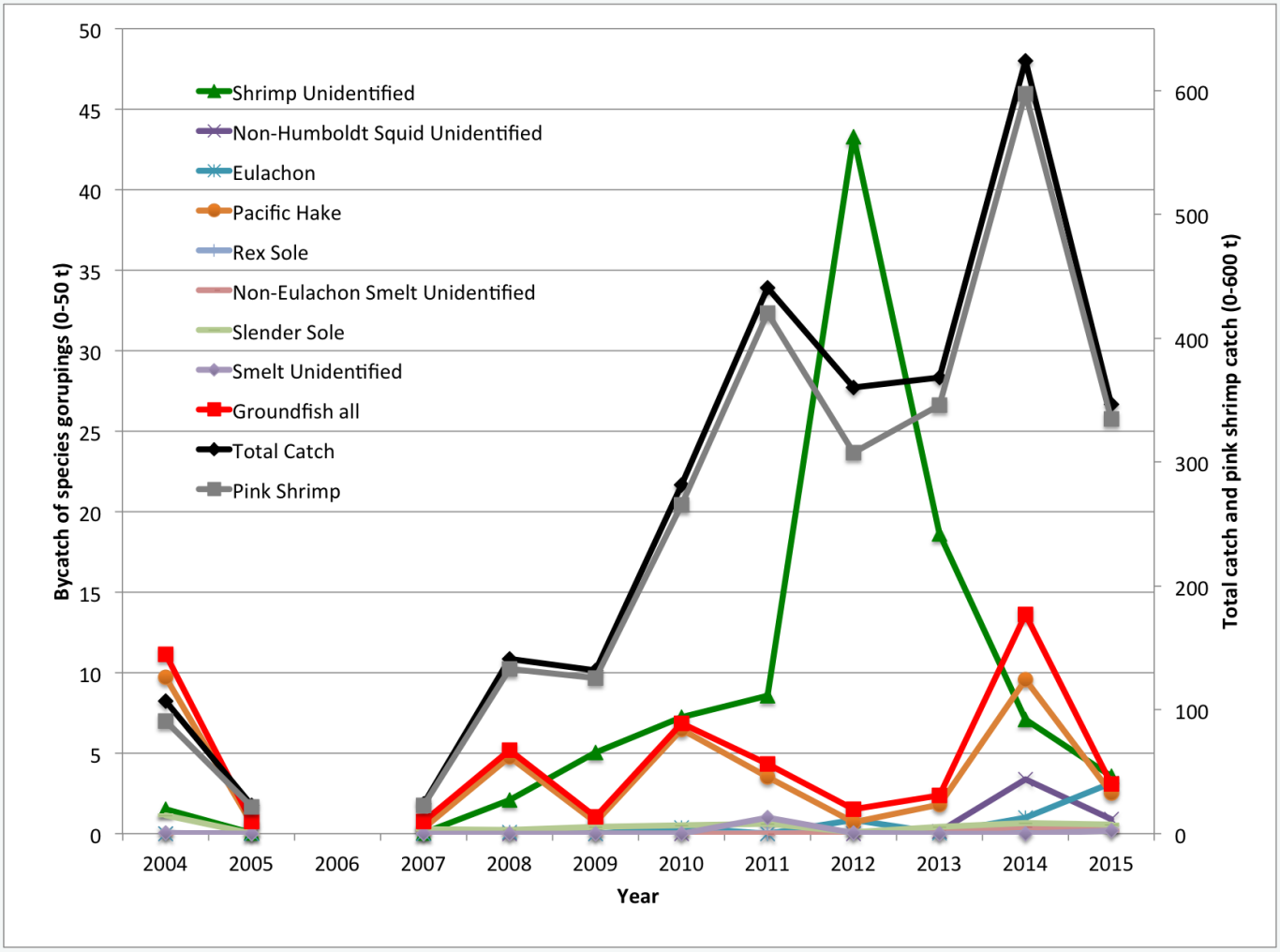

Figure 47: Bycatch by species groupings the California pink shrimp trawl fishery (t, primary Y axis) and total catch and catch of pink shrimp (t, secondary Y axis), 2004-2015. There was no observer coverage in 2006 (Somers et al. 2016).

Pink shrimp trawl vessels are allowed to land up to 500 lb of groundfish per day but not to exceed 1,500 lb per trip; however, since BRDs were required in 2001 in the California fishery, groundfish species are rarely landed (NWFSC 2008). Based on phone survey results in 2007 and 2008, although there are three types of BRDs allowed in California, the majority of California fishermen employ the most effective type of BRD, with rigid-gate excluders (Frimodig et al. 2009)(Figure 39). In accordance with research by ODFW, BRD efficacy could potentially be improved in California if the rigid-gate excluders with ¾ inch bar spacing were required for the entire fleet {Collier et al. 2006}.

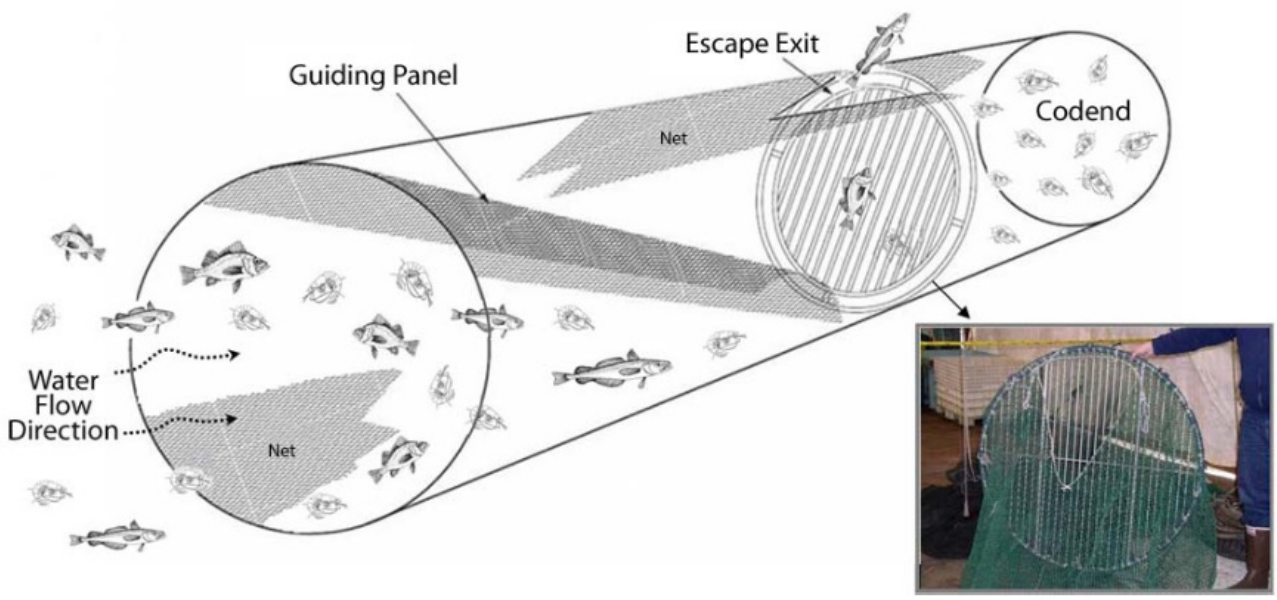

Figure 48: Diagram of a typical rigid-grate BRD used in the pink shrimp trawl fishery. The diagram depicts shrimp traveling through the BRD, and larger fish species deflected by the BRD and guided through the escape exit opening. The inset picture is an actual rigid-grate BRD with 1 1/2 inch bar spacing. Credit: Diagram and inset picture modified from Robert W. Hannah, ODFW (CDFW 2007).

In March 2010, the southern DPS of eulachon, ranging from northern California to British Columbia, were listed as "threatened" under the ESA. Pink shrimp trawl fisheries along the US west coast were deemed a moderate threat to eulachon recovery (Wargo et al. 2016). At that time, the observer program received additional funding to enhance observer coverage in the Washington, California, and Oregon pink shrimp fisheries. The bycatch ratio of eulachon in the observed California pink shrimp fishery is generally lower than in Washington and Oregon (Gustafson et al. 2017) {Figure 40).

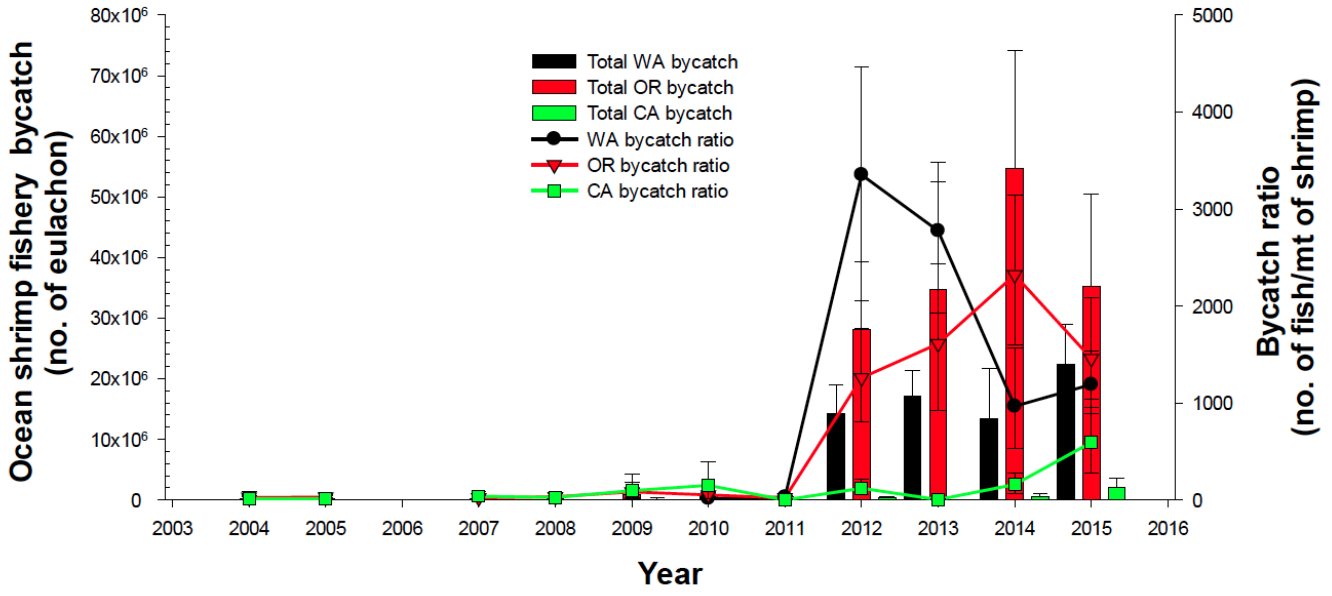

Figure 49: Estimated total bycatch and bycatch ratios of eulachon in the California, Oregon (2004–2015), and Washington (2010–2015) ocean shrimp trawl fisheries. Ocean shrimp fisheries were not observed in 2006 (Gustafson et al. 2017).

In summary, measures to reduce bycatch in California have been successful and monitored through the observer program. Therefore, the California pink shrimp fishery receives a rating of "highly effective" for bycatch strategy.

Northeast Pacific | Pots | United States | Alaska

Moderately Effective

The spot prawn and coonstripe pot fisheries in SEAK and PWS employ a number of measures to minimize bycatch in the fleet, and bycatch rates are likely relatively low based on research conducted in a recent Washington study (~30% bycatch/total catch; mostly composed of mixed invertebrates) (pers. comm., Smith, ADFG 2017) (Wargo et al. 2013) {Love and Bishop 2005). Escape mechanisms are required and hatches must include a biodegradable twine to minimize ghost fishing of lost gear. Pot marking requirements mandate marked buoys on each end of a longline with more than five pots to prevent gear entanglement and loss/ghost fishing in congested fishing areas (Smith et al. 2014). Bycatch or entanglement of marine mammals is a concern in pot fisheries; however, there are no gear requirements specific to minimizing entanglements with marine mammals (pers.comm., Smith, CDFW 2017). The bycatch weight to target shrimp weight ratio likely exceeds 5% for this fishery, but measures are taken to allow escape of bycatch species and minimize ghost fishing. The efficacy of bycatch reduction measures in the Alaska pot fishery is unknown due to limited observer coverage; therefore, the Alaska pot fishery receives a "moderately effective" rating for bycatch strategy.

Northeast Pacific | Pots | United States | California

Moderately Effective

The California spot prawn and coonstripe fisheries employ a number of measures to minimize bycatch and ghost fishing. The spot prawn fishery includes a mesh size requirement to avoid unwanted shrimp species. Pots in both fisheries are required to have an escape mechanism and a destructive device (degradable twine) should the gear become lost. Additionally, there is California legislation in place that prohibits abandoning pot gear. However, the efficacy of these measures is unknown as both fisheries are unobserved at this time. Therefore, the spot prawn and coonstripe shrimp fisheries in California receive a "moderately effective" rating for bycatch strategy.

Justification:

A 2002 California study found that the ratio of total pot bycatch (invertebrates, finfish and rockfish) to spot prawn catch was 1/1 in northern California and 2/1 in southern California. While the bycatch/target species ratio is relatively high overall, all bycatch is required to be discarded and most invertebrates and finfish can be returned to the water alive {Reilly & Geibel 2002}

Due to limited capacity, there are no ongoing management efforts to tag or remove lost fishing gear (pers. comm., Coates, CDFW 2017. However, a recent industry-funded program in northern California recovered and recycled lost pot gear in the Crescent City, Eureka, and Trinidad areas (NOAA Marine Debris Program 2017). Although this program largely targeted Dungeness crab pots, the pot removals can extend into lost shrimp fishing gear as well.

Monitoring for marine mammal interactions with fishing gear is ongoing. Under Section 118 of the MMPA, spot prawn fishermen are required to report any marine mammal interactions with the fishing gear (this includes ESA listed humpback whales that are known to interact with spot prawn fishing gear) (NMFS 2017c). It is important to note that spot prawn fishing gear is often left unattended for periods of time, and the total number of interactions reported may be a conservative estimate of actual interactions (pers. comm., Teerlink, NMFS 2017).

Data on bycatch in the coonstripe fishery are limited because the fishery is not observed and logbooks are not required. Fishermen report bycatch of hermit crabs, snails, juvenile Dungeness and rock crabs, hagfish, juvenile lingcod and rockfish, sculpin, octopus, and small unidentified shrimp {McVeigh 2008}. Pots are generally a tapered circular pot with ½ $inch^2$ cord mesh to allow non-target shrimp to escape.

Northeast Pacific | Pots | United States | Washington

Moderately Effective

From 2003 to 2007, over 3,000 pot-lifts were monitored by on-board observers to estimate bycatch in the Washington spot prawn fishery, and bycatch was found to account for approximately 30% of total catch (Wargo et al. 2013). There has been no observer coverage since 2007. All pot fishing gear in Washington is required to include an escape mechanism including biodegradable twine or fibers to prevent ghost fishing. Trap loss from commercial fishers in Washington is thought to be extremely low (Antonelis et al. 2018). Therefore, the fishery receives a rating of "moderately effective" for bycatch strategy.

Justification:

Spot shrimp in Washington were historically fished with both trawl gear and pot gear. However, due to high bycatch rates (approximately 80% bycatch/total landings) of groundfish, especially rockfish, trawl fishing gear was banned in Washington in 2003. This management measure dramatically reduced bycatch rates in the spot shrimp fishery (Wargo et al. 2013).

Factor 3.3 - Scientific Research And Monitoring

Eastern Central Pacific | Bottom trawls | United States | California | Ridgeback Shrimp Fishery

Moderately Effective
Since the inception of the fishery in 1967, California has required that all ridgeback trawl participants complete logbooks to assess trends in CPUE over time as a proxy for ridgeback stock status. There are no fishery-independent data collected to assess the ridgeback stock, but two indicators of exploitation are monitored: yield per unit area and CPUE (Ocean Protection Council 2019). The fishery has been included in the West Coast Groundfish Observer Program since 2017 (ibid). Some data is collected and analyzed, and the fishery is monitored by on-board observers, but there is no formal stock assessment. Therefore, the ridgeback trawl fishery receives a "moderately effective" rating.

Northeast Pacific | Beam trawls | United States | Alaska

Moderately Effective
The Alaska northern and sidestripe shrimp trawl fisheries are monitored via reported landings and fish ticket data, but the fishery lacks stock assessment surveys (Smith and Gray 2017). Dockside sampling provide additional information, and data gathered include size frequency, sex, fishing location (Smith et al. 2014). Previously, Smith and Gray (2017) noted that without reliable effort data, basic fishery metrics (i.e. CPUE) cannot be measured (Smith and Gray 2017). There are no recent fishery-independent trawl surveys for the northern and sidestripe shrimp in SEAK, but the Board of Fisheries began requiring logbooks in 2018 to cover all shrimp beam trawl fishing areas (ADFG 2018). This data will allow ADFG to track trends in CPUE and improve management of the fishery (ADFG 2017) and inform harvest level decisions (J. Stratman, ADFG, personal communication 2021). The beam trawl fishery does not have mandatory observer coverage, but managers observe the fishery opportunistically; additionally, port sampling staff record bycatch during dockside interviews (J. Stratman, ADFG, personal communication 2021).

There is data analyzed to monitor stock health and develop harvest recommendations, some level of bycatch monitoring exists, but data is not sufficient to meet the 'highly' effective strategy. Therefore, a "moderately" effective score is awarded.

Northeast Pacific | Bottom trawls | United States | California | Pink Shrimp Fishery

Moderately Effective
Both the Oregon and Washington pink shrimp fisheries are MSC certified, and substantial research into catch composition, bycatch avoidance, and shrimp life history have occurred towards that end in the last decade. Because pink shrimp off the west coast of the United States are assumed to be one genetic stock {Collier et al. 2006}, research from Washington and Oregon can be used to inform California fishery management and science programs.

While California is not leading the majority of current pink shrimp research projects, collaborations between fishery researchers and managers along the west coast of the US supports effective research and monitoring in each state. Partial observer coverage in California supports in-season catch accounting and monitoring. California is lacking data on pink shrimp stock status to date and receives "moderately effective" for research and monitoring.
Justification:
A recent study from ODFW used quantitative modeling approaches to evaluate environmental and gear parameters that may influence bycatch rates of eulachon, rockfish and flatfish. The research suggested that a bar-spacing of 0.875 inches was associated with the lowest bycatch ratios. Additionally, bycatch ratios tended to be higher in spring and lower in the fall (Table 10) (Wargo et al. 2016).

	State observed								State fleetwide				
Year	Bycatch (kg of eulachon)	Bycatch (no. of eulachon)	Observed ocean shrimp catch (mt)	Bycatch ratio (kg per mt of ocean shrimp)	95% CI	Bycatch ratio (no. per mt of ocean shrimp)	95% CI	Percent landings observed	Fleet ocean shrimp landings (mt)	Bycatch estimate (kg eulachon)	95% CI	Bycatch estimate (no. of eulachon)	95% CI
2004	*	*	*	0.3	0.1 0.7	11.5	0.0 40.6	*	996.8	311.1	108.9 711.6	11,442	351 40,431
2005	*	*	*	0.3	0.0 0.5	11.4	0.0 40.7	*	860.6	225.9	25.1 404.7	9,848	0 35,051
2006	--	--	--	--	-- --	--	-- --	--	63.6	--	-- --	--	-- --
2007	*	*	*	0.6	0.3 0.9	39.6	0.0 86.3	*	289.1	168.4	86.8 272.0	11,450	978 24,943
2008	*	*	*	0.3	0.0 0.5	26.2	0.0 66.0	*	945.5	251.5	82.9 517.8	24,793	5,908 62,402
2009	*	*	*	0.6	0.3 1.2	96.2	16.0 270.3	*	1,183.5	740.6	405.2 1,399.5	113,815	18,953 319,844
2010	367.9	40,040	265.5	1.4	0.4 2.2	150.8	16.0 396.7	15.0	1,771.0	2,454.0	718.6 3,927.1	267,057	40,040 702,623
2011	3.7	59	420.6	0.0	0.0 0.0	0.1	0.1 0.2	12.6	3,333.0	29.6	15.2 33.0	471	198 827
2012	857.2	42,018	347.6	2.5	1.4 5.3	120.9	53.3 217.2	12.5	2,790.7	6,882.0	4,023.3 14,793.4	337,344	148,647 606,034
2013	65.8	1,533	359.8	0.2	0.1 0.3	4.3	1.0 8.7	9.2	3,915.4	715.9	221.5 1,295.2	16,684	3,816 33,998
2014	1,020.2	94,976	597.5	1.7	0.8 2.4	158.9	62.8 276.7	15.5	3,845.0	6,564.9	2,901.4 9,327.7	611,152	241,491 1,063,825
2015	3,134.5	198,759	334.7	9.4	5.9 14.7	593.9	278.0 1,033.0	9.7	3,453.0	32,341.9	20,503.8 50,622.0	2,050,791	960,061 3,567,063

Figure 50: Numbers and weight of eulachon observed and bycatch ratios from ocean shrimp trawl vessels that landed their catch in California (2010–2015). Bycatch ratios were calculated for each year by dividing the observed catch of eulachon (in numbers of eulachon and in kg of eulachon) by the observed weight (in mt) of retained ocean shrimp. A fleet-wide bycatch estimate (in both weight and number of fish) was obtained by multiplying the bycatch ratios by fleet-wide ocean shrimp landings. 95% bootstrapped confidence intervals (CI) are provided for the estimates. Asterisks (*) signify strata with fewer than three observed vessels (Gustafson et al. 2017).

Recent research through ODFW demonstrates that the use of LED lights on the fishing line of the footrope further reduces bycatch of eulachon by as much as 90% (Figure 43, 44) (Hannah et al. 2015) (ODFW 2017). California fishery managers are collaborating with researchers from ODFW on this work and are likely to propose legislation requiring LED lights in the California fishery by 2018 or 2019 (pers. comm., Coates, CDFW 2017).

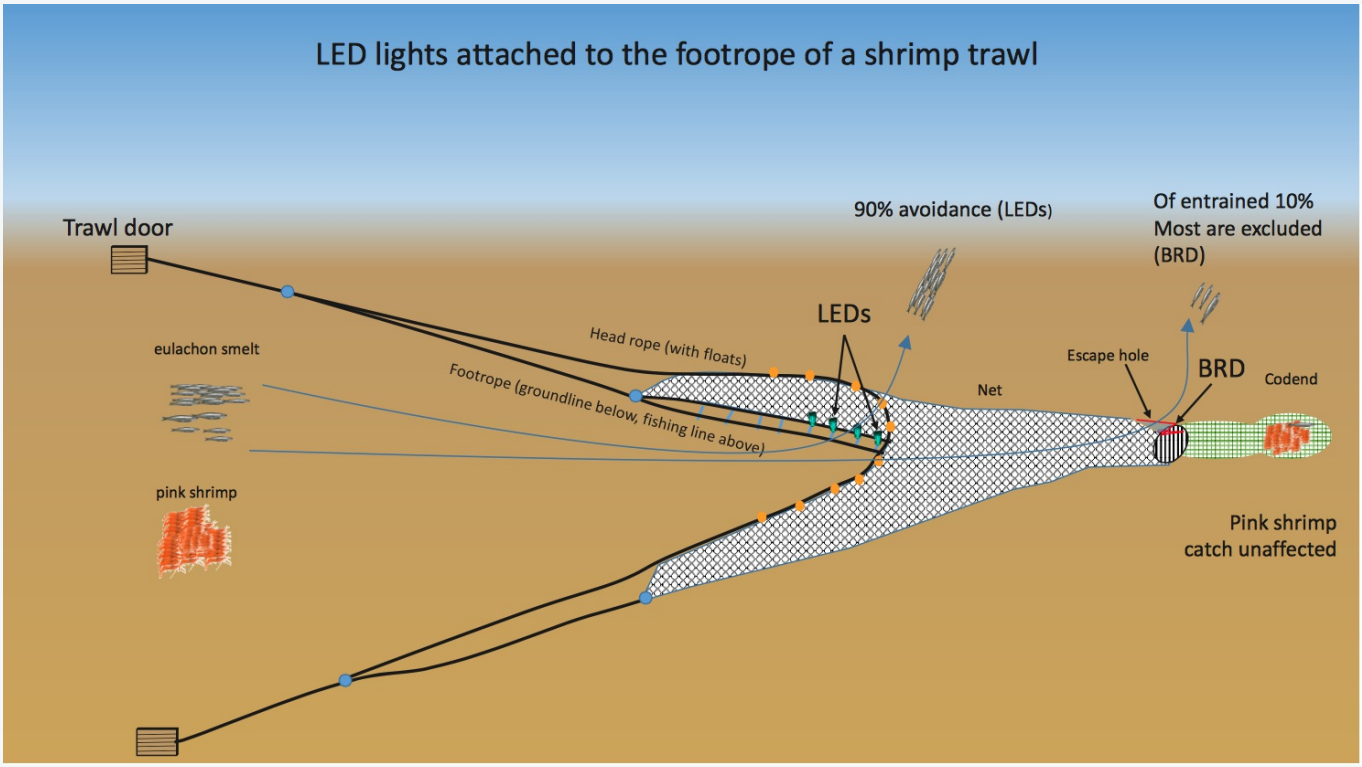

Figure 51: Schematic of modern pink shrimp trawl net, illustrating the exclusion of eulachon smelt by LEDs and BRD (ODFW 2017)

Figure 52: A divided shrimp hopper where no LEDs were used on the left side and LEDs were used on the right side, notice the marked difference in eulachon smelt (the silver fish)(ODFW 2017).

Northeast Pacific | Pots | United States | Alaska

Moderately Effective

Monitoring in the Alaska spot prawn and coonstripe shrimp pot fishery occurs at a number of fishery dependent and independent levels. Reported landings, estimated fishery and survey CPUE data inform annual stock assessments. Dockside sampling and voluntary logbooks provide additional monitoring information. Unique pot identification requirements enable fishery managers to identify lost or ghost fishing gear (Smith et al. 2014). Although there are no specific programs to monitor lost gear, shrimp pot gear is relatively to easy to retrieve and suspected lost gear rates are quite low (pers. comm., Smith, ADFG 2017). Onboard sampling occurs annually and onboard observing has occurred in some years (Smith and Gray 2017). Although management assesses spot prawn stocks, there is little data on the magnitude of non-commercial harvest--which introduces uncertainty in the stock assessment--and the fishery is not regularly observed (Smith and Gray 2017). Therefore, Alaska spot prawn and coonstripe shrimp receive a "moderately effective" rating for research and monitoring.

Justification:

Since 1996, directed pot shrimp surveys have been conducted annually in a number of SEAK sub-areas. The objectives of these surveys were to obtain information on shrimp abundance and life history, define pot selectivity, and eventually develop a survey-based index of abundance for both spot and coonstripe shrimp (Smith et al. 2014). Current research aims to develop a biologically based index of abundance for spot prawn in SEAK that would be used to more accurately determine GHLs and associated confidence intervals for sustainable harvests (Smith et al. 2014). In PWS, directed shrimp surveys have been conducted annually since 1992. These surveys are designed to estimate standardized CPUE and sex ratios, in addition to collecting more basic life history information for spot prawns and coonstripe shrimp (Figure 41) (Wessel et al. 2015)

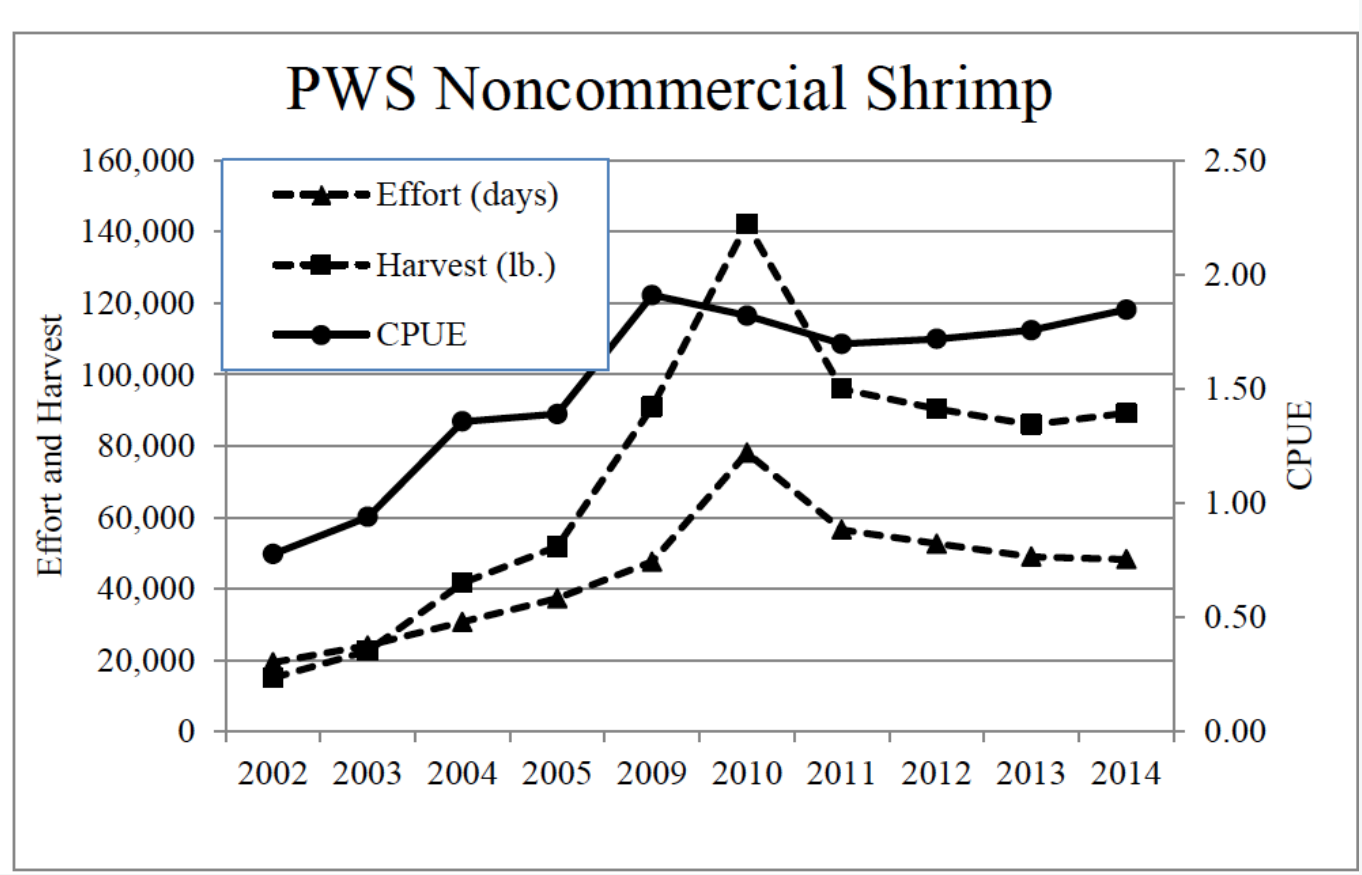

Figure 53: Total estimated harvest, effort, and catch per unit effort (lb of whole shrimp caught in 1 pot soaked for 24 hr; CPUE) in the noncommercial pot shrimp fishery of Prince William Sound (Wessel et al. 2015).

Northeast Pacific | Pots | United States | California

Moderately Effective
The California spot prawn fishery is a limited entry fishery with voluntary logbooks and mandatory landing receipts to track landings and CPUE over time. These data are used as reference points to manage the stock and fishery. Little additional fishery dependent or fishery-independent research has been conducted beyond the 2002 study that evaluated bycatch in the pot and trawl spot prawn fisheries.

The coonstripe fishery is open access and has no pot or catch limits and no logbook reporting requirements. Landings data are collected via landings receipts and can be used as a proxy to estimate coonstripe CPUE (weight of shrimp per trip; pers. comm., Coates, CDFW 2017). CPUE data are used as reference points to manage the stock and fishery. There are no fishery-independent studies specific to coonstripe shrimp.

There is no stock assessment for either spot prawns or coonstripe shrimp; however, there is monitoring of landings and effort in both fisheries; therefore, they receive a rating of "moderately effective."

Northeast Pacific | Pots | United States | Washington

Moderately Effective
There have been a number of fishery dependent and fishery-independent measures to evaluate the stock status of spot prawns in Washington. A portion of spot prawn catch is annually sampled dockside to determine ovigery (egg-bearing periods) and size composition data. Also, carapace lengths were investigated using trawl data and pot gear 2003 to 2009. From 2003 to 2007, over 3,000 pot-lifts were monitored by on-board observers to estimate bycatch in the fishery, and bycatch was found to account for approximately 30% of total catch (Figure 45,Table 11). Each year, landings and CPUE are monitored via required logbooks. Lost fishing gear is also tracked via logbook reporting requirements {pers. comm., Ayres, WDFW 2017}. The stability of the prawn stock suggests that research and monitoring have been sufficient to manage this stock despite the lack of updated reference points and no observer coverage since 2007. The fishery, therefore, receives a rating of "moderately effective."
Justification:

Figure 54: Example of pot fishery bycatch composed largely of invertebrates (Wargo et al. 2013).

Observed Trip Number - pot gear	1	2	3	4	5	6
Month-Year	April-03	June-03	April-04	June-06	April-07	August-07
No. of Pot lifts observed	804	279	300	178	1248	250
Total Spot Shrimp catch (pounds)	1245	445	295	137	2620	227
Total Bycatch (pounds)	978	173	381	5	971	71
Fish	42	30	46	0	15	3
Invertebrates	818	128	325	5	706	59
Percent spot shrimp (total spot shrimp/total catch)	56%	72%	44%	97%	73%	76%
Bycatch by species/species group (pounds)						
Canary Rockfish	-	-	-	-	-	0.1
Crab sp.	5.9	17.3	24.1	1.5	26.6	1.5
Hagfish sp.	18.2	23.4	42.1	-	15.0	-
Jellyfish sp.	-	0.2	-	-	-	-
Kelp Greenling	-	5.0	0.6	-	-	-
Lingcod	-	-	-	-	-	2.4
Octopus sp.	30.7	0.7	5.0	0.0	1.5	1.5
Pacific Cod	3.1	-	-	-	-	-
Poacher sp.	0.2	-	0.3	-	-	-
Rat fish	2.0					
Red banded Rockfish	0.5	0.2	0.7	-	0.2	0.2
Rockfish sp.	0.2	0.4	1.6	-	-	-
Rosethorn Rockfish	1.3	0.8	0.5	0.1	-	0.4
Sablefish	16.5	-	-	-	-	-
Sculpin sp.	11.7	11.7	32.5	0.0	4.7	0.8
Sea Stars sp.	130.3	75.0	201.0	3.2	323.4	34.7
Snail sp.	117.7	14.9	10.4	-	250.5	8.2
Urchin sp.	639.4	23.3	62.6		349.6	20.7
Bycatch of fish by species/species group (count)						
Canary Rockfish	-	-	-	-	-	1
Hagfish sp.	46	59	105	-	38	
Kelp greenling	-	10	1	-	-	-
Lingcod	-	-	-	-	-	1
Pacific cod	1	-	-	-	-	-
Poacher sp.	1		1			
Rat fish	2					
Red banded Rockfish	5		8		2	2
Rockfish sp.	1	4	4		0	0
Rosethorn Rockfish	10	6	4	1	0	3
Sablefish	6	-				
Sculpin sp.	37	34	79		11	4
Splitnose Rockfish	-	-	4	-	-	-

Figure 55: At-sea observations of the coastal spot shrimp pot fishery, 2003-2007 (Wargo et al. 2013).

Factor 3.4 - Enforcement Of Management Regulations

Eastern Central Pacific | Bottom trawls | United States | California | Ridgeback Shrimp Fishery

Moderately Effective

State enforcement personnel including police officers, marine patrol officers, wildlife officers, park rangers, and US Coast Guard officers carry out general enforcement in the ridgeback shrimp trawl fishery (CDFW 2017a). There are concerns about unreported groundfish retention in the ridgeback shrimp trawl fleet, and the fishery therefore receives a "moderately effective" rating for enforcement of management regulations (pers. comm., Coates, CDFW 2017).

Northeast Pacific | Beam trawls | United States | Alaska

Highly effective
ADF&G manages shrimp trawl fisheries across the state. ADF&G enforces regulations through permits, area, and landing requirements. Voluntary measures, such as dockside sampling and monitoring on the fishing grounds are fully complied with by the fleet (pers. comm., Smith, ADFG 2017). ADF&G routinely receives input, questions, and potential violation information from the public. Additional enforcement duties fall within the purview of the Alaska State Troopers and US Coast Guard. Comprehensive regulations and enforcement in Alaska result in a "highly effective" rating for the shrimp trawl fishery in Alaska.

Northeast Pacific | Bottom trawls | United States | California | Pink Shrimp Fishery

Highly effective
State enforcement personnel include police officers, marine patrol officers, wildlife officers, park rangers, and US Coast Guard officers to carry out general enforcement (CDFW 2017a). A number of state and federal agencies provide effective enforcement for the California pink shrimp trawl fishery, and it receives a rating of "highly effective" for enforcement.

Northeast Pacific | Pots | United States | Alaska

Highly effective
The Alaska Department of Fish and Game (ADF&G) manages shrimp pot fisheries across the state. ADF&G enforces regulations through permits, area, and landing requirements. Voluntary measures, such as dockside sampling and monitoring on the fishing grounds are fully complied with by the fleet (pers. comm., Smith, ADFG 2017). ADF&G routinely receives input, questions, and potential violation information from the public. Additional enforcement duties fall within the purview of the Alaska State Troopers and US Coast Guard. Comprehensive regulations and enforcement in Alaska result in a rating of "highly effective."

Northeast Pacific | Pots | United States | California

Moderately Effective
State enforcement personnel including police officers, marine patrol officers, wildlife officers, park rangers, and US Coast Guard officers carry out general enforcement (CDFW 2017a). There is minimal in-season management and regulation in this fishery; therefore, it receives a rating of "moderately effective" for enforcement of management regulations.

Northeast Pacific | Pots | United States | Washington

Highly effective
Enforcement personnel that carry out general marine enforcement include Washington Fish and Wildlife Police, NOAA Law Enforcement, other general authority police officers acting within their jurisdiction, and the US Coast Guard (pers. comm., Chadwick, WDFW police 2017). A number of state and federal agencies support the regulation of the Washington spot prawn fishery, and it receives a score of "highly effective" for enforcement of management regulations.

Factor 3.5 - Stakeholder Inclusion

Eastern Central Pacific | Bottom trawls | United States | California | Ridgeback Shrimp Fishery

Highly effective
The ridgeback trawl fishery in California is managed by the California Department of Fish and Wildlife in concert with the California Fish and Game Commission. California Fish and Game Commission meetings are held every other month and fishermen and the general public are invited to provide comment, testify, propose research programs, and management actions. Appropriate and transparent management processes are in place, and stakeholder input is included in the regulation process. Therefore, the ridgeback trawl fishery receives a "highly effective" rating for the stakeholder inclusion criterion.

Northeast Pacific | Bottom trawls | United States | California | Pink Shrimp Fishery

Highly effective
The pink shrimp fishery in California is managed by the California Department of Fish and Wildlife in conjunction with the California Fish and Game Commission. The Commission meetings are conducted throughout the year; fishermen and the general public are invited to provide comment, testify, and propose research programs and management actions. Stakeholder involvement in the management process yields a rating of "highly effective" for the California pink shrimp trawl fishery.

Northeast Pacific | Pots | United States | Alaska
Northeast Pacific | Beam trawls | United States | Alaska

Highly effective
The Alaska Board of Fisheries meets numerous times throughout the year across various regions in Alaska. Stakeholder participation, testimony, and recommendations are a key component of these management strategy meetings. There are regional advisory committees, often composed of fishermen and community stakeholders, that also inform the shrimp management process in Alaska. ADF&G managers maintain an open-door policy with fishermen and processors, and communication with the fleet is ongoing in-season (pers. comm., Smith, ADFG 2017). The ADF&G management process is inclusive of stakeholders; therefore, the shrimp fisheries receive a rating of “highly effective” for this criterion.

Northeast Pacific | Pots | United States | California

Highly effective
The spot prawn and coonstripe shrimp pot fisheries in California are managed by the California Department of Fish and Wildlife in concert with the California Fish and Game Commission. California Fish and Game Commission meetings are conducted each year; fishermen and the general public are invited to provide comment, testify, and propose research programs and management actions. This high degree of stakeholder inclusion supports a rating of "highly effective" for California pot fisheries.

Northeast Pacific | Pots | United States | Washington

Highly effective

The coastal spot prawn pot fishery in Washington is managed by the Washington Department of Fish and Wildlife (WDFW). WDFW meetings are conducted each year; fishermen and the general public are invited to provide comment, testify, and propose research programs and management actions. The Puget Sound regional fishery is managed through a state-tribal management process that includes input from tribal leaders and state managers. Transparent management coupled with stakeholder inclusion in the management process results in a rating of "highly effective" for stakeholder inclusion in the Washington spot prawn fishery.

Criterion 4: Impacts on the Habitat and Ecosystem

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

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

Guiding principles

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

Rating cannot be Critical for Criterion 4.

Criterion 4 Summary

FISHERY	FISHING GEAR ON THE SUBSTRATE	MITIGATION OF GEAR IMPACTS	ECOSYSTEM-BASED FISHERIES MGMT	SCORE
Eastern Central Pacific | Bottom trawls | United States | California | Ridgeback Shrimp Fishery	2	+.5	Low Concern	**Yellow (3.162)**
Northeast Pacific | Beam trawls | United States | Alaska	2	+.5	Very Low Concern	**Green (3.536)**
Northeast Pacific | Bottom trawls | United States | California | Pink Shrimp Fishery	2	+.5	Low Concern	**Yellow (3.162)**
Northeast Pacific | Pots | United States | Alaska	2	+.5	Very Low Concern	**Green (3.536)**
Northeast Pacific | Pots | United States | California	2	+.5	Low Concern	**Yellow (3.162)**
Northeast Pacific | Pots | United States | Washington	2	+.5	Low Concern	**Yellow (3.162)**

Criterion 4 Assessment

SCORING GUIDELINES

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

- *5 - Fishing gear does not contact the bottom*

- *4 - Vertical line gear*
- *3 - Gears that contacts the bottom, but is not dragged along the bottom (e.g. gillnet, bottom longline, trap) and is not fished on sensitive habitats. Or bottom seine on resilient mud/sand habitats. Or midwater trawl that is known to contact bottom occasionally. Or purse seine known to commonly contact the bottom.*
- *2 - Bottom dragging gears (dredge, trawl) fished on resilient mud/sand habitats. Or gillnet, trap, or bottom longline fished on sensitive boulder or coral reef habitat. Or bottom seine except on mud/sand. Or there is known trampling of coral reef habitat.*
- *1 - Hydraulic clam dredge. Or dredge or trawl gear fished on moderately sensitive habitats (e.g., cobble or boulder)*
- *0 - Dredge or trawl fished on biogenic habitat, (e.g., deep-sea corals, eelgrass and maerl)*
  Note: When multiple habitat types are commonly encountered, and/or the habitat classification is uncertain, the score will be based on the most sensitive, plausible habitat type.

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

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

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

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

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

Eastern Central Pacific | Bottom trawls | United States | California | Ridgeback Shrimp Fishery

2
The ridgeback shrimp trawl fishery in Southern California occurs over soft-bottom habitat composed of green mud, shell and sand; therefore, it receives a score of 2 based on the 2017 Seafood Watch standard.

Northeast Pacific | Beam trawls | United States | Alaska

2
The fishery occurs over soft bottom and muddy substrates. The northern and sidestripe shrimp fisheries typically employ beam trawls, which are unable to access rocky habitat and are specifically designed for soft bottom habitat (Smith et al. 2014). The fishery receives a score of 2 for the physical impact of fishing gear on the seafloor based on the 2017 Seafood Watch standard.

Northeast Pacific | Bottom trawls | United States | California | Pink Shrimp Fishery

2
This fishery employs trawl vessels that are double-rigged with high-rise box trawls that are used over soft and muddy substrate {Collier et al. 2006}. Bottom trawling on this type of substrate is considered, in the 2017 Seafood Watch criteria, to have a "moderate-to-severe" impact. Although shrimp trawl gear generally fishes slightly off the seafloor, there is documentation of some deleterious effects of the fishing gear on the benthic habitat and biota. Therefore, the fishery receives a score of 2 for the physical impact of fishing gear on the seafloor.
Justification:
The only fishery-specific study assessing impacts to seafloor biota was conducted in four sites at Nehalem Bank off Oregon (Hannah et al 2010). The data indicated 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). ?

Northeast Pacific | Pots | United States | Alaska

2
The fishery occurs over rocky, biogenic habitat including reefs and corals (Smith et al. 2014) and receives a score of 2 based on 2017 Seafood Watch criteria.

Northeast Pacific | Pots | United States | California
Northeast Pacific | Pots | United States | Washington

2
The spot prawn pot fishery occurs over rocky or hard bottoms that include glass-sponge reefs, coral beds, and edges of canyons (Wargo et al. 2013). The coonstripe pot fishery occurs over muddy seafloor, and habitat damage is considered minimal in this fishery {McVeigh 2009}. Overall, the shrimp pot fisheries in California and Washington receive a score of 2 because spot prawn pots come into contact with vulnerable rocky substrates.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

Eastern Central Pacific | Bottom trawls | United States | California | Ridgeback Shrimp Fishery

+.5

The ridgeback fishery is subject to similar restrictions as the pink shrimp trawl fishery, including regional Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (HAPC) closures associated with conservation of groundfish stocks. However, the ridgeback fishery employs a single-rig shrimp trawl net with small mesh size, which may have a greater impact on the seafloor than the pelagic box trawl (Owens 2006) {Hannah 2010}. Some state and federal management measures are in place to reduce fishing effort over a portion of the seafloor where the fishery operated historically. Amendment 28 to the Pacific Coast Groundfish Fishery Management Plan became effective on January 1, 2020; among other things, the rule closed over 12,000 square miles of the exclusive economic zone (EEZ) to bottom trawl gear (NOAA 2019). As a result of Amendment 28 and other measures, approximately 90% of the waters in the West Coast EEZ are closed to bottom trawl fishing, there is a freeze on the bottom trawl footprint, and sensitive habitats are protected (Shester et al. 2021). It's estimated that 71% of the combined EEZ area off Alaska, British Columbia, and the U.S. West Coast is now closed to bottom trawling (Shester et al. 2021). For these reasons, a mitigation credit of +0.5 is given.

Northeast Pacific | Beam trawls | United States | Alaska

+.5

Historically, productive shrimp fishing grounds that are now closed to bottom trawling occur in the Kodiak, Chignik and South Peninsula districts (ADFG 2017). 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) {Bolt & Zador 2010} {Witherell and Woodby 2005} (Figure 47). Therefore, a significant portion of the representative habitat is protected. The shrimp trawl fisheries in Alaska are effectively mitigating the effects of fishing gear on benthic systems and receive a +0.5 based on the Seafood Watch Criteria.

Justification:

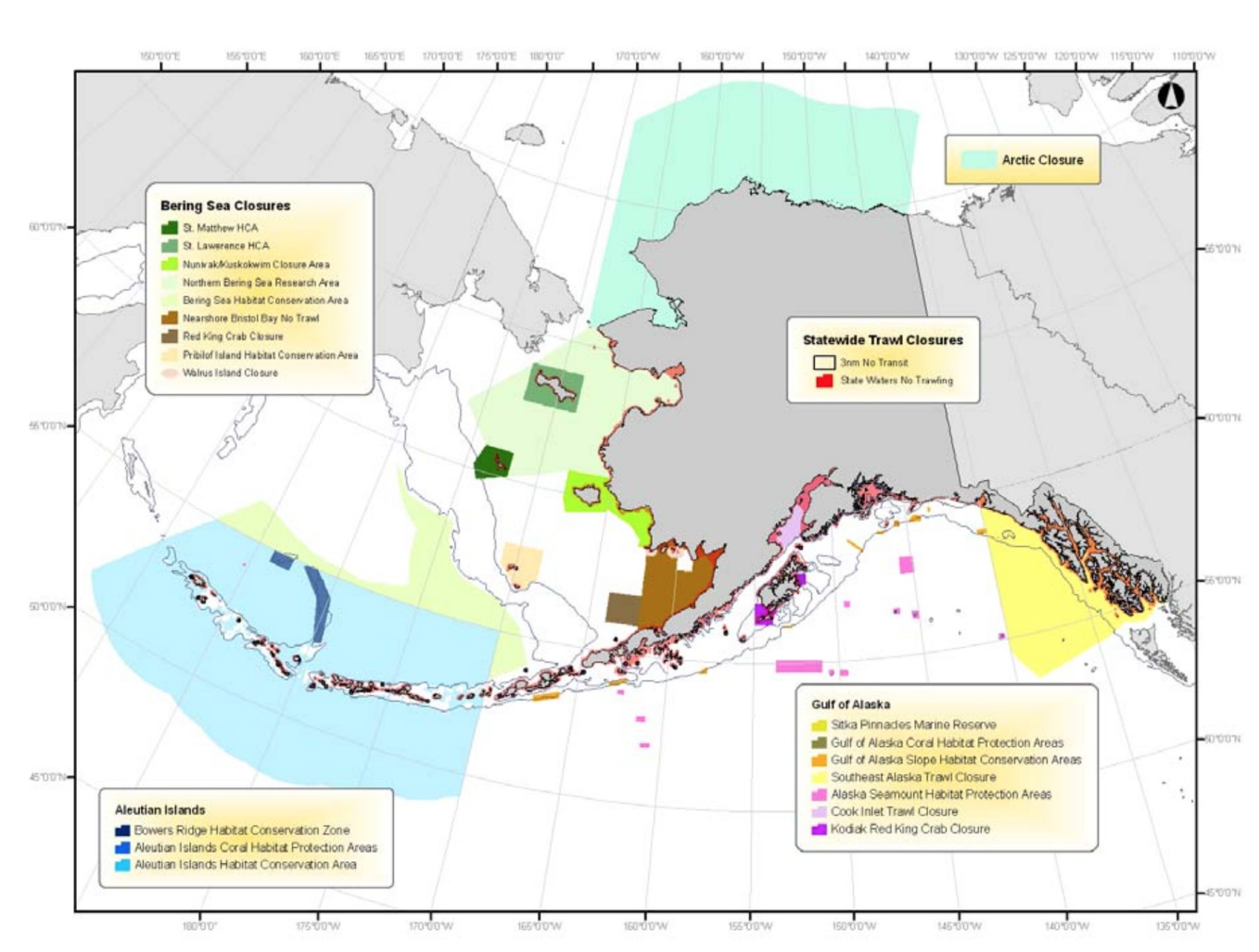

Figure 56: Year-round groundfish closures in the U.S. Exclusive Economic Zone (EEZ) off Alaska (Bolt & Zador 2009).

Northeast Pacific | Bottom trawls | United States | California | Pink Shrimp Fishery

+.5

The combination of gear modifications, limited access effort restrictions, closures in federal waters through EFH and HAPC designations, and a ban on bottom trawling in the majority of California state waters demonstrate significant effort to mitigate fishing gear impacts on the seafloor. The fishery therefore receives a +0.5 based on the Seafood Watch Criteria.

Justification:
The gear used to catch pink shrimp is a semi-pelagic box trawl {Collier et al. 2006} 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).

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 48). The states have also closed areas where groundfish EFH has been identified. California prohibits bottom trawling in most state waters.

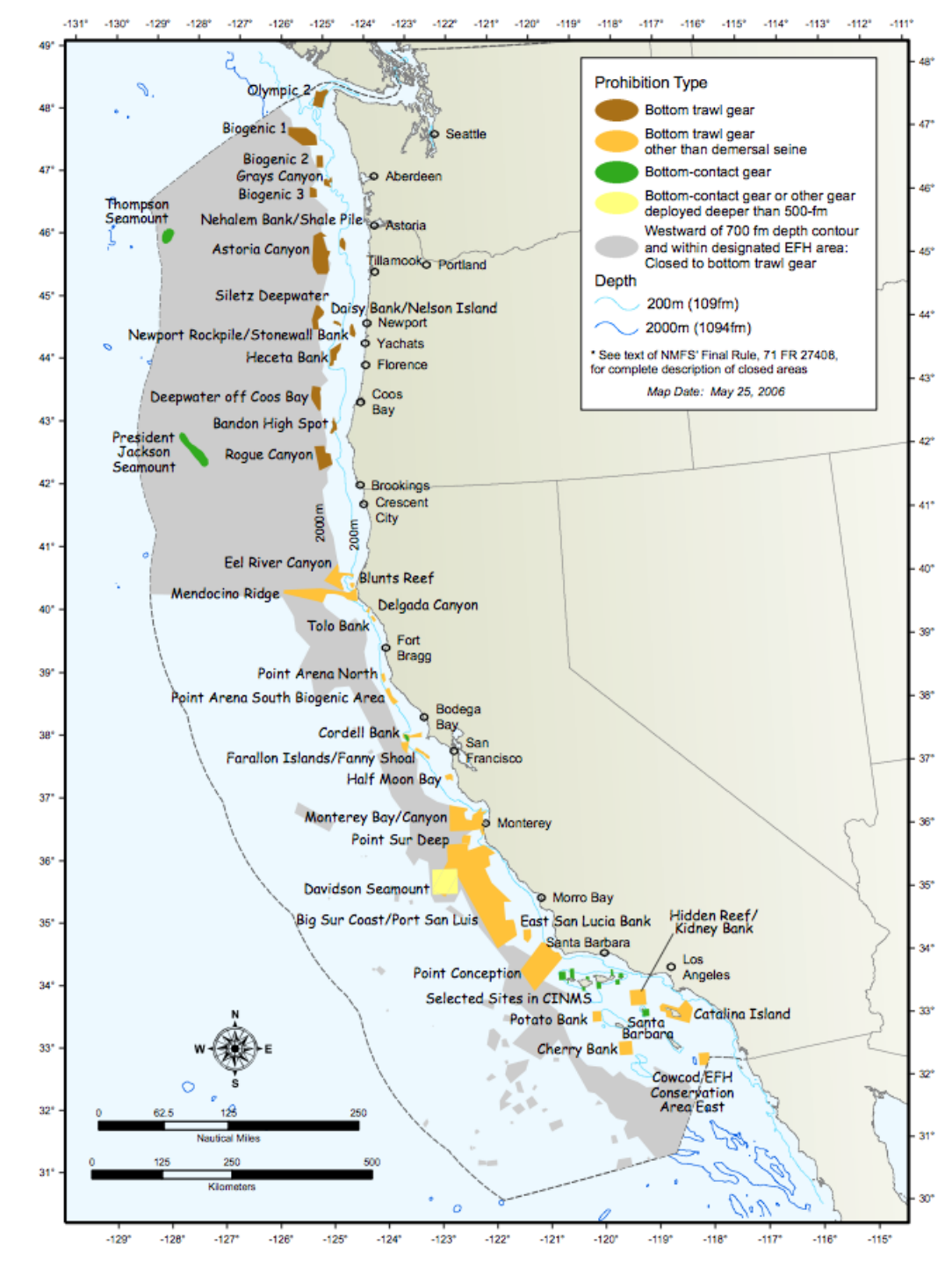

Figure 57: Essential Fish Habitat (EFH) area closures to protect Pacific Coast groundfish habitat coastwide (NOAA West Coast Region 2017).

Northeast Pacific | Pots | United States | Alaska

+.5

State water closures to commercial fishery harvests have been enacted by the Alaska Board of Fisheries for research purposes and to conserve target fish and shrimp stocks, protect habitats, reduce bycatch, and provide subsistence and recreational harvest opportunities. These closures are enacted through regulations governing invertebrate dive fisheries, scallop dredge fisheries, crab pot fisheries, shrimp pot fisheries, and various groundfish fisheries {Witherell and Woodby 2005}. Overall, there are fewer regulations in place to minimize the effects of shrimp pot fisheries on habitats as compared to shrimp trawl fisheries in Alaska. Nonetheless, efforts are being made to mitigate gear impacts on the seafloor, and the Alaska pot fisheries receive a +0.5 based on the Seafood Watch Criteria.

Northeast Pacific | Pots | United States | California
Northeast Pacific | Pots | United States | Washington

+.5

A significant portion of marine zones in Washington and California are closed to pot fishing gear as part of state-managed networks of marine protected areas (MPAs) or reserves, and California and Washington pot fisheries receive a +0.5 based on the Seafood Watch Criteria.

Justification:

In Washington state, there are 127 MPAs managed by 11 federal, state, and local agencies. These conservation sites occur in Puget Sound and on the coast, and cover approximately 644,000 acres and over 6 million feet of shoreline. The median size of an MPA in the state is slightly over 23 acres, although the size ranges from less than 1 acre to over 300,000 acres. MPAs in Washington tend to be focused around the San Juan archipelago, Puget Sound (significant prawn effort) and along the outer coast. A portion of these reserves are no take zones where pot fishing is prohibited (Figure 49, 50) (Van Cleve et al. 2009).

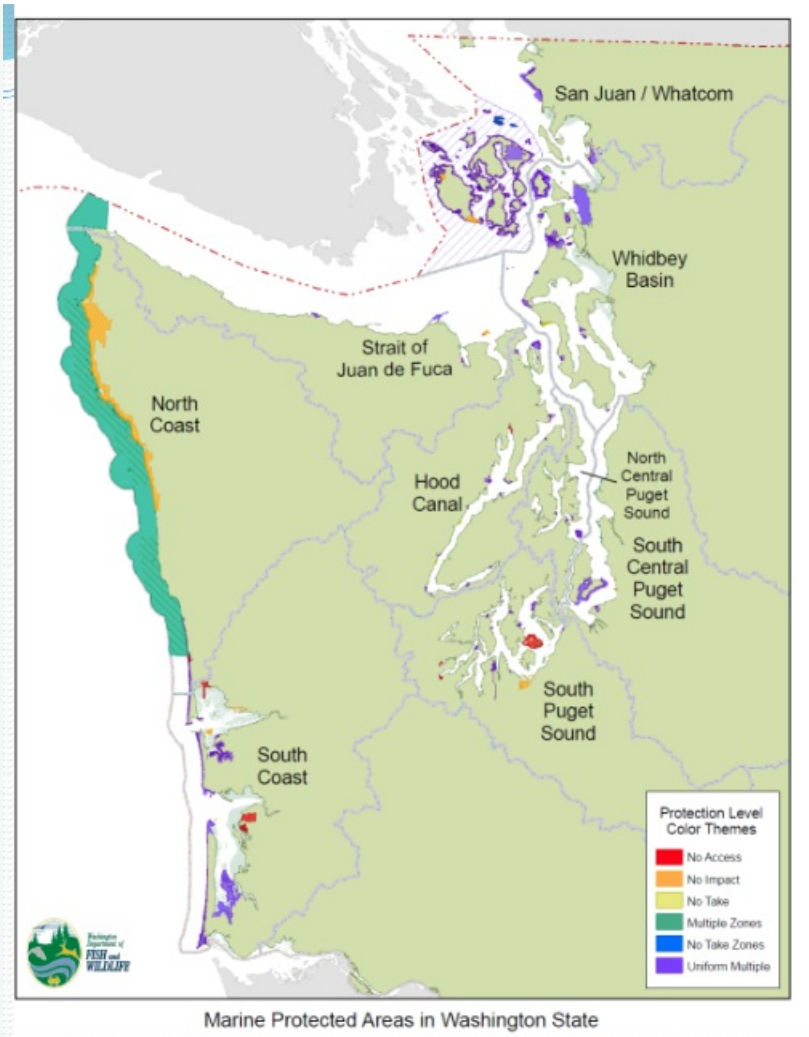

Figure 58: Marine Protected Areas in Washington state (Burley 2010).

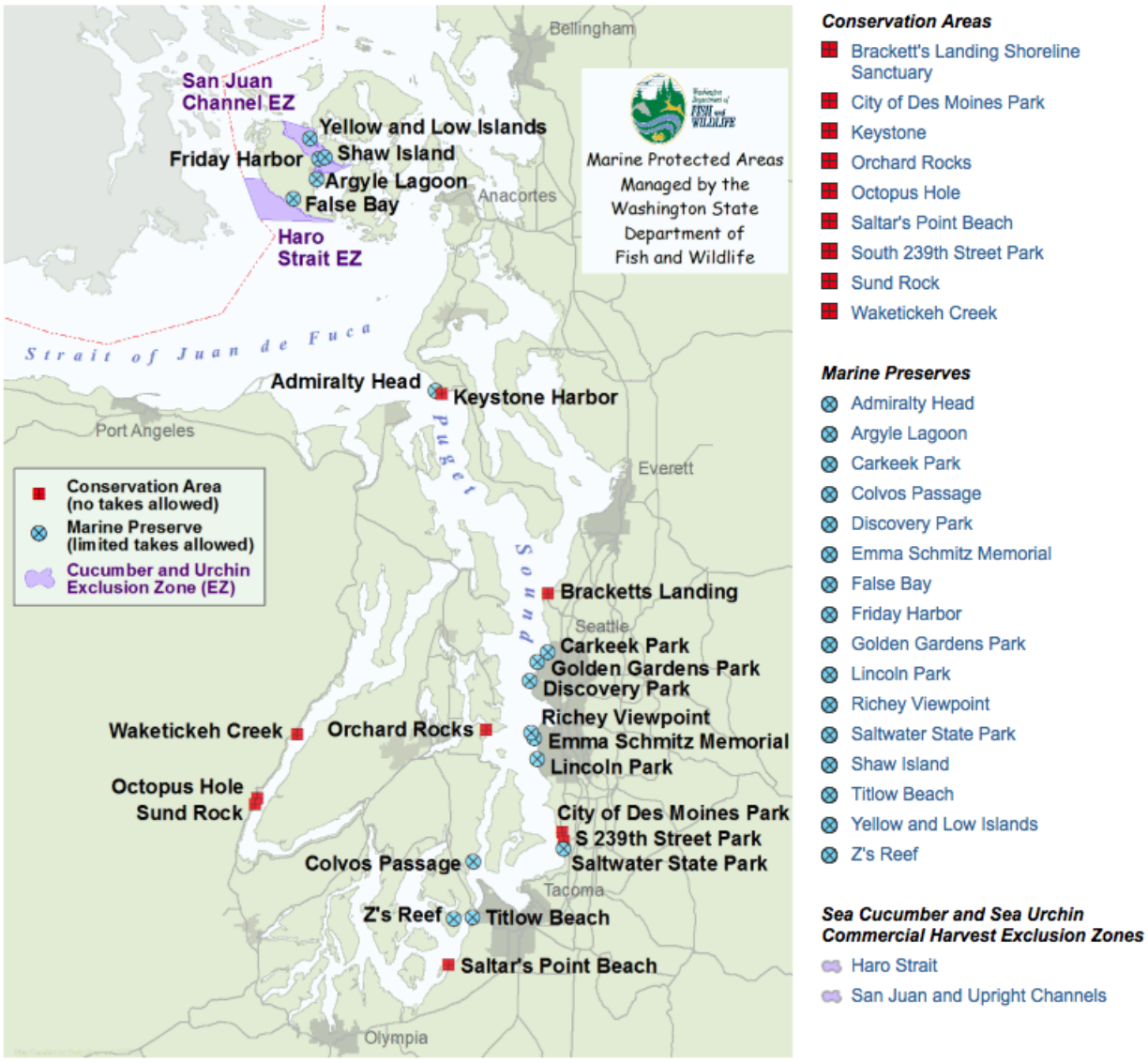

Figure 59: Puget Sound and San Juan marine conservation areas.

Similarly, California implemented a number of MPAs along the coast beginning in 1999 as part of the Marine Life Protection Act. Since that time, over 119 MPAs have been established with varying levels of protection, covering approximately 852 miles or about 16% of all coastal state waters (approximately 9% of these are no-take zones where pot fishing is prohibited; (Figure 51) (CDFW 2013). As such, a substantial proportion of representative spot prawn habitat are protected from pot gear due to area closures in Washington and California.

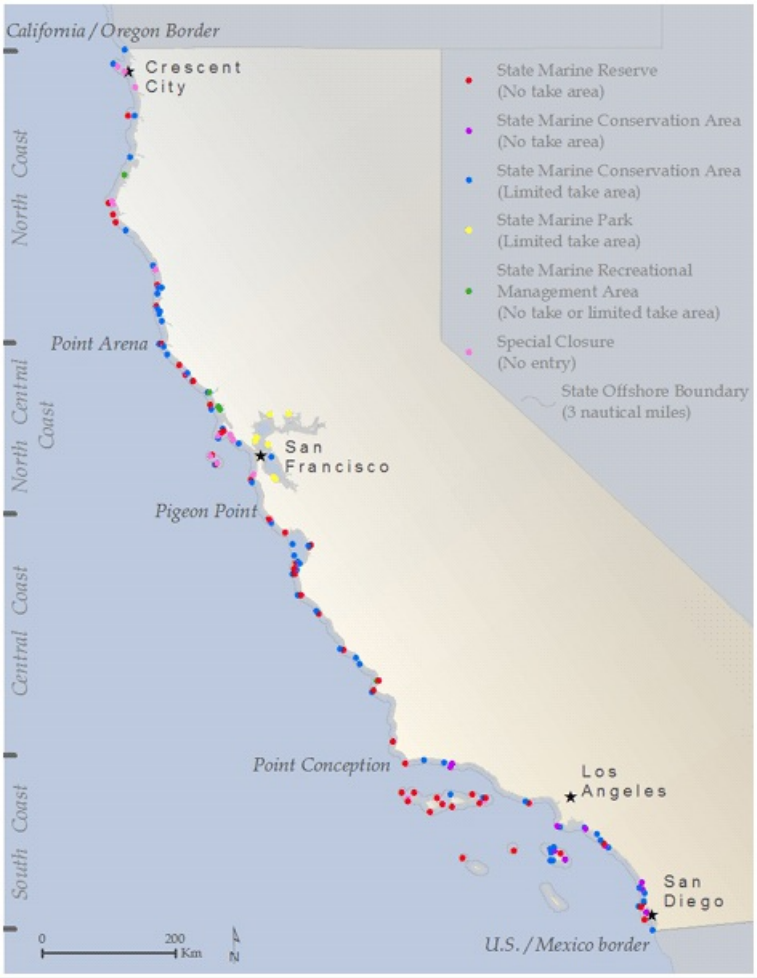

Figure 60: Marine Protected Areas by type along the California coast (CDFW 2013).

Factor 4.3 - Ecosystem-based Fisheries Management

Northeast Pacific | Pots | United States | Alaska
Northeast Pacific | Beam trawls | United States | Alaska

Very Low Concern
Shrimp management in Alaska includes the following EBFM measures: limits on directed and incidental catches; a prohibition on fishing of forage fishes; habitat protections for groundfish, crabs and marine mammals; and temporal and spatial controls on fishing effort across the state (see 4.2, Figure 52) {Witherell and Woodby 2005}. Also, beginning in the early 2000's, the Ecosystem Monitoring and Assessment Program (EMA) was developed by NOAA principally to assess factors affecting early marine ecology of Pacific salmon and other marine nekton in the Gulf of Alaska. This program has developed into additional comprehensive ecosystem function research programs (GOA EMA and the GOA Integrated Ecosystem Research Program or GOA IERP) utilizing process-based, fisheries independent survey assessment that measure a suite of biophysical and species interaction variables to advance ecosystem-based fisheries management is conducting a series of comprehensive, process-based, fisheries independent survey assessment that measures a suite of biophysical variables and advance EBFM in the state (AFSC 2017). Management measures to control harvests and minimize negative ecosystem-level effects coupled with major ecosystem research/monitoring programs yield a rating of "very low" concern for EBFM for shrimp fisheries in Alaska.
Justification:

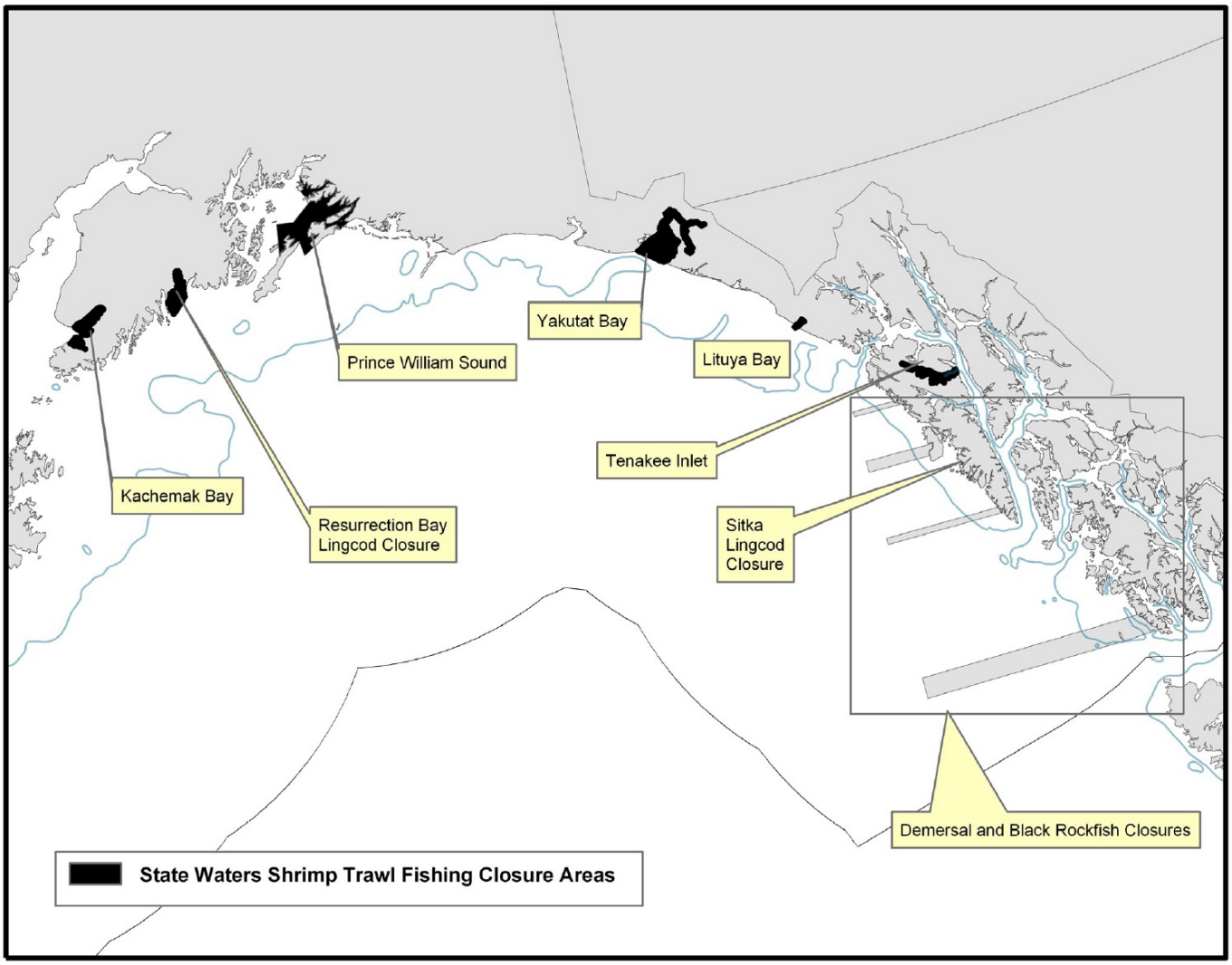

Figure 61: MPA's designed to reduce impacts on vulnerable stocks of lingcod, rockfish, and shrimp (Witherell & Woodby 2005).

Northeast Pacific | Pots | United States | California
Northeast Pacific | Bottom trawls | United States | California | Pink Shrimp Fishery
Eastern Central Pacific | Bottom trawls | United States | California | Ridgeback Shrimp Fishery
Northeast Pacific | Pots | United States | Washington

Low Concern
EBFM is a federal and state priority in marine systems along the US west coast. In 2013, the Pacific Fishery Management Council (PFMC includes CA, OR, WA, ID) finalized the Pacific Coast Fishery Ecosystem Plan (FEP). The purpose of the Pacific Coast FEP is to enhance state and federal fisheries management programs with more ecosystem science and broader ecosystem and socio-economic considerations. The FEP should assist fishery managers in identifying ecosystem research priorities, developing policies that account for ecosystem-level uncertainty, and coordinating PFMC management across its Fishery Management Plans (FMPs) and the California Current Ecosystem (CCE) {PFMC 2013}. This revised management framework considers the critical role that shrimp play in CCE trophic ecology and as an important socio-economic fishery along the US west coast {PFMC 2013}. At the state level, California managers have proposed amendments to MLMA implementation procedures, and some of the proposed changes will elevate ecosystem health and habitat considerations in the management decision-making process {Shuman 2017}. This legislation should be finalized later in 2017 and 2018. Additionally, the network of MPAs (noted in 4.2 above) includes a significant portion of no-take zones specifically designed to promote ecosystem function. The emphasis on developing EBFM at the state and federal level, in addition to spatial management and area closures, results in a score of "low" concern for California and Washington shrimp fisheries. The efficacy of recent EBFM measures is unknown at this early stage.

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

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Appendix

Appendix A

Updates to the U.S. Pacific Shrimp Report :
Updates to the March 5, 2018 U.S. Pacific Shrimp report were made on October 6, 2021

Overall Recommendations for ridgeback shrimp caught by bottom trawls in California upgraded from Avoid to Good Alternative.

All other Overall Recommendations coldwater shrimp in Alaska, Washington, and California remained unchanged**.**

Criteria-specific Updates Included:

C2.2 California ridgeback shrimp fishery: Corals and other biogenic habitats upgraded from "high concern" to "moderate concern" because although fishing mortality is unknown, the fishery is now managed in a way that reduces impact.

C2 California ridgeback shrimp fishery: Seabirds were removed and Brandt's cormorant was added. The score was previously based on the Unknown Bycatch Matrix (UBM) because the fishery was not observed. However, bycatch data has become available since this report was published. Therefore, the UBM is overridden, seabirds were removed as a main species group, and Brandt's cormorant was added.

C2.2 California ridgeback shrimp fishery: Finfish upgraded from "high concern" to "moderate concern" because none of the finfish species incidentally caught are of high conservation concern, but sustainable fishing levels are not known for most of those species.

C3.1 Alaska beam trawl fishery downgraded from "highly effective" to "moderately effective" because while there are some management measures in place, their effectiveness is unknown and there is a need for more active management.

C3.3 Alaska pot fishery downgraded from "highly effective" to "moderately effective" because there is not adequate observer coverage and the stock assessment does not include all relevant sources of fishing mortality.

C4.2 California bottom trawl fisheries upgraded from "+0" to "+0.5" because a substantial portion of all representative habitats are protected from bottom trawl contact, vulnerable habitats are protected, and the expansion of the footprint of trawl fisheries into untrawled habitat is prohibited.