The Safina Center
at Stony Brook University

AND

Monterey Bay Aquarium
Seafood Watch®

Lingcod & Yelloweye rockfish

Ophiodon elongatus
Sebastes ruberrimus

United States: Gulf of Alaska

Set longlines, Jigs, and Troll lines

June 3, 2019

Seafood Watch Consulting Researcher

Disclaimer

Seafood Watch and The Safina Center strive to ensure that all our Seafood Reports and recommendations contained therein are accurate and reflect the most up-to-date evidence available at the time of publication. All our reports are peer-reviewed for accuracy and completeness by external scientists with expertise in ecology, fisheries science or aquaculture.Scientific review, however, does not constitute an endorsement of the Seafood Watch program or of The Safina Center or their recommendations on the part of the reviewing scientists.Seafood Watch and The Safina Center are solely responsible for the conclusions reached in this report. We always welcome additional or updated data that can be used for the next revision. Seafood Watch and Seafood Reports are made possible through a grant from the David and Lucile Packard Foundation and other funders.

Seafood Watch Standard used in this assessment: Standard for Fisheries vF3

Table of Contents

About The Safina Center

The Safina Center (formerly Blue Ocean Institute) translates scientific information into language people can understand and serves as a unique voice of hope, guidance, and encouragement. The Safina Center (TSC) works through science, art, and literature to inspire solutions and a deeper connection with nature, especially the sea. Our mission is to inspire more people to actively engage as well-informed and highly motivated constituents for conservation.

Led by conservation pioneer and MacArthur fellow, Dr. Carl Safina, we show how nature, community, the economy and prospects for peace are all intertwined. Through Safina's books, essays, public speaking, PBS television series, our Fellows program and Sustainable Seafood program, we seek to inspire people to make better choices.

The Safina Center was founded in 2003 by Dr. Carl Safina and was built on three decades of research, writing and policy work by Dr. Safina.

The Safina Center's Sustainable Seafood Program
The Center's founders created the first seafood guide in 1998. Our online seafood guide now encompasses over 160-wild-caught species. All peer-reviewed seafood reports are transparent, authoritative, easy to understand and use. Seafood ratings and full reports are available on our website under Seafood choices. tsc's sustainable seafood program helps consumers, retailers, chefs and health professionals discover the connection between human health, a healthy ocean, fishing and sustainable seafood.

- Our online guide to sustainable seafood is based on scientific ratings for more than 160 wild-caught seafood species and provides simple guidelines. Through our expanded partnership with the Monterey Bay Aquarium, our guide now includes seafood ratings from both The Safina Center and the Seafood Watch® program.
- We partner with Whole Foods Market (WFM) to help educate their seafood suppliers and staff, and provide our scientific seafood ratings for WFM stores in the US and UK.
- Through our partnership with Chefs Collaborative, we created Green Chefs/Blue Ocean, a free, interactive, online sustainable seafood course for chefs and culinary professionals.
- Our website features tutorials, videos, blogs, links and discussions of the key issues such as mercury in seafood, bycatch, overfishing, etc.

Check out our Fellows Program, learn more about our Sustainable Seafood Program and Carl Safina's current work at www.safinacenter.org .

The Safina Center is a 501 (c) (3) nonprofit organization based in the School of Marine & Atmospheric Sciences at Stony Brook University, Long Island, NY. www.safinacenter.org admin@safinacenter.org | 631.632.3763

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

The Safina Center and Seafood Watch define 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.

Based on this principle, Seafood Watch and the Safina Center have developed four sustainability **criteria** for evaluating wild-catch fisheries for consumers and businesses. These criteria are:

- How does fishing affect the species under assessment?
- How does the fishing affect other, target and non-target species?
- How effective is the fishery's management?
- How does the fishing affect habitats and the stability of the ecosystem?

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 the Safina Center's online guide:

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

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

Avoid/Red Take a pass on these for now. These items are overfished or caught 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

Lingcod and yelloweye rockfish are found in the Northeast Pacific from Alaska to California, and are associated with hard substrate. This assessment covers the fisheries in Alaska, and covers three kinds of fishing gear: 1) jig gear targeting lingcod and sometimes rockfish; this gear category includes mechanical jig, dinglebar, and rod and reel gears); 2) troll gear used to target salmon and rockfish, although lingcod is a retained bycatch species, and 3) longlines, which target other species, though lingcod and yelloweye rockfish are retained as a bycatch species.

Lingcod and yelloweye rockfish are both vulnerable to fishing pressure because they are slow-growing and relatively long-lived. Stock status has not been formally assessed for either species, but the fisheries are conservatively managed by the Alaska Department of Fish and Game.

Dinglebar is the primary "jig" gear used to catch lingcod, which is targeted in the Southeast Gulf of Alaska. Yelloweye rockfish is targeted primarily with troll gear. In other regions, fisheries for groundfish include demersal and pelagic rockfish, halibut, sablefish, and also land lingcod.

Lingcod, yelloweye rockfish, and other co-landed species are generally well managed by several federal and state organizations; typical management measures include catch limits, minimum size limits, gear restrictions, and closed areas and seasons.

Jig and longline fisheries have moderate contact with bottom habitats including sensitive cold-water coral habitat. Ecosystem approaches to fishery management are implemented, and managers are working to improve upon them. These fisheries are not expected to have large negative effects on the Gulf of Alaska large marine ecosystem.

Lingcod in Alaska caught by jig, longline, or troll gear is rated Yellow/Good Alternative. Yelloweye rockfish caught by longline gear in Alaska is rated Yellow/Good Alternative.

Final Seafood Recommendations

SPECIES/FISHERY	CRITERION 1: IMPACTS ON THE SPECIES	CRITERION 2: IMPACTS ON OTHER SPECIES	CRITERION 3: MANAGEMENT EFFECTIVENESS	CRITERION 4: HABITAT AND ECOSYSTEM	OVERALL RECOMMENDATION
Lingcod United States of America Gulf of Alaska, Set longlines	Yellow (2.644)	Red (1.732)	Green (4.000)	Yellow (2.449)	**Good Alternative (2.588)**
Lingcod United States of America Gulf of Alaska, Trolling lines	Yellow (2.644)	Red (1.000)	Green (4.000)	Green (3.873)	**Good Alternative (2.529)**
Lingcod United States of America Gulf of Alaska, Jig	Yellow (2.644)	Yellow (2.236)	Yellow (3.000)	Yellow (3.000)	**Good Alternative (2.700)**
Yelloweye rockfish United States of America Gulf of Alaska, Set longlines, Pacific halibut longline	Yellow (2.236)	Red (1.732)	Green (4.000)	Yellow (2.449)	**Good Alternative (2.481)**

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 either Criterion 1 or Criterion 3 (or both) is Green, 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 assesses the US Alaska fisheries for lingcod (*Ophiodon elongatus*) and yelloweye rockfish (*Sebastes ruberrimus*).

Lingcod and yelloweye rockfish are managed in state and federal waters of the Gulf of Alaska by the Alaska Department of Fish and Game (ADFG). There are directed fisheries for lingcod using "dinglebar" troll gear and mechanized jigging (both of which are considered "jig" in this report) that usually participate concurrently in the directed rockfish fishery. Also, yelloweye rockfish and lingcod are frequently caught as bycatch and are retained in troll fisheries that target salmon. Finally, a substantial number of lingcod are caught in the benthic, longline fisheries that target demersal rockfish and halibut. These multi-species fisheries are assessed separately within this report.

Species Overview

Lingcod

Lingcod is the largest member of the greenling family, the Hexagrammidae, and is not true cod (Shaw and Hassler 1989). It is found in waters from Baja, Mexico to the Gulf of Alaska, and can be fished from surface waters to 420 m, although most lingcod are found in depths shallower than 100 m (Shaw and Hassler 1989). Adults mature at 3.2 years and 46 cm for males, and 3.8 years and 56 cm for females (50% maturity estimates (Silberberg et al. 2001)). The pelagic, larval stage can last up to three months (Marko et al. 2007), but the extent of genetic homogeneity among most of the coastal lingcod along their range is debated (Jagielo et al. 1996) (Marko et al. 2007). Both adults and juveniles use rocky and structurally complex benthic habitats (Petrie and Ryer 2006) (Reynolds et al. 2010). In Alaska, they are found in the Southeast, Central, and Western regions of the Gulf of Alaska. They feed primarily on fish, cephalopods, and crustaceans (Tinus 2012). Lingcod are vulnerable and susceptible to overfishing because of their complex migratory patterns and reproductive strategies, which include short movements within their home range (Starr et al. 2005), male guarding of benthic egg masses (King and Withler 2005) (Bishop et al. 2010), and long residence times (Bishop et al. 2010). Studies in British Columbia indicate mature fish tend to remain in areas to which they were first recruited, and that males display higher site fidelity than females, but overall the species is considered non-migratory with seasonal variation in dispersal (King et al. 2012).

Lingcod are managed solely by ADFG within the Gulf of Alaska; management is further broken down into three regions: the Western, Central, and Southeast Gulf of Alaska. There are directed fisheries for the species in the Southeast and Central regions, but all lingcod caught in the Western region are bycatch in other fisheries including the federal groundfish trawl fishery, longline, jig, and pot fisheries for other demersal species such as rockfish, cod, and halibut. Since the fisheries in the Western region are excluded from this report, we include information on management in the Southeast and Central regions. All areas have regulations to protect spawning females and nest-guarding males, minimum size limits, catch limits, and bycatch quotas. Specific limits and quotas vary by management region. Starting in 2000, sport catch in the Southeast Region was included in the quota allocation, which is divided into seven lingcod management areas (see second map below). Lingcod is also subject to management in fisheries where they are landed as bycatch (e.g., The International Pacific Halibut Commission and North Pacific Fishery Management Council). This is discussed further in Criteria 3 of this report.

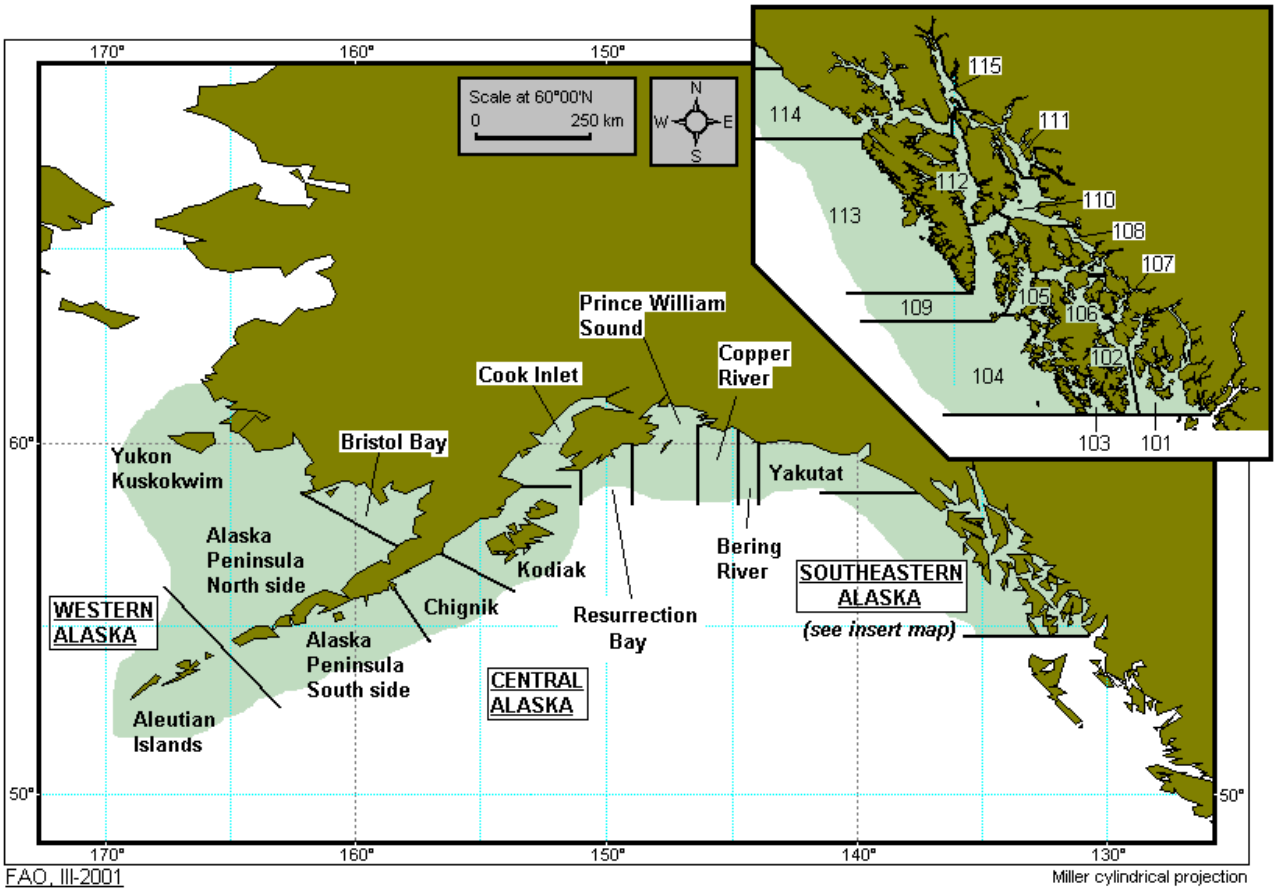

Figure 1 Fishing management divisions of the State of Alaska. There are directed fisheries for the species in the Southeast and Central regions, but all lingcod caught in the Western region are bycatch in other fisheries for demersal species such as rockfish, cod, and halibut. From FAO.org

Map Key:

- Central Southeast Outside (CSEO) Section
- East Yakutat (EYKT) Section
- Icy Bay Subdistrict (IBS)
- Northern Southeast Inside (NSEI) Subdistrict
- Northern Southeast Outside (NSEO) Section
- Southern Southeast Internal Waters (SSEIW) Sector
- Southern Southeast Outer Coast (SSEOC) Sector

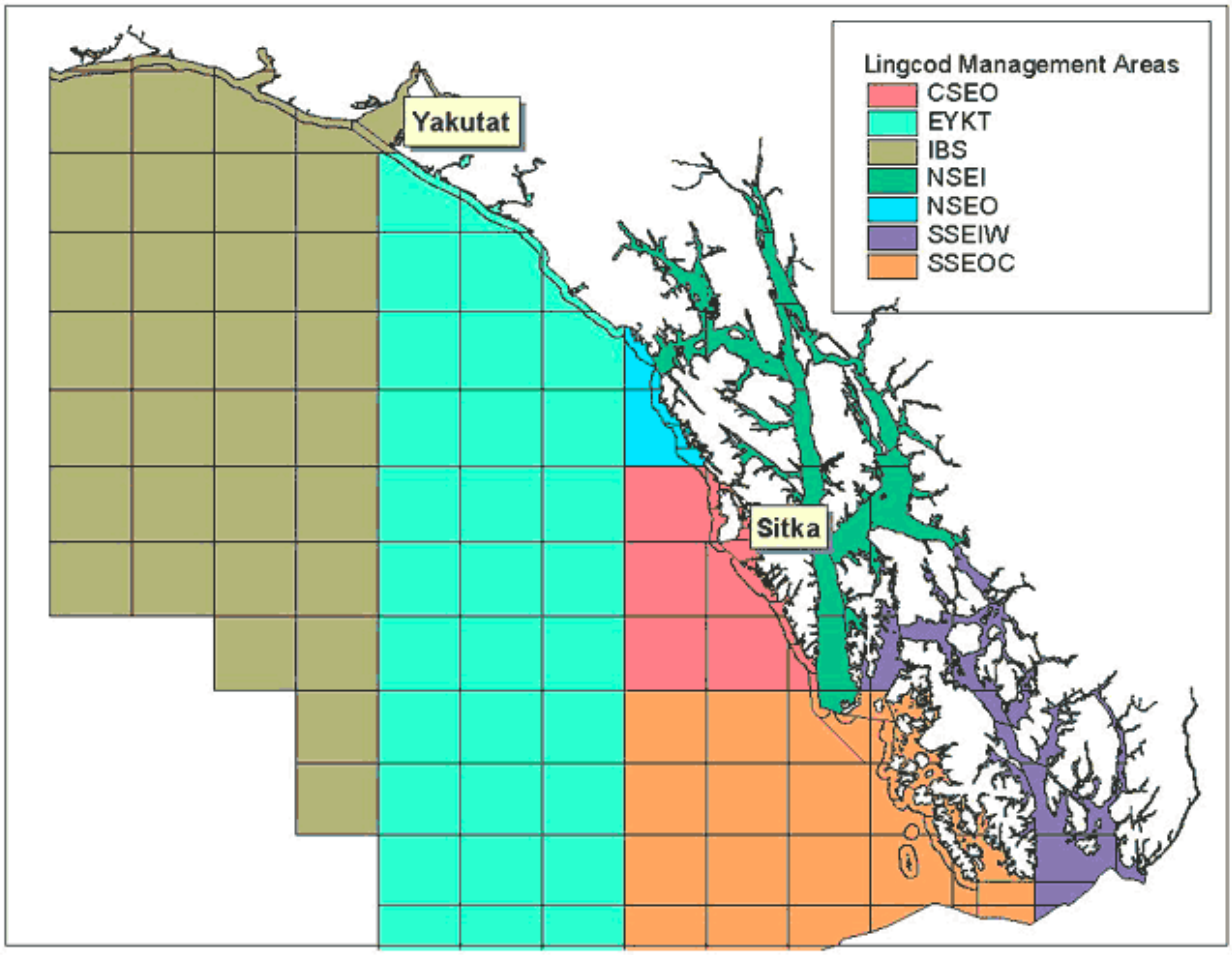

Figure 2 Lingcod management areas in Southeast Alaska & Yakutat Commercial Fisheries. Retrieved from: http://www.adfg.alaska.gov/index.cfm?adfg=commercialbyareasoutheast.lingcod_management_map

Yelloweye Rockfish

Yelloweye rockfish is a member of the Family Sebastidae, and is one of the largest and oldest of the Pacific rockfish, reaching a maximum size of 91 cm (ADFG 2017g) and recorded ages of 118 years and older (Froese and Pauly 2016). Yelloweye rockfish are very late to mature (18 or more years (Kronlund and Yamanaka 2001)) and are live-bearers (McGreer and Frid 2017) which make them very susceptible to overfishing. They have a similar distribution to lingcod, from Alaska to California (Froese and Pauly 2016). The Puget Sound/Georgia Basin DPS is listed as threatened (Green et al. 2012).

Yelloweye rockfish are managed by the Alaskan Dept. of Fish and Game in state waters and by the North Pacific Fishery Management Council in Federal waters, but by both management bodies in the demersal shelf rockfish complex (which includes yelloweye, quillback, copper, rosethorn, canary, China, and tiger rockfish) in Southeast Alaska (ADFG 2017g).

Production Statistics

Lingcod

The directed lingcod fishery is centered around the Southeastern region of the Gulf of Alaska and uses dinglebars (a type of troll line with a lead weight that keeps hooks close to the bottom), rod and reel, and mechanical jigs (Table 1) (ADFG 2016a). In this same region, troll fisheries targeting salmon and other demersal species will land substantial numbers of lingcod as bycatch, and much of this is retained. The directed lingcod dinglebar fishery and the halibut longline fishery account for the bulk of landings of lingcod covered in this report.

In the Central region, the directed fishery uses jigs and longlines. The Cook Inlet directed fishery, a jig fishery in the Central region, saw a seven-fold increase in harvest from 2015 to 2017 (ADFG 2018). The majority of lingcod are caught in Canada, while the US lands approximately 280.3 MT/yr in Alaska and 420.5 MT/yr from California, Oregon and Washington in the US (NOAA 2017).

Table 1. Average annual landings in metric tons per year (MT/yr) from 2007 to 2016. Lingcod is considered retained bycatch in rockfish/halibut, groundfish, and salmon directed fisheries.

Region	Gear	Directed Fishery	Average Lingcod Landings (mt/yr)
Southeast	Jig (dinglebar, hand troll, mechanical jig)	Lingcod	113.9
*Southeast	Longline	Halibut and rockfish	60.9
Southeast	Troll	Salmon	12.2
**Central (Cook Inlet)	Mechanical jig	Lingcod	20.3
**Central (Prince William Sound)	Longline	Lingcod	5.6
Western (landings)	Multiple	Groundfish	68.3
Western (discards)	Multiple	Groundfish	29.5

*Lingcod landings in the halibut and rockfish longline fisheries is averaged from 2012 to 2016 (ADFG 2016d).
** Lingcod landings from 2017 only (ADFG 2018).

Yelloweye rockfish

Yelloweye rockfish represents a modest contribution to rockfish landings in the longline fisheries in the Central and Southeast regions of the Gulf of Alaska. Between 2012 and 2016, an average of 165.9 MT/year were landed in the directed demersal shelf rockfish and halibut longline fisheries (ADFG 2017e) (ADFG 2017a). The halibut longline is the most significant contributor to the incidental mortality of the DSR complex (94.1%) (Olson et al. 2017). Yelloweye rockfish are not commonly landed in longline fisheries in the Western region.

Importance to the US/North American market.

The US exported 59 MT of lingcod with a value of USD 179,000 in 2017; in the same year, approximately 227 MT were landed in Alaskan waters (ADFG 2018). Approximately 102 MT were imported to the US from

Canadian waters at a value of USD 861,586 in 2017 (NOAA 2018b).

64,000 MT of rockfish was landed in Alaska in 2016, with an ex-vessel value of USD 23.7 million; 34,000 MT of which came from the Gulf of Alaska and had an ex-vessel value of USD 13.7 million (Fissel et al. 2017). Alaskan fisheries accounted for 99% of US rockfish landings by volume (NOAA 2018c). Landings in the Gulf of Alaska are dominated by Pacific ocean perch, dusky, rougheye and northern rockfish. Most of rockfish products are delivered to Asia, where fish are sold to local markets or reprocessed and sold internationally (Fissel et al. 2017). Import/export data is not available for yelloweye rockfish.

Common and market names.

Lingcod may be referred to as cultus, blue, green, leopard, buffalo, and white cod, as well as bluefish, greenling, and ling (FDA 2016) (Fishwatch 2016). Yelloweye rockfish may be called (Pacific) red snapper, red rock cod, and yellow belly (ADFG 2017g).

Primary product forms

Lingcod and yelloweye rockfish are sold fresh and frozen whole (cleaned), or in fillets or steaks (Fishwatch 2016) (Fissel et al. 2017).

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

Criterion 1 Summary

LINGCOD			
Region | Method	**Abundance**	**Fishing Mortality**	**Score**
United States of America/Gulf of Alaska | Set longlines	2.33: Moderate Concern	3.00: Moderate Concern	Yellow (2.644)
United States of America/Gulf of Alaska | Trolling lines	2.33: Moderate Concern	3.00: Moderate Concern	Yellow (2.644)
United States of America/Gulf of Alaska | Jig	2.33: Moderate Concern	3.00: Moderate Concern	Yellow (2.644)

YELLOWEYE ROCKFISH			
Region | Method	**Abundance**	**Fishing Mortality**	**Score**
United States of America/Gulf of Alaska | Set longlines | Pacific halibut longline	1.00: High Concern	5.00: Low Concern	Yellow (2.236)

Criterion 1 Assessment

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.*

LINGCOD

Factor 1.1 - Abundance

UNITED STATES OF AMERICA/GULF OF ALASKA, SET LONGLINES
UNITED STATES OF AMERICA/GULF OF ALASKA, TROLLING LINES
UNITED STATES OF AMERICA/GULF OF ALASKA, JIG

Moderate Concern

The abundance of lingcod (*Ophiodon elongatus*) in Alaska is unknown. The International Union for the Conservation of Nature (IUCN) has not yet assessed this species, but the Productivity-Susceptibility Analysis (below) indicates that lingcod has a moderate vulnerability to fishing. The Alaska Department of Fish and Game, however, considers it to be a species that is highly vulnerable to overfishing (ADFG 2007). Because this species exhibits moderate vulnerability, and abundance is unknown, we awarded a score of "moderate" concern.

Justification:

No routine, fisheries-independent stock assessment is conducted for lingcod in the Southeast Gulf of Alaska region (ADFG 2014), and attempts to estimate biomass in the Central region have not been successful due to low sample sizes (ADFG 2015). Some population monitoring via tagging studies has been performed in the past (Green et al. 2014) (ADFG 2015), but these appear to have focused on understanding migratory patterns. Lingcod were overfished in Resurrection Bay, and fishing remains closed today (ADFG 2015). Catch Per Unit Effort (CPUE) has declined in some parts of the Southeast region, but has remained relatively high in others (ADFG 2015) suggesting abundance may be localized and variable.

The PSA score for lingcod = 3.07. For this reason, the species is deemed as having a "medium vulnerability." Detailed scoring of each attribute is shown below.

Productivity analysis for lingcod, *Ophiodon elongatus*

PRODUCTIVITY ATTRIBUTE	RELEVANT INFORMATION (REFERENCE)	SCORE (1 = LOW RISK, 2 = MEDIUM RISK, 3 = HIGH RISK)
AVG. AGE AT MATURITY	3.8 years, females (Silberberg et al. 2001)	1
AVG. MAXIMUM AGE	36 years in Alaska (ADFG 2014)	3
FECUNDITY	100,000 to 500,000 eggs (King and Withler 2005)	1
AVG. MAXIMUM SIZE (FISH ONLY)	152 cm (Mecklenburg et al. 2002)	2
AVG. SIZE AT MATURITY (FISH ONLY)	56 cm (Silberberg et al. 2001)	2
REPRODUCTIVE STRATEGY	Demersal egg layer (Shaw and Hassler 1989)	2
TROPHIC LEVEL	4.3 (Froese and Pauly 2016)	3
DENSITY DEPENDENCE (INVERTEBRATES ONLY)	N/A	
QUALITY OF HABITAT	Unknown	

Susceptibility analysis for lingcod, *Ophiodon elongatus*

SUSCEPTIBILITY ATTRIBUTE	RELEVANT INFORMATION	SCORE (1 = LOW RISK, 2 = MEDIUM RISK, 3 = HIGH RISK)
AREAL OVERLAP	Fished in nearly all of the species' range	3
VERTICAL OVERLAP	Fished in nearly all of the vertical distribution by various fisheries	3
SELECTIVITY OF FISHERY	Species is targeted and retained as bycatch; conditions under "high risk" do not apply	2
POST-CAPTURE MORTALITY	Lingcod is a retained species	3

Factor 1.2 - Fishing Mortality

UNITED STATES OF AMERICA/GULF OF ALASKA, SET LONGLINES
UNITED STATES OF AMERICA/GULF OF ALASKA, TROLLING LINES
UNITED STATES OF AMERICA/GULF OF ALASKA, JIG

Moderate Concern

Overfishing has been documented for lingcod in Resurrection Bay in south-central Alaska (ADFG 2016a), but whether overfishing is occurring in other regions is unknown (ADFG 2014). In recent years, landings have remained well below the historic maximum landings of approximately 2.5 million lb in the early- to mid-1990s (Figure 3). The Alaska Department of Fish and Game has not performed a stock assessment, but they do actively manage lingcod across the Gulf of Alaska. Because fishing mortality relative to maximum sustainable yield is unknown, we have awarded a score of "moderate" concern.

Justification:

Directed commercial fishing effort today by jig and dinglebar troll is greatest in the Southeast region, with smaller, mostly directed landings coming from Central Alaska, and larger landings of lingcod caught in trawl (mostly), troll, and longline fisheries in the Westward region (ADFG 2015). Bycatch of lingcod in the federal and state-managed trawl fisheries accounts for about 17% of all lingcod landings (ADFG 2016c) with lingcod trawl discards occasionally exceeding lingcod landings in that fishery (ADFG 2016c). Lingcod landings and discards in Western region trawls from 2007 to 2017 averaged 103,293 lb/year and 56,961 lb/year, respectively (ADFG 2016c). Lingcod are generally thought to be resistant to stress associated with trawl capture, and are likely to have low mortality if they are returned to the water soon after capture (Parker et al. 2003), but there is limited information about bycatch mortality in other fisheries. Commercial landings in 2015 were 433,400 lb (NOAA 2017), with the majority of landings coming from the Southeast region of the Gulf of Alaska (ADFG 2014). Between 2006 and 2015, approximately 33,800 lb/yr of lingcod were landed by the recreational fishery (ADFG 2017b).

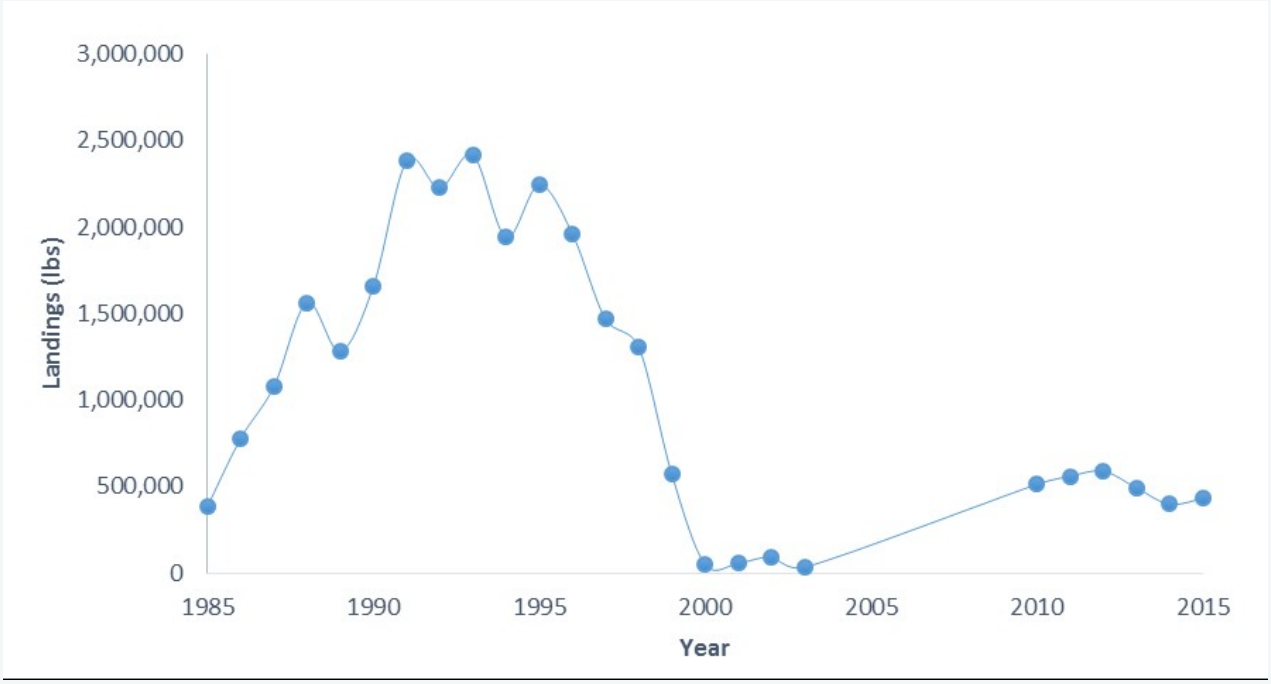

Figure 3 Total lingcod landings in Alaska. Data were not available for 2004-2009. From: NOAA 2016.

Factor 1.1 - Abundance

UNITED STATES OF AMERICA/GULF OF ALASKA, SET LONGLINES, PACIFIC HALIBUT LONGLINE

High Concern

Yelloweye rockfish (*Sebastes ruberrimus*) is managed as part of the demersal shelf rockfish complex. The most recent stock assessment evaluated demersal shelf rockfish in the Southeast Outside (SEO) District of the Gulf of Alaska using remotely operated vehicle (ROV) surveys; the statistical age-structured assessment model was not available for the most recent assessment (Olson et al. 2018). From 2018 to 2019, the estimated yelloweye rockfish biomass increased from 11,508 MT to 12,029 MT, which was driven by an increase in the average weight of yelloweye sampled; long-term trends indicate a decline in biomass (Olson et al. 2018). Surveys show a decline in yelloweye rockfish density in all management areas in recent years, except for Central Southeast Outside (CSEO) (Olson et al. 2018). Reliable estimates of spawning biomass and recruitment are not available.

The stock assessment report notes that species in the demersal shelf rockfish complex are "particularly vulnerable to overfishing given their longevity, late maturation, and habitat-specific residency" (Olson et al. 2016), and a productivity sensitivity analysis indicates this species has a "high vulnerability" (see below). Due to the declines in yellow rockfish densities, and the vulnerable nature of this species, we have rated its abundance as "high" concern.

Justification:

The North Pacific Fishery Management Council manages yelloweye rockfish under the Gulf of Alaska Groundfish Fishery Management Plan. The demersal shelf rockfish complex is managed as a single stock. Estimated densities of yelloweye rockfish from submersible and ROV surveys have declined in the Gulf of Alaska from the late 1990s to 2015, indicating possible declining abundance (Olson et al. 2016). Surveys are conducted in four management areas in the SEO. Current funding allows for one survey per year; managers hope to conduct a region-wide assessment in the future (Olson et al. 2016).

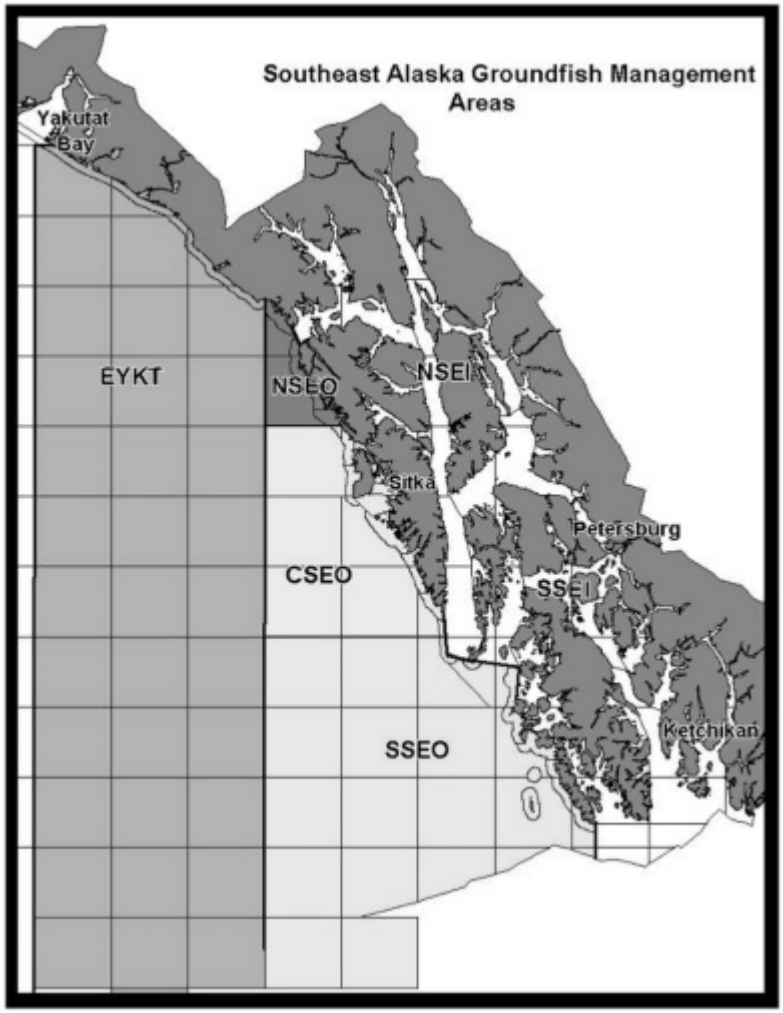

Figure 4 Southeast Outside (SEO) Subdistrict used to manage the demersal shelf rockfish fishery: East Yakutat (EYKT), Northern Southeast Outside (NSEO), Central Southeast Outside (CSEO), and Southern Southeast Outside (SSEO). Figure from: Olson et al. 2018.

The PSA score for yelloweye rockfish = 3.26. For this reason, the species is deemed as having a "high vulnerability." Detailed scoring of each attribute is shown below.

Productivity analysis for yelloweye rockfish, *Sebastes ruberrimus*

PRODUCTIVITY ATTRIBUTE	RELEVANT INFORMATION (REFERENCE)	PRODUCTIVITY SCORE
AVG. AGE AT MATURITY	18 years (Kronlund and Yamanaka 2001)	3
AVG. MAXIMUM AGE	44+ years (Kerr et al. 2003) (Kronlund and Yamanaka 2001)	3
FECUNDITY	2 million eggs (McGreer and Frid 2017)	1
AVG. MAXIMUM SIZE	91 cm (ADFG 2017g)	1
AVG. SIZE AT MATURITY	46 cm (Kronlund and Yamanaka 2001)	2

REPRODUCTIVE STRATEGY	Live bearer (McGreer and Frid 2017)	3
TROPHIC LEVEL	4.4 (Froese and Pauly 2016)	3
HABITAT QUALITY	Unknown	-

Susceptibility analysis for yelloweye rockfish, *Sebastes ruberrimus*

SUSCEPTIBILITY ATTRIBUTE	RELEVANT INFORMATION (REFERENCE)	SUSCEPTIBILITY SCORE
AREAL OVERLAP	Southern California to western Alaska (McGreer and Frid 2017)	3
VERTICAL OVERLAP	48 to 1800 ft distribution (ADFG 2017g)	3
SELECTIVITY OF FISHERY	No suggested exceptional selectivity (ADFG 2017g)	2
POST-CAPTURE MORTALITY	Retained, or possibility of barotrauma (ADFG 2017g)	3

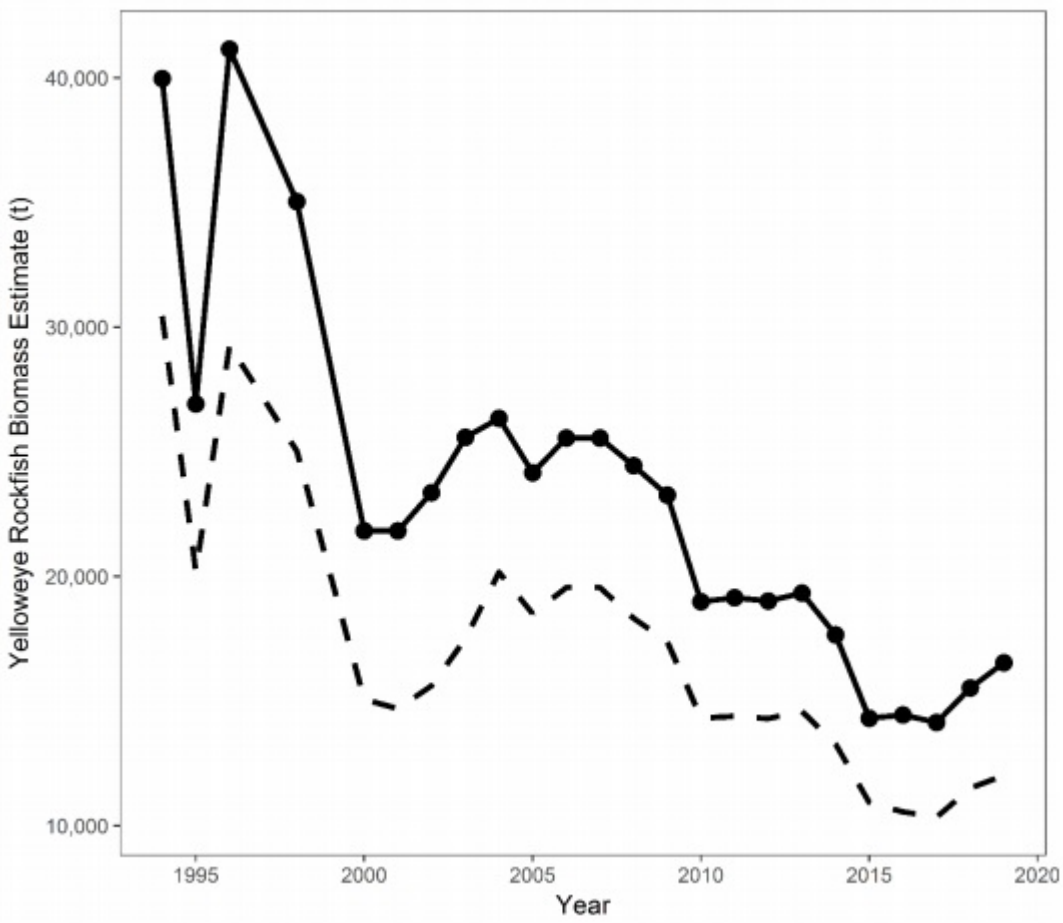

Figure 5 Yelloweye rockfish biomass estimate (t) (solid line) and 90% lower confidence interval (dashed line) for the Southeast Outside Subdistrict from 1994 to 2018. Figure from: Olson et al. 2018.

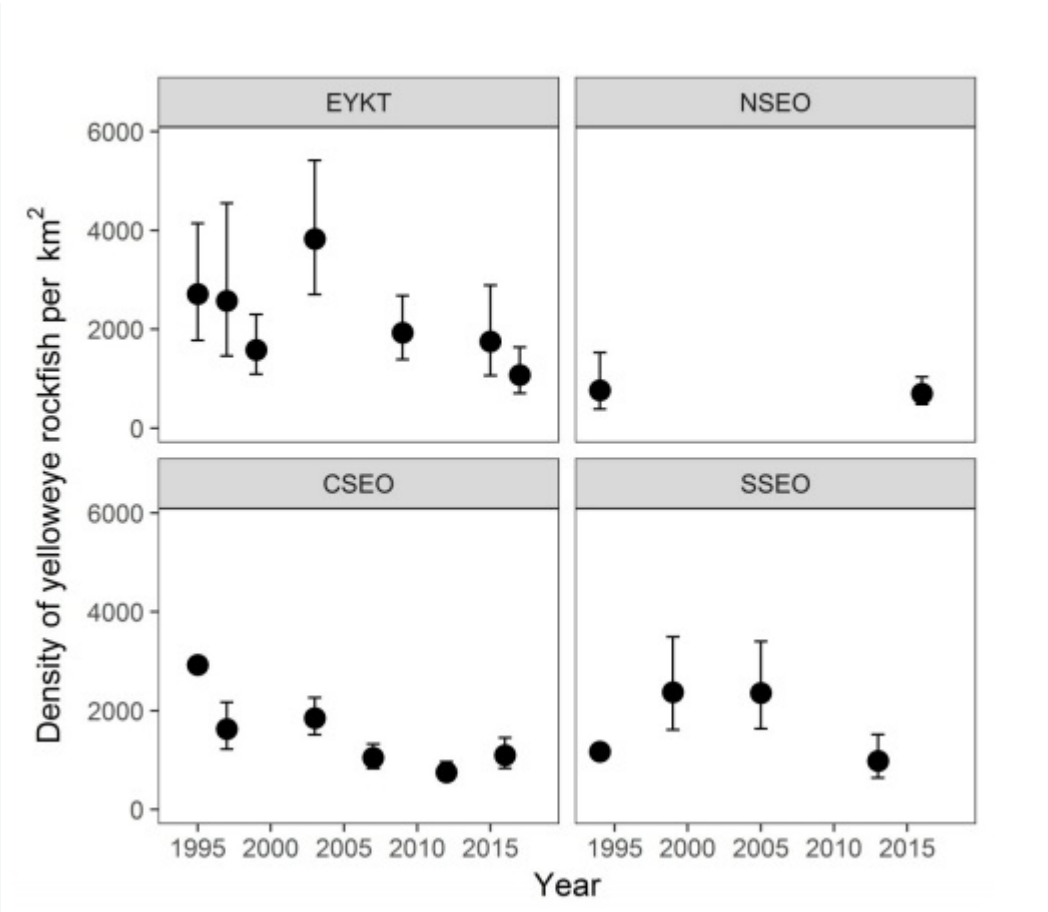

Figure 6 Density of yelloweye rockfish predicted by DISTANCE (circles) +/- two standard deviations in each management area (Central Southeast Outside (CSEO), East Yakutat (EYKT), Southern Southeast Outside (SSEO), and Northern Southeast Outside (NSEO). Figure from: Olson et al. 2018.

Factor 1.2 - Fishing Mortality

UNITED STATES OF AMERICA/GULF OF ALASKA, SET LONGLINES, PACIFIC HALIBUT LONGLINE

Low Concern

The maximum allowable acceptable biological catch (ABC) for the rockfish complex in 2018 was 319 MT, but the recommended catch is lower than the maximum allowed (Olson et al. 2018). In 2018, the actual catch (research + commercial + recreational + subsistence) was 181 MT, well below the total allowable catch (250 MT) and overfishing level (394 MT).

The demersal shelf rockfish (DSR) complex (including yelloweye rockfish) in the Gulf of Alaska is not subject to overfishing (Olson et al. 2018). The DSR assemblage is managed conservatively due to its life history vulnerabilities. Because fishing mortality is well below the overfishing level, we have rated fishing mortality for yelloweye rockfish as "low" concern.

Justification:

The overfishing level is set using $F_{35\%}$ = 0.032 (Olson et al. 2018). The total allowable catch (TAC) is divided by commercial (84%) and sport (16%) fisheries, and is set after deducting the estimated subsistence catch (7 MT in 2018) (Olson et al. 2018).

To determine the ABC for the DSR complex, the lower bound of the 90% confidence interval of the yelloweye rockfish biomass for the region is multiplied by the natural mortality rate (M = 0.02) and average estimated harvest from all fisheries of other species in the DSR assemblage is added to the yelloweye rockfish ABC (Olson et al. 2017).

Quantity	As estimated or *specified last* year for: 2018	2019	As estimated or *recommended this* year for: 2019	2020
M (natural mortality rate)	0.02	0.02	0.02	0.02
Tier	4	4	4	4
Yelloweye Biomass (t)	11,508		12,029	
$F_{OFL}=F_{35\%}$	0.032	0.032	0.032	0.032
$maxF_{ABC}$	0.026	0.026	0.026	0.026
F_{ABC}	0.020	0.020	0.020	0.020
DSR OFL (t)	394	394	411	411
DSR max ABC (t)	319	319	333	333
ABC (t)	250	250	261	261
Status	As determined last year for: 2016	2017	As determined this year for: 2017	2018
Overfishing	No	n/a	No	n/a

Figure 7 Reference values for the demersal shelf rockfish complex in the Southeast Outside Subdistrict of the Gulf of Alaska. Table from: Olson et al. 2018

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

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

LINGCOD - UNITED STATES OF AMERICA/GULF OF ALASKA - JIG					
Subscore:	**2.236**	**Discard Rate:**	**1.00**	**C2 Rate:**	**2.236**
Species	**Abundance**	**Fishing Mortality**	**Subscore**		
Yelloweye rockfish	1.00:High Concern	5.00:Low Concern	Yellow (2.236)		
Black rockfish	2.33:Moderate Concern	3.00:Moderate Concern	Yellow (2.644)		

LINGCOD - UNITED STATES OF AMERICA/GULF OF ALASKA - SET LONGLINES					
Subscore:	**1.732**	**Discard Rate:**	**1.00**	**C2 Rate:**	**1.732**
Species	**Abundance**	**Fishing Mortality**	**Subscore**		
Seabirds	1.00:High Concern	3.00:Moderate Concern	Red (1.732)		
Corals and other biogenic habitats	1.00:High Concern	3.00:Moderate Concern	Red (1.732)		
Shortraker rockfish	1.00:High Concern	5.00:Low Concern	Yellow (2.236)		
Pacific cod	2.33:Moderate Concern	3.00:Moderate Concern	Yellow (2.644)		
Pacific halibut	2.33:Moderate Concern	5.00:Low Concern	Green (3.413)		

Rougheye rockfish	2.33:Moderate Concern	5.00:Low Concern	Green (3.413)
Shortspine thornyhead rockfish	2.33:Moderate Concern	5.00:Low Concern	Green (3.413)
Sablefish	5.00:Very Low Concern	5.00:Low Concern	Green (5.000)

LINGCOD - UNITED STATES OF AMERICA/GULF OF ALASKA - TROLLING LINES					
Subscore:	**1.000**	**Discard Rate:**	**1.00**	**C2 Rate:**	**1.000**

Species	Abundance	Fishing Mortality	Subscore
Chinook salmon	1.00:High Concern	1.00:High Concern	Red (1.000)
Black rockfish	2.33:Moderate Concern	3.00:Moderate Concern	Yellow (2.644)
Coho salmon	3.67:Low Concern	3.00:Moderate Concern	Green (3.318)

YELLOWEYE ROCKFISH - UNITED STATES OF AMERICA/GULF OF ALASKA - SET LONGLINES - PACIFIC HALIBUT LONGLINE					
Subscore:	**1.732**	**Discard Rate:**	**1.00**	**C2 Rate:**	**1.732**

Species	Abundance	Fishing Mortality	Subscore
Corals and other biogenic habitats	1.00:High Concern	3.00:Moderate Concern	Red (1.732)
Seabirds	1.00:High Concern	3.00:Moderate Concern	Red (1.732)
Shortraker rockfish	1.00:High Concern	5.00:Low Concern	Yellow (2.236)
Pacific cod	2.33:Moderate Concern	3.00:Moderate Concern	Yellow (2.644)
Pacific halibut	2.33:Moderate Concern	5.00:Low Concern	Green (3.413)
Rougheye rockfish	2.33:Moderate Concern	5.00:Low Concern	Green (3.413)
Shortspine thornyhead rockfish	2.33:Moderate Concern	5.00:Low Concern	Green (3.413)
Sablefish	5.00:Very Low Concern	5.00:Low Concern	Green (5.000)

Lingcod and associated species are caught in either 1) targeted jig lingcod fisheries, which also catch and retain some rockfish, or 2) in fisheries that target other species (salmon, halibut, demersal rockfish) but these fisheries also land lingcod. Lingcod is a C1 species in all gears in this report; yelloweye rockfish are a C1 species in the longline fishery only.

The directed jig fishery for lingcod in the Southeast (primary) and Central regions land assorted rockfish species, but only yelloweye rockfish and black rockfish represent >5% of the catch in each region, respectively. Also, since limits are placed on co-landings of these species, some are likely to be discarded once limits are met, or when individuals are undersized (ADFG 2016b) so landings represent the lower limit of "bycatch." Many other rockfish species are also caught, but they represent a small proportion of landings (<5%) in trips that catch lingcod, so they have not been included.

In some cases, such as the fisheries for halibut, sablefish, cod and pollock (longline) and coho and Chinook salmon (troll), lingcod are retained, non-target species and the target species of those fisheries are included. Approximately 5% and 10% of all the coho and Chinook salmon caught in the southeast Gulf of Alaska, respectively, are co-landed with lingcod in a directed salmon troll fishery (ADFG 2017e). Estimates are not available on how many salmon are discarded in the directed lingcod fisheries. This fishery is also a major source of fishing mortality for black rockfish (Hagerman et al. 2017). The longline fisheries for demersal shelf rockfish (DSR), halibut, pollock, and cod have average lingcod specific discard values of 17% in the past 10 years (ADFG 2017a). These set longline fisheries may retain relatively small amounts of rockfish due to the large landings of cod, halibut, and other demersal species. Other rockfish species (shortraker and yelloweye rockfish, for example) have been included because the longline fishery is a substantial contributor to all landings of those species.

Alaska has historically one of the largest bycatch rates for seabirds in the benthic longline fishery. Given major declines in this mortality and small potential overall impact to populations in current fisheries, all seabirds were grouped together. This includes species for which populations are healthy, and also species that are threatened or endangered. Interactions with coldwater corals by benthic longlines is also documented, so coral and associated habitat were also included (Stone and Shotwell 2009) (Stone et al. 2015). Together, seabirds and corals bycatch reduce the final score for longline-caught lingcod.

Data used to determine inclusion came from managers in three regions: Western, Central and Southeast Gulf of Alaska (ADFG 2017a) (ADFG 2016c) (ADFG 2016d). The data obtained included the primary species caught on trips that landed lingcod over the past 10 years (one dataset in the Southeast Gulf of Alaska was limited to 5 years). This was used to determine the relative contribution to landings by those fisheries. In cases where the species contribution to landings associated with lingcod was part of a much larger fishery (i.e., pollock and Pacific cod), these species were excluded because landings amounted to <1% of the total fishery.

For Gulf of Alaska troll fishery that lands lingcod, Chinook salmon was the lowest scoring species due to demonstrated and significant landings of Chinook in Southeast Alaska that originate from ESA-listed populations. In the longline fishery for lingcod and yelloweye rockfish, seabirds received the lowest score because some bycatch species are both threatened or endangered; coral and biogenic habitat also received the same low score due to likely gear interaction. Yelloweye rockfish limits the score in the lingcod jig fishery because of their unknown abundance and high vulnerability to fishing.

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)

SEABIRDS

Factor 2.1 - Abundance

UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES, PACIFIC HALIBUT LONGLINE

High Concern

Many of the species that are commonly caught as longline bycatch (albatross, fulmars, gulls and shearwaters) are considered by the IUCN to be "Near Threatened" or "Vulnerable" (BirdLife International 2017b) (BirdLife International 2017a). The three albatross species found in Alaskan waters include Laysan (*Phoebastria immutabilis*) and black-footed albatross (*Phoebastria nigripes*), which are species of conservation concern (IUCN "Near Threatened"), and the short-tailed albatross (*Phoebastria albatrus*), which is "Endangered" (Eich et al. 2016). Seabirds automatically receive a score of "high" concern.

Factor 2.2 - Fishing Mortality

UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES, PACIFIC HALIBUT LONGLINE

Moderate Concern

Demersal longlines in the Gulf of Alaska result in seabird mortality estimates of albatross, fulmars, gulls and shearwaters at 0.06 birds/1000 hooks (1993 to 1997 (Stehn et al. 2001)) and <1 to 16 birds/1 million hooks (2002 to 2015 (WSG 2016)). Gear modifications and increased regulations have drastically decreased seabird bycatch in the region since the 1990s (Dietrich and Fitzgerald 2010). In the 14 years following introduction of streamer lines to reduce bycatch of seabirds, approximately 9,400 albatrosses and 141,000 other seabirds have been saved (WSG 2016). Bycatch has been reduced by approximately 77 to 89%, depending on the species ((WSG 2016), Figure 8), although it varies annually. However, nearly 600 albatrosses and more than 4,500 non-albatross seabirds were taken in 2015 (WSG 2016). Without population level data on these seabirds, it is difficult to discern if these bycatch levels are contributing to population decline. Further, we do not know the contribution to seabird mortality from longlines that catch lingcod. Improvements to seabird bycatch have been substantial, but information that places mortality into the context of the total population is not available. Due to this uncertainty, bycatch mortality of seabirds receives a score of "moderate" concern.

Justification:

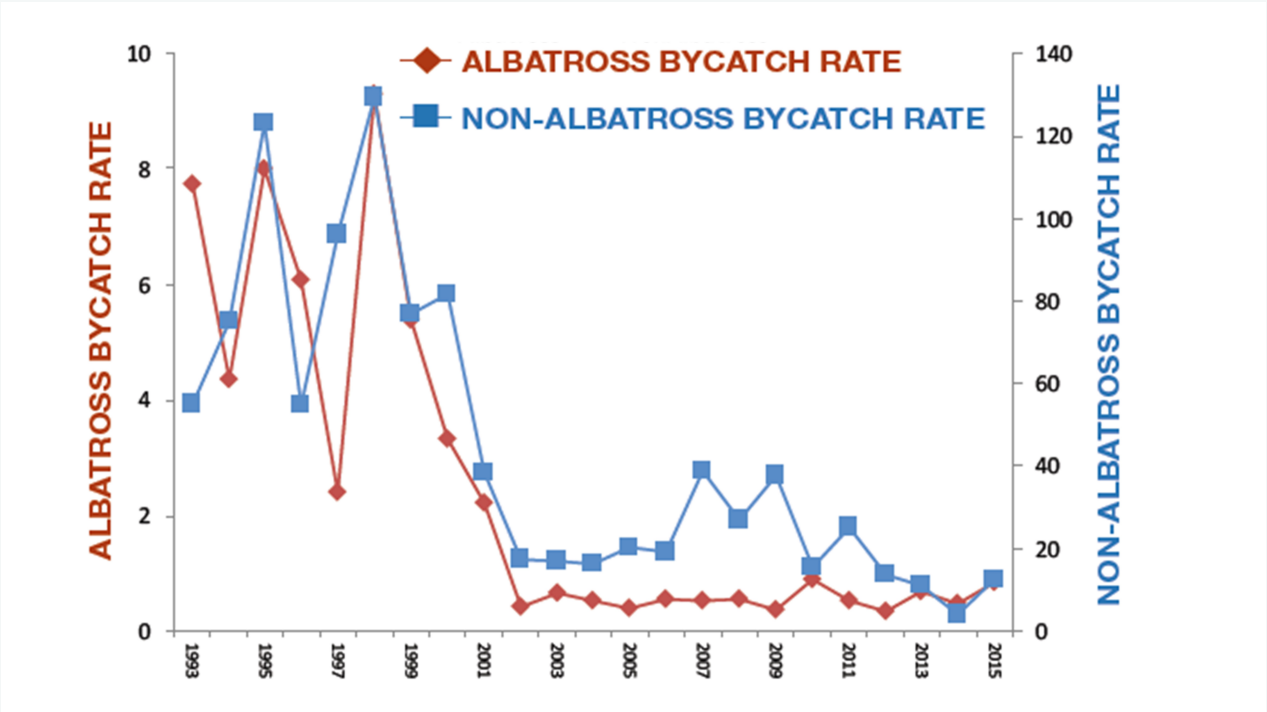

Figure 8 Mean albatross and non-albatross seabird bycatch rates (1993–2015). Number of birds per million hooks. From: WSG 2016 .

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

UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES, PACIFIC HALIBUT LONGLINE

< 100%

The longline fishery in the Gulf of Alaska targets Pacific cod, halibut, rockfish, sablefish, and various flatfish, but few data exist on discard to landings ratios and bait use. In 2012, the North Pacific Fishery Management Council decreased halibut bycatch limits in longline fisheries by 15% in an attempt to curb bycatch in this fishery (NPFMC 2013). In the early 1990's, NOAA estimated bycatch rates in the Gulf of Alaska groundfish fisheries, which include bottom longlines, to be between 4 and 22% (Queirolo, et al. 1995). Longlines use lures and bait, but are likely to include herring and squid/octopus (NPFMC 2017b) (Woodby et al. 2005). Bait use in this fishery is not quantified, but it is unlikely to increase the discard to landings ratio substantially. Given that there is no evidence that discards have increased substantially since NOAA's assessment, or that bait use is generally unknown, we have awarded a score of "1" or <100%.

CORALS AND OTHER BIOGENIC HABITATS

Factor 2.1 - Abundance

UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES, PACIFIC HALIBUT LONGLINE

High Concern

Corals, especially those found in deep and cold water, as in the Gulf of Alaska, are automatically considered to have high inherent vulnerability. There are no extensive measures of abundance of corals and other habitat-forming invertebrates in the Gulf of Alaska, but surveys of coral thickets indicate moderate, but patchy, abundance and relatively high instances of damage from fishing gear (Stone and Shotwell 2009) (Stone et al. 2015). Because there is limited information on abundance of all biogenic habitat in the Gulf of Alaska, and corals exhibit high inherent vulnerability, we have assigned a score of "high" concern.

Factor 2.2 - Fishing Mortality

UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES, PACIFIC HALIBUT LONGLINE

Moderate Concern

Bottom longlines have been considered as gear of moderate concern in the Gulf of Alaska in the past (Stone

and Shotwell 2009) and are generally thought to be relatively less damaging than other benthic fishing gear (Pham et al. 2014) (Doherty et al. 2017). A recent study suggests that longline gear used in fisheries for rockfish, halibut, and sablefish in the eastern Gulf of Alaska may overlap with and significantly damage coral thickets (Stone et al. 2015). Also, derelict gear was observed in one study in 68% of transects, with damaged coral in the surrounding vicinity (Stone et al. 2015), but this damage may have come from fishing gear other than (or in addition to) longlines. The potential for interaction of benthic longlines with coral and other biogenic habitat (sponges and other invertebrates) ranges from low to high, with an overall rating of "moderate" by Stone and Shotwell in an extensive review (Stone and Shotwell 2009). In the sablefish fishery, which includes longline, but also trawl and pot gear, damage to coral and benthic invertebrates is listed as a "possible concern" (Hanselman, et al. 2014); however, it has been proposed that longline (hook) gear might pose a greater risk to benthic habitats than gear like longline sablefish pots (Doherty et al. 2017). Because there is limited and conflicting information, this results in a rating of "moderate" concern.

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

UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES, PACIFIC HALIBUT LONGLINE

< 100%

The longline fishery in the Gulf of Alaska targets Pacific cod, halibut, rockfish, sablefish, and various flatfish, but few data exist on discard to landings ratios and bait use. In 2012, the North Pacific Fishery Management Council decreased halibut bycatch limits in longline fisheries by 15% in an attempt to curb bycatch in this fishery (NPFMC 2013). In the early 1990's, NOAA estimated bycatch rates in the Gulf of Alaska groundfish fisheries, which include bottom longlines, to be between 4 and 22% (Queirolo, et al. 1995). Longlines use lures and bait, but are likely to include herring and squid/octopus (NPFMC 2017b) (Woodby et al. 2005). Bait use in this fishery is not quantified, but it is unlikely to increase the discard to landings ratio substantially. Given that there is no evidence that discards have increased substantially since NOAA's assessment, or that bait use is generally unknown, we have awarded a score of "1" or <100%.

CHINOOK SALMON

Factor 2.1 - Abundance

UNITED STATES OF AMERICA / GULF OF ALASKA, TROLLING LINES

High Concern

Approximately 10% of the Chinook salmon (*Oncorhynchus tshawytscha*) landings in southeast Gulf of Alaska are landed by troll gear with lingcod as bycatch (ADFG 2016d) (ADFG 2017e). Twelve native Chinook stocks

are assessed for escapement in the southeast region of the Gulf of Alaska. In the past 15 years of available data (2002 to 2016), no stock has missed escapement goals more than 50% of the time (Munro and Volk 2017) (Munro and Volk 2010). However, a substantial proportion of Chinook landed in troll fisheries are caught as they are migrating to their natal streams and genetic analyses demonstrate they include stocks from Oregon through Canada (Gilk-Baumer et al. 2017) (Gilk-Baumer et al. 2017b). From 1985 to 2010, 96% of Chinook caught in SE Alaska did not originate from the region; there are estimates that up to 18% of Chinook may originate from ESA-listed Chinook runs (Blyth-Skyrme et al. 2013). Because Chinook from outside of Southeast Alaska comprise a large proportion of catches, and these fish may be from threatened or endangered populations, we have awarded a score of "high" concern.

Justification:

The Chinook Salmon Research Initiative was established in 2013 to study declining Chinook salmon runs in Alaska rivers and make research recommendations. Twelve river systems of varying sizes were chosen across Alaska as “indicator stocks”; nine of these river systems empty into the Gulf of Alaska (ADFG 2013). The ADFG sets escapement goals, which are measured in numbers of fish returning to freshwater habitat for spawning. There has been widespread decline in escapement across Alaska, starting around 2004 to 2007, but most of these indicator stocks meet most management goals greater than 50% of the time and are deemed relatively healthy (Munro and Volk 2015). ADFG notes that these fish have generally good freshwater spawning success and fry survival, and attributes the declines to poor survival in smolt stages upon migration to salt water, possibly driven by large-scale oceanographic changes (ADFG 2013).

Contribution to commercial troll fisheries by Chinook from populations originating outside of Alaska is significant, depending on the time of year. For example, between 2010 and 2014, the spring fishery was composed mostly of fish originating in Alaska, but during other reporting periods, Chinook from the lower US states and Canada comprised the majority of landings (Gilk-Baumer et al. 2017b). The contribution by Chinook not originating in Alaska has persisted across the time-scale of these reported genetic studies (2004 to 2016)(Gilk-Baumer et al. 2017) (Gilk-Baumer et al. 2017b). There is a significant contribution by SA-listed Evolutionary Significant Units (ESUs), which include Chinook from Puget Sound, Upper Willamette River, Lower Columbia Bright and Snake River Fall; contributions by runs in each of the ESUs are generally small, but 5 of the 11 runs in these ESUs represent more than 5% (and up to 18%) of the Southeast Alaska catches of Chinook salmon (Blyth-Skyrme et al. 2013).

Factor 2.2 - Fishing Mortality

UNITED STATES OF AMERICA / GULF OF ALASKA, TROLLING LINES

High Concern

Chinook salmon in Alaska are managed by the Alaska Department of Fish and Game (ADFG). Formal stock assessment began in 2014, but there are no stock assessment reports or estimates of fishing mortality available (ADFG 2013). General trends for the nine indicator Chinook stocks in the Gulf of Alaska demonstrate a decline in escapement and productivity in recent years (ADFG 2013). ADFG sets escapement goals (number of fish returning to freshwater habitat to spawn) with a “high degree of precaution” for each river system (ADFG 2013). Additionally, genetic analyses have demonstrated a >5% contribution by 5 of 11 runs from four ESUs: Puget Sound, Upper Willamette, Lower Columbia Bright, and Snake River Fall (Blyth-Skyrme et al. 2013). Due to the lack of fishing mortality estimates, indication of declines in Gulf of Alaska originating Chinook in recent years, and demonstrated contributions to the fishery by ESA-listed Chinook runs, we have rated Chinook salmon fishing mortality as “high" concern.

Justification:

Chinook salmon in the river habitat is caught by commercial, recreational, and subsistence fishers using a

variety of methods. Chinook salmon is also caught as bycatch in the offshore groundfish and pollock fisheries; limits on salmon bycatch in these federally-managed fisheries are set by the North Pacific Fisheries Management Council.

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

UNITED STATES OF AMERICA / GULF OF ALASKA, TROLLING LINES

< 100%

Trolling gear included in this report are primarily used to capture salmon, but lingcod may be landed as bycatch. Limited discard or bait use data exist for this fishery to quantify a discard to landings ratio. Salted herring is a common bait used to target chinook salmon, but lures are also used to target other salmonids (R. Ehresmann, personal communication 2018). Because handline fisheries generally have low discard rates, there is evidence to suggest that landings of non-target species are well below 100%, and bait use is unknown but unlikely to increase the discard+bait use/landings ratio substantially, we have awarded a score of "1" or <100%.

YELLOWEYE ROCKFISH

Factor 2.1 - Abundance

UNITED STATES OF AMERICA / GULF OF ALASKA, JIG
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES, PACIFIC HALIBUT LONGLINE

High Concern

Yelloweye rockfish (*Sebastes ruberrimus*) is managed as part of the demersal shelf rockfish complex. The most recent stock assessment evaluated demersal shelf rockfish in the Southeast Outside (SEO) District of the Gulf of Alaska using remotely operated vehicle (ROV) surveys; the statistical age-structured assessment model was not available for the most recent assessment (Olson et al. 2018). From 2018 to 2019, the estimated yelloweye rockfish biomass increased from 11,508 MT to 12,029 MT, which was driven by an increase in the average weight of yelloweye sampled; long-term trends indicate a decline in biomass (Olson et al. 2018). Surveys show a decline in yelloweye rockfish density in all management areas in recent years, except for Central Southeast Outside (CSEO) (Olson et al. 2018). Reliable estimates of spawning biomass and recruitment are not available.

The stock assessment report notes that species in the demersal shelf rockfish complex are "particularly

vulnerable to overfishing given their longevity, late maturation, and habitat-specific residency" (Olson et al. 2016), and a productivity sensitivity analysis indicates this species has a "high vulnerability" (see below). Due to the declines in yellow rockfish densities, and the vulnerable nature of this species, we have rated its abundance as "high" concern.

Justification:

The North Pacific Fishery Management Council manages yelloweye rockfish under the Gulf of Alaska Groundfish Fishery Management Plan. The demersal shelf rockfish complex is managed as a single stock. Estimated densities of yelloweye rockfish from submersible and ROV surveys have declined in the Gulf of Alaska from the late 1990s to 2015, indicating possible declining abundance (Olson et al. 2016). Surveys are conducted in four management areas in the SEO. Current funding allows for one survey per year; managers hope to conduct a region-wide assessment in the future (Olson et al. 2016).

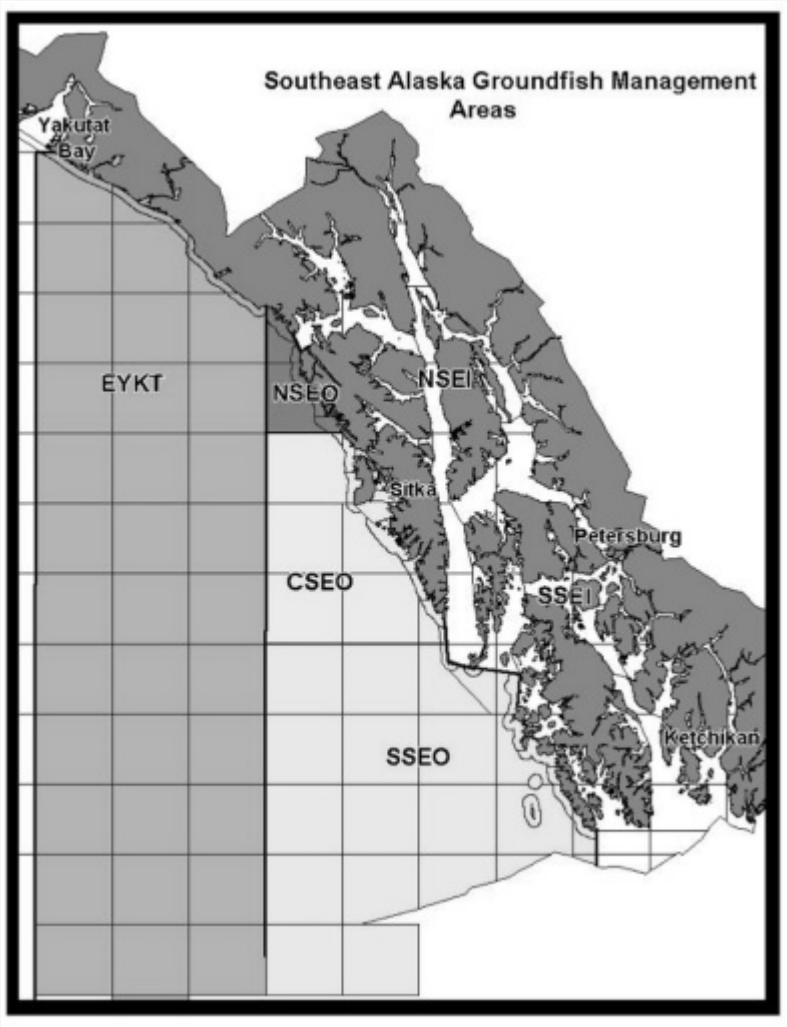

Figure 9 Southeast Outside (SEO) Subdistrict used to manage the demersal shelf rockfish fishery: East Yakutat (EYKT), Northern Southeast Outside (NSEO), Central Southeast Outside (CSEO), and Southern Southeast Outside (SSEO). Figure from: Olson et al. 2018.

The PSA score for yelloweye rockfish = 3.26. For this reason, the species is deemed as having a "high vulnerability." Detailed scoring of each attribute is shown below.

Productivity analysis for yelloweye rockfish, *Sebastes ruberrimus*

PRODUCTIVITY ATTRIBUTE	RELEVANT INFORMATION (REFERENCE)	PRODUCTIVITY SCORE
AVG. AGE AT MATURITY	18 years (Kronlund and Yamanaka 2001)	3
AVG. MAXIMUM AGE	44+ years (Kerr et al. 2003) (Kronlund and Yamanaka 2001)	3
FECUNDITY	2 million eggs (McGreer and Frid 2017)	1
AVG. MAXIMUM SIZE	91 cm (ADFG 2017g)	1
AVG. SIZE AT MATURITY	46 cm (Kronlund and Yamanaka 2001)	2
REPRODUCTIVE STRATEGY	Live bearer (McGreer and Frid 2017)	3
TROPHIC LEVEL	4.4 (Froese and Pauly 2016)	3
HABITAT QUALITY	Unknown	-

Susceptibility analysis for yelloweye rockfish, *Sebastes ruberrimus*

SUSCEPTIBILITY ATTRIBUTE	RELEVANT INFORMATION (REFERENCE)	SUSCEPTIBILITY SCORE
AREAL OVERLAP	Southern California to western Alaska (McGreer and Frid 2017)	3
VERTICAL OVERLAP	48 to 1800 ft distribution (ADFG 2017g)	3
SELECTIVITY OF FISHERY	No suggested exceptional selectivity (ADFG 2017g)	2
POST-CAPTURE MORTALITY	Retained, or possibility of barotrauma (ADFG 2017g)	3

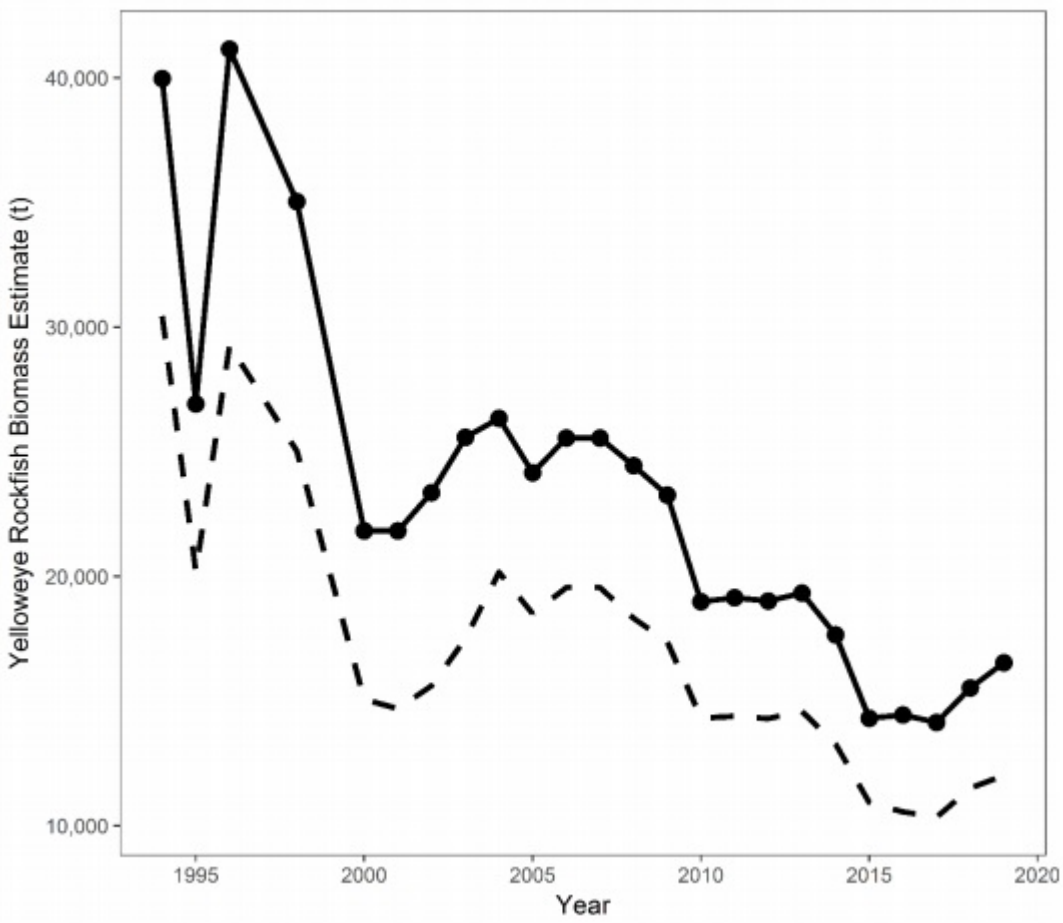

Figure 10 Yelloweye rockfish biomass estimate (t) (solid line) and 90% lower confidence interval (dashed line) for the Southeast Outside Subdistrict from 1994 to 2018. Figure from: Olson et al. 2018.

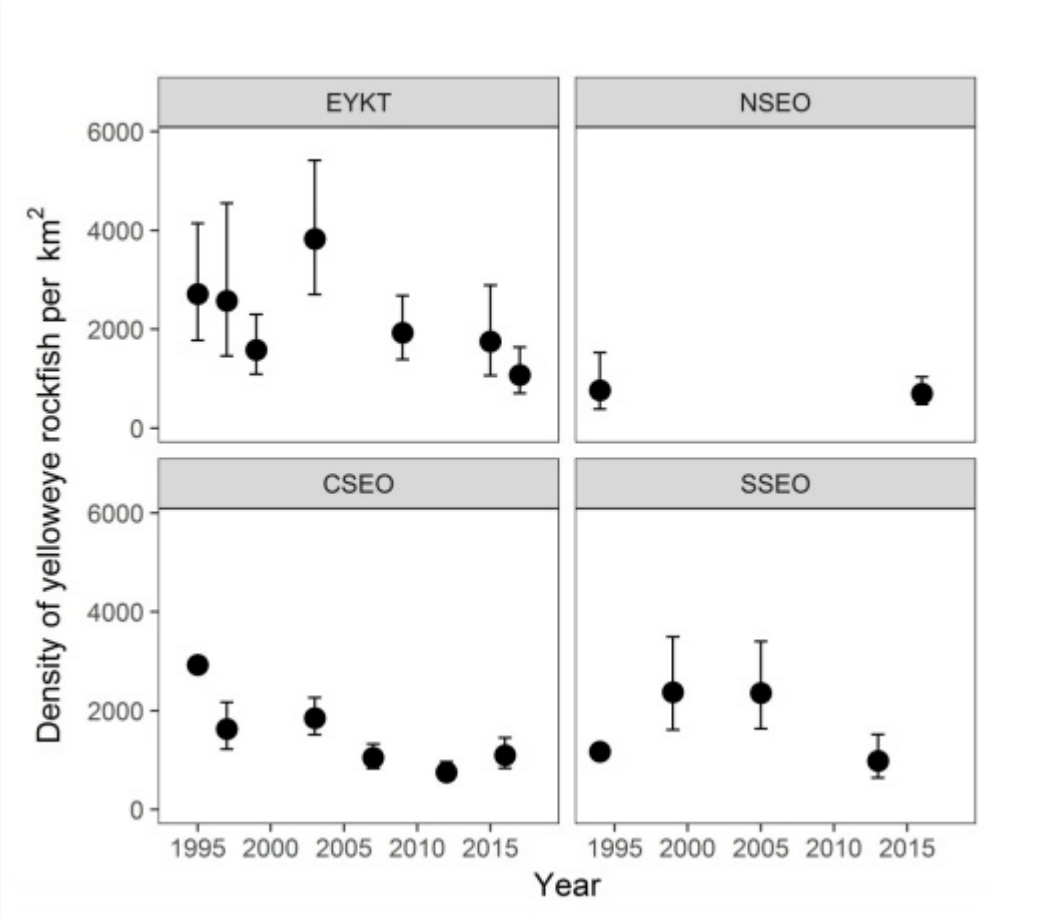

Figure 11 Density of yelloweye rockfish predicted by DISTANCE (circles) +/- two standard deviations in each management area (Central Southeast Outside (CSEO), East Yakutat (EYKT), Southern Southeast Outside (SSEO), and Northern Southeast Outside (NSEO). Figure from: Olson et al. 2018.

Factor 2.2 - Fishing Mortality

UNITED STATES OF AMERICA / GULF OF ALASKA, JIG
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES, PACIFIC HALIBUT LONGLINE

Low Concern

The maximum allowable acceptable biological catch (ABC) for the rockfish complex in 2018 was 319 MT, but the recommended catch is lower than the maximum allowed (Olson et al. 2018). In 2018, the actual catch (research + commercial + recreational + subsistence) was 181 MT, well below the total allowable catch (250 MT) and overfishing level (394 MT).

The demersal shelf rockfish (DSR) complex (including yelloweye rockfish) in the Gulf of Alaska is not subject to overfishing (Olson et al. 2018). The DSR assemblage is managed conservatively due to its life history vulnerabilities. Because fishing mortality is well below the overfishing level, we have rated fishing mortality for yelloweye rockfish as "low" concern.

Justification:

The overfishing level is set using $F_{35\%}$ = 0.032 (Olson et al. 2018). The total allowable catch (TAC) is divided by commercial (84%) and sport (16%) fisheries, and is set after deducting the estimated subsistence catch (7 MT in 2018) (Olson et al. 2018).

To determine the ABC for the DSR complex, the lower bound of the 90% confidence interval of the yelloweye rockfish biomass for the region is multiplied by the natural mortality rate (M = 0.02) and average estimated harvest from all fisheries of other species in the DSR assemblage is added to the yelloweye rockfish ABC (Olson et al. 2017).

Quantity	As estimated or *specified last* year for: 2018	2019	As estimated or *recommended this* year for: 2019	2020
M (natural mortality rate)	0.02	0.02	0.02	0.02
Tier	4	4	4	4
Yelloweye Biomass (t)	11,508		12,029	
$F_{OFL}=F_{35\%}$	0.032	0.032	0.032	0.032
$maxF_{ABC}$	0.026	0.026	0.026	0.026
F_{ABC}	0.020	0.020	0.020	0.020
DSR OFL (t)	394	394	411	411
DSR max ABC (t)	319	319	333	333
ABC (t)	250	250	261	261
Status	As determined last year for: 2016	2017	As determined this year for: 2017	2018
Overfishing	No	n/a	No	n/a

Figure 12 Reference values for the demersal shelf rockfish complex in the Southeast Outside Subdistrict of the Gulf of Alaska. Table from: Olson et al. 2018

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

UNITED STATES OF AMERICA / GULF OF ALASKA, JIG

< 100%

Jig gear in this report includes rod and reel and dinglebar troll gear, both of which are relatively species-specific. Limited discard and bait use data exist for these fisheries to quantify a discard to landings ratio. In targeted jig (dinglebar troll) fishery for lingcod, species like rockfish account for 3 to 7% of the landings (ADFG 2016d) and either lures, bait, or lures soaked in bait to scent the lures may be used (ADFG 2016a) (Vaughn, personal communication 2018). In the Western region, very few lingcod are discarded in the jig fishery, which

primarily focuses on rockfish; in most years discards of lingcod are zero in this fishery (ADFG 2016c). Because jig fisheries generally have low discard rates, there is evidence to suggest that landings of non-target species are well below 100%, and there is no evidence to suggest bait use would increase the discard rate substantially, we have awarded a score of "1" or <100%.

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.

Criterion 3 Summary

Fishery	Management Strategy	Bycatch Strategy	Research and Monitoring	Enforcement	Stakeholder Inclusion	Score
Fishery 1: United States of America / Gulf of Alaska | Jig	Moderately Effective	Highly Effective	Moderately Effective	Highly Effective	Highly Effective	Yellow (3.000)
Fishery 2: United States of America / Gulf of Alaska | Set longlines	Highly Effective	Highly Effective	Moderately Effective	Highly Effective	Highly Effective	Green (4.000)
Fishery 3: United States of America / Gulf of Alaska | Set longlines | Pacific halibut longline	Highly Effective	Highly Effective	Moderately Effective	Highly Effective	Highly Effective	Green (4.000)
Fishery 4: United States of America / Gulf of Alaska | Trolling lines	Highly Effective	Moderately Effective	Moderately Effective	Highly Effective	Highly Effective	Green (4.000)

Several types of gear are used that target and/or incidentally catch and retain lingcod and other species in the

Gulf of Alaska. We have scored management according to the collective management of the main targeted and retained species:

1) The lingcod targeted jig fishery (dinglebar in the Southeast region and mechanical jig in the Central region), which also targets rockfish. Yelloweye rockfish commonly accounts for >5% of the catch in the Southeast region, while black rockfish is targeted alongside lingcod in Cook Inlet in the Central region. Of lingcod harvest, 92% in Cook Inlet is from the directed jig fishery, while 91% of the harvest in Prince William Sound (PWS) is in the directed longline fishery {ADFG 2018}. Because targeted and retained species differ between longlines and jigs, only management in the the Cook Inlet area fishery and Southeast region fishery is considered in the jig score.

2) The directed salmon fishery (troll) in the Southeast region, which also targets and retains lingcod, yelloweye rockfish, coho salmon, chinook salmon, and black rockfish. Demersal shelf rockfish (which includes yelloweye rockfish) landings averaged just 3,030 lb in the salmon troll fishery over the last 10 years {Hagerman et al. 2017}; however, commercial interest is increasing. Pelagic shelf rockfish (which includes black rockfish) landings averaged 17,868 lb over the same time period in the salmon troll fisheries. Fishing mortality for black rockfish primarily occurs in salmon fisheries, and the directed black rockfish landings have consistently been less than half of the total black rockfish landings (bycatch + directed) in Southeast Alaska {Hagerman et al. 2017}. Therefore, black rockfish is considered a main species. The salmon troll fishery is neither a major contributor to lingcod fishing mortality {ADFG 2018}, nor does lingcod account for >5% of the catch in the salmon troll fishery {Blyth-Skyrme et al. 2013}. Therefore, lingcod is not considered a main species.

3) The halibut and sablefish-directed longline fishery in the Southeast region, which retains Pacific cod, lingcod, and several species of rockfish. All of these targeted and retained species are considered main species.

In the Westerly region, most lingcod are landed as retained bycatch in the trawl fisheries, but many are discarded. Lingcod bycatch in this region peaked in 2008, and managers reduced the total lingcod that could be retained from 20% to 5% {ADFG 2014}. Those fisheries are not scored in this report.

Criterion 3 Assessment

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.

UNITED STATES OF AMERICA / GULF OF ALASKA, JIG

Moderately Effective

Lingcod Management
The Alaska Department of Fish and Game (ADFG) manages lingcod in both state and federal waters in Alaska (ADFG 2016b), but currently, no fisheries-independent measures of abundance have been able to estimate biomass. Lingcod was overfished in Resurrection Bay, but no formal rebuilding plan exists for this population (ADFG 2014). Management is split into Southeast, Central, and Western regions, all of which have slight variations in management of lingcod within those regions (ADFG 2014). Jigs (primarily dinglebar gear) are used in targeted lingcod fishery in the Southeast Region, while longlines and mechanized jigs are used in the Central region to target lingcod and rockfish.

The species is managed conservatively in Alaska, with seasonal closures from 1 December to 15 May to prevent capture while males are guarding nests, areal closures to protect habitat and areas where the species is depleted, and limiting retention as bycatch in other fisheries (5% in halibut fishery and 35% in demersal shelf rockfish fishery) (ADFG 2016a). TACs are based on historical catches and management has responded to increased bycatch of lingcod by limiting retention of the species in other fisheries (Olson et al. 2017). All vessels in the directed fishery must be registered and harvest levels are applied conservatively in the central and southeast Gulf of Alaska (ADFG 2015). Minimum commercial sizes of 27 in to 35 in, depending on region, ensure that the fish reproduces at least once before it is landed, and slot limits are used in the recreational fishery (ADFG 2016a). Lingcod are managed by guideline harvest ranges (GHR) with allocation between fishing sectors and areas (Olson et al. 2017). In Cook Inlet (Central region), the GHL is set at 52,500 lb, which is based on 75% of the average harvest during 1992 to 1996 (Rumble et al. 2016). Taken together, these suggest that lingcod management and implementation is highly effective, despite lacking a quantitative stock assessment.

Yelloweye Rockfish

Yelloweye rockfish are managed by ADFG in several management areas within the Gulf of Alaska with oversight from the North Pacific Fishery Management Council (Council), which develops the Fishery Management Plan for Groundfish in the Gulf of Alaska (ADFG 2018). Yelloweye rockfish is managed under the demersal shelf rockfish assemblage (DSR) along with quillback, China, copper, rosethorn, canary and tiger rockfish (ADFG 2018). Management measures include GHRs (determined by the Council), seasonal closures, gear restrictions and trip limits; only hook and line gear may be used in directed fisheries; quotas are determined by biennial stock assessments, and bycatch limits are placed on other fisheries that incidentally catch rockfish (ADFG 2018) (Olson et al. 2016). Fishers in the lingcod directed fishery in Cook Inlet (Central region) participate concurrently in the directed rockfish fishery (ADFG 2018).

In the Southeast region in 2018, the maximum acceptable biological catch (ABC) for the DSR is 319 t (299 t of yelloweye), the overfishing limit (OFL, $F_{35\%}$) is 394 t, and the TAC is set below both reference values at 250 t (Olson et al. 2018). The method to determine ABC is more conservative than using $F_{40\%}$ and the OFL is set using a rate of $F_{30\%}$; however, despite these precautionary measures, yelloweye rockfish biomass continues to decrease in the Southeast District (Olson et al. 2017). Only the East Yakutat Section (EYKT) and internal waters were opened to directed fisheries for DSR in 2017 because of low TAC allocations (ADFG 2018). There is no stock assessment for internal waters (Northern Southeast Inside and Southern Southeast Inside Subdistricts) and the GHL is set at approximately half of GHR (Olson et al. 2017). There is no directed fishery for DSR in Cook Inlet, and these rockfish may only be taken as bycatch in halibut and directed groundfish fisheries (10%) and pelagic shelf rockfish (PSR) jig fishery (20%) (Rumble et al. 2016).

Black Rockfish

Black rockfish are part of the pelagic shelf rockfish (PSR) assemblage and are targeted alongside lingcod. Other PSR species include dusky rockfish, dark rockfish, yellowtail rockfish, widow rockfish, and blue rockfish (Rumble et al. 2016), but those species account for <5% of the catch in the jig fishery landing lingcod in this region (ADFG 2017a). Black rockfish is managed by the state of Alaska. Management measures for all rockfish within Cook Inlet include a GHL of 150,000 lb, mandatory retention, 5-day trip limits, bycatch limits in other fisheries, season closures, logbook and registration requirements, and gear restrictions (Rumble et al. 2016). Overall, the directed fisheries in both Central and Southeast regions are small and conservatively managed (ADFG 2017c).

Species like lingcod and black rockfish lack reference points, but are managed conservatively by the state of Alaska. Management is in place for yelloweye rockfish, but abundance has been declining for this species. Lingcod and black rockfish do not meet the criteria for a highly effective score. Because precautionary measures and harvest control rules are in place that are expected to be effective for these species, we award a score of "moderately effective."

Justification:

Map Key:

- Central Southeast Outside (CSEO) Section
- East Yakutat (EYKT) Section
- Icy Bay Subdistrict (IBS)
- Northern Southeast Inside (NSEI) Subdistrict
- Northern Southeast Outside (NSEO) Section
- Southern Southeast Internal Waters (SSEIW) Sector
- Southern Southeast Outer Coast (SSEOC) Sector

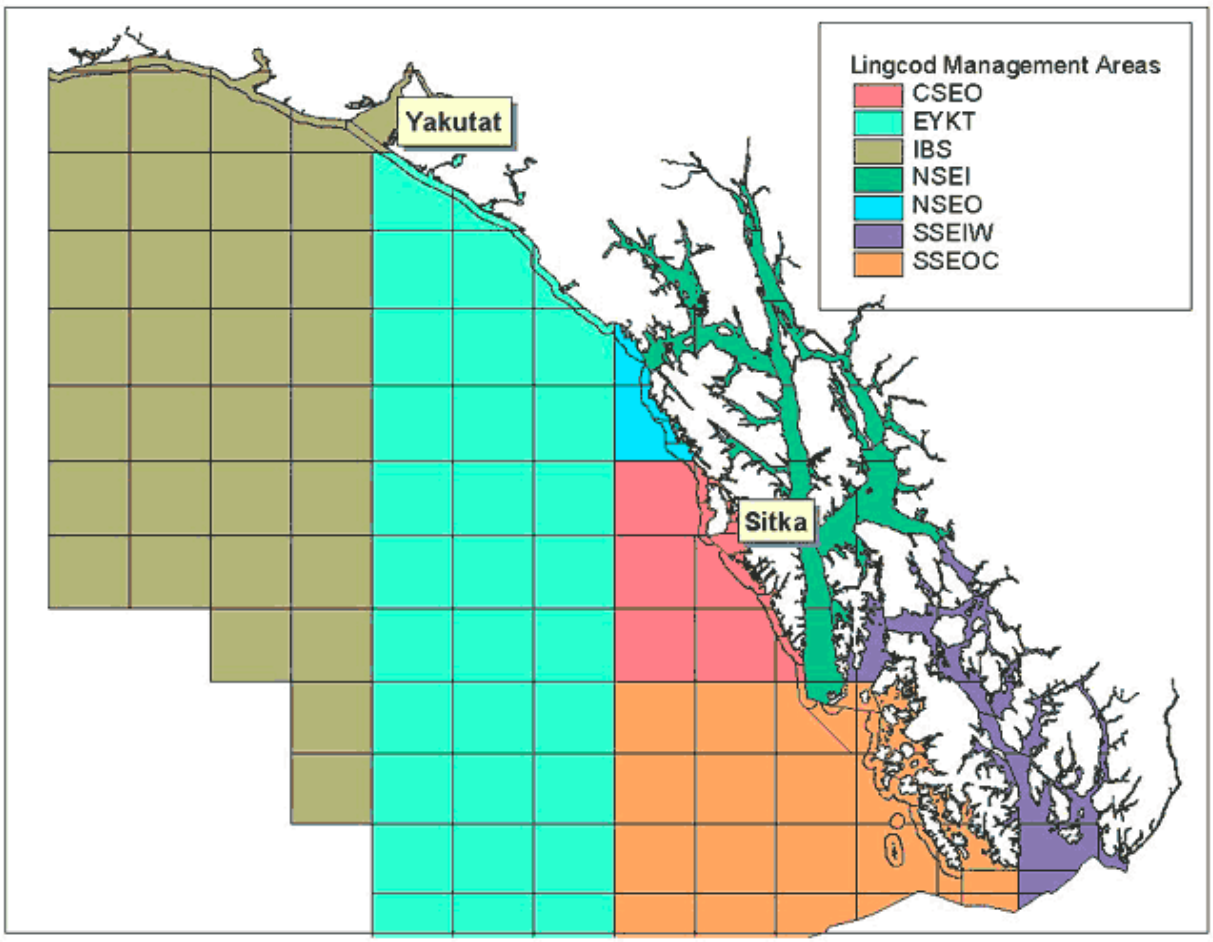

Figure 15 Lingcod management areas in Southeast Alaska & Yakutat Commercial Fisheries. Retrieved from: http://www.adfg.alaska.gov/index.cfm?adfg=commercialbyareasoutheast.lingcod_management_map

Region-Specific Rockfish Management

1) *DSR in the Southeast Region*
-Directed quotas for internal water management areas (NSEI and SSEI) set at 25 MT annually
-Directed quotas for outside waters (NSEO, CSEO, SSEO, EYKY) set based on stock assessment
-6,000 lb trip limit (5-day period) in all areas except EYKT where 12,000 lb is allowed
-Directed fishery occurs 5 January until the day before commercial halibut season, or until quota is met
-TAC is set after considering estimated subsistence harvest and remainder is allocated 84% to commercial fishing and 16% to sport fishing

2) *DSR in the Central Region: Cook Inlet and Prince William Sound (PWS)*

-GHL of 68 MT in each area
-5-day trip limits of 0.5 MT in the Cook Inlet District, 1.8 MT in the North Gulf District, and 1.4 MT in PWS
-5% rockfish bycatch limit for jig gear during state-waters cod season
-PWS closed to directed fishery, and is now a bycatch-only fishery with mandatory full retention of all rockfish
-Cook Inlet Areas has a full retention requirement for rockfish, with a directed harvest allowed only for pelagic shelf rockfish
-Cook Inlet rockfish bycatch levels are 20% in the sablefish fishery, 5% in the Pacific cod fishery, and 10% in all other directed fisheries

3) *PSR in Cook Inlet Area*
-Season open from 1 July to 31 December unless closed by emergency order
-Legal gear restricted to jig and hand troll
-Logbooks required
-Registration required
-150,000 lb GHL for all rockfish species combined
-Mandatory retention
-Cook Inlet rockfish bycatch levels are 10% in the halibut and directed groundfish fisheries and 20% DSR in the directed PSR jig fishery

UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES, PACIFIC HALIBUT LONGLINE

Highly Effective

Longline Fisheries Management
Two longline fisheries retain lingcod in significant numbers. The halibut longline fishery is managed by the International Pacific Halibut Commission (IPHC) and the North Pacific Fishery Management Council (NPFMC) (Stewart and Martell 2017). The demersal shelf rockfish (DSR) are managed by Alaska Department of Fish and Game (ADFG) within state and federal waters in the Southeast Outside (SEO) District (Olson et al. 2017), and by the NPFMC in other regions under the Fishering Management Plan (FMP) for Groundfish in the Gulf of Alaska Management Area (NPFMC 2016b).

Lingcod Management
The Alaska Department of Fish and Game manages lingcod in both state and federal waters in Alaska (ADFG 2016b), but currently, no fisheries-independent measures of abundance have been able to estimate biomass. Lingcod was overfished in Resurrection Bay, but no formal rebuilding plan exists for this population (ADFG 2014). Management is split into Southeast, Central, and Western regions, all of which have slight variations in management of lingcod within those regions (ADFG 2014).

The species is managed conservatively in Alaska, with seasonal closures from 1 December to 15 May to prevent capture while males are guarding nests, areal closures to protect habitat and areas where the species is depleted, and limiting retention as bycatch in other fisheries (5% in halibut fishery and 35% in demersal shelf rockfish fishery) (ADFG 2016a). TACs are based on historical catches and management has responded to increased bycatch of lingcod by limiting retention of the species in other fisheries (Olson et al. 2017). All vessels in the directed fishery must be registered and harvest levels are applied conservatively in the Central and Southeast Gulf of Alaska (ADFG 2015). Minimum commercial sizes of 27 in to 35 in, depending on region, ensure that the fish reproduces at least once before it is landed, and slot limits are used in the recreational fishery (ADFG 2016a). Lingcod are managed by guideline harvest ranges (GHR) with allocation between fishing sectors and areas (Olson et al. 2017). In Cook Inlet (Central region), the GHL is set at 52,500 lb, which is

based on 75% of the average harvest during 1992 to 1996 (Rumble et al. 2016). Taken together, these suggest that lingcod management and implementation is highly effective, despite lacking a quantitative stock assessment.

Yelloweye Rockfish Management

Yelloweye rockfish are managed by ADFG in several management areas within the Gulf of Alaska with oversight from the North Pacific Fishery Management Council (Council), which develops the Fishery Management Plan for Groundfish of the Gulf of Alaska (ADFG 2018). Yelloweye rockfish is managed under the demersal shelf rockfish assemblage (DSR) along with quillback, China, copper, rosethorn, canary and tiger rockfish (ADFG 2018). Management measures include GHRs (determined by the Council), seasonal closures, gear restrictions and trip limits; only hook and line gear may be used in directed fisheries, quotas are determined by biennial stock assessments, and bycatch limits are placed on other fisheries that incidentally catch rockfish (ADFG 2018) (Olson et al. 2016). Fishers in the lingcod directed fishery in Cook Inlet (Central region) participate concurrently in the directed rockfish fishery (ADFG 2018).

In the Southeast region in 2018, the maximum acceptable biological catch (ABC) for the DSR is 319 t (299 t of yelloweye), the overfishing limit (OFL, F35%) is 394 t, and the TAC is set below both reference values at 250 t (Olson et al. 2018). The method to determine ABC is more conservative than using F40% and the OFL is set using a rate of F30%; however, despite these precautionary measures, yelloweye rockfish biomass continues to decrease in the Southeast District (Olson et al. 2017). Only the East Yakutat Section (EYKT) and internal waters were opened to directed fisheries for DSR in 2017 because of low TAC allocations (ADFG 2018). There is no stock assessment for internal waters (Northern Southeast Inside and Southern Southeast Inside Subdistricts) and the GHL is set at approximately half of GHR (Olson et al. 2017). There is no directed fishery for DSR in Cook Inlet, and these rockfish may only be taken as bycatch in halibut and directed groundfish fisheries (10%) and pelagic shelf rockfish (PSR) jig fishery (20%) (Rumble et al. 2016).

Co-Landed Species Management

Most other species commonly landed in the longline fisheries for halibut and DSR with lingcod are generally well-managed and are not overfished or experiencing overfishing. Stock assessments are conducted for most species in this fishery and harvest control rules are in place. Pacific halibut is actively managed as a single stock within 10 management areas by the IPHC and NPFMC, with target (30% of unfished spawning biomass, B_0 ($B_{30\%}$), 153 million lb) and limit reference points ($B_{20\%}$, 102 million lb) defined (Morgan et al. 2016). Groundfish are managed so that acceptable biological catch (ABC) is lower than overfishing limit (OFL); the total acceptable catch (TAC) can equal but not exceed ABC. Tier 3 stocks include rougheye rockfish, Pacific cod, and sablefish; tier 4 stocks include yelloweye rockfish; tier 5 stocks include shortraker rockfish and shortspine thornyhead rockfish. See description of tier system below.

Shortraker and yelloweye rockfish have demonstrated trends of declining abundance in recent years, and combined with high vulnerability to fishing, it is uncertain if management in place is effective for those species. However, because more than 70% of the targeted or retained species have set reference points and are conservatively and/or well managed, and no stocks are considered overfished we have awarded a score of "highly effective."

Justification:

Groundfish are managed under a tier system in Alaska. Stocks managed under Tier 3 have OFLs and ABCs derived from stock-specific estimates of biomass (B), the fishing mortality rate estimated to result in 40% of the equilibrium level of spawning per recruit that would occur in the absence of fishing ($F_{40\%}$), and the long-term average biomass expected under $F_{40\%}$ and average recruitment ($B_{40\%}$). Tier 4 stocks have reliable estimates of B, $F_{30\%}$, and $F_{40\%}$. Tier 5 stocks are those for which reliable estimates of B and natural mortality (M) exist, but $F_{40\%}$ and $F_{35\%}$ do not. Tier 5 stocks are therefore managed with OFLs and ABCs that are derived from B and M such that F_{OFL} = M, and maxF_{ABC} = 0.75*M.

UNITED STATES OF AMERICA / GULF OF ALASKA, TROLLING LINES

Highly Effective

Troll Fisheries Management

The salmon fishery in Alaska is actively managed by the Alaska Department of Fish and Game (ADFG) through a limited entry program with regulations established by the Board of Fisheries (BOF) (Clark et al. 2006). This fishery also falls under regulations of The North Pacific Fishery Management Council, National Marine fisheries Service, and the US/Canada Pacific Salmon Commission (Hagerman and Ehresmann 2018). The troll fishery operates in both federal and state waters, is the primary gear used for coho and Chinook salmon (Gilk-Baumer et al. 2017), and has accounted for roughly 5% of the total commercial salmon harvest in Southeast Alaska since 1959 (Clark et al. 2006). Among other things, ADFG monitors progress towards escapement goals, provides annual salmon stock status reports, and develops Action Plans for stocks of concern (Blyth-Skyrme et al. 2013). The Pacific Salmon Treaty is an international agreement with the US, Canada, and First Nations that provided policy and management guidance for salmon stocks in Southeast Alaska and other areas (Blyth-Skyrme et al. 2013). Under the Pacific Salmon Treaty, the Pacific Salmon Technical Committee determines the annual Chinook salmon quota, Alaska BOF allocates their portion of the quota to commercial and sport fisheries, and Chinooks are assessed under 11 indicator stocks within Southeast Alaska that are all considered healthy; similarly, coho salmon are managed under numerous, predominantly healthy indicator stocks. Fishing seasons are broken into winter, spring, and summer fisheries, with in-season management implemented according to seasonal management plans (Hagerman and Ehresmann 2018).

Lingcod Management

ADFG manages lingcod in both state and Federal waters in Alaska (ADFG 2016b), but currently, no fisheries-independent measures of abundance have been able to estimate biomass. Lingcod was overfished in Resurrection Bay, but no formal rebuilding plan exists for this population (ADFG 2014). Management is split into Southeast, Central, and Western regions, all of which have slight variations in management of lingcod within those regions (ADFG 2014).

The species is managed conservatively in Alaska, with seasonal closures from 1 December to 15 May to prevent capture while males are guarding nests, areal closures to protect habitat and areas where the species is depleted, and limiting retention as bycatch in other fisheries (5% in halibut fishery and 35% in demersal shelf rockfish fishery) (ADFG 2016a). TACs are based on historical catches and management has responded to increased bycatch of lingcod by limiting retention of the species in other fisheries (Olson et al. 2017). All vessels in the directed fishery must be registered and harvest levels are applied conservatively in the Central and Southeast Gulf of Alaska (ADFG 2015). Minimum commercial sizes of 27 to 35 in, depending on region, ensure that the fish reproduces at least once before it is landed, and slot limits are used in the recreational fishery (ADFG 2016a). Lingcod are managed by guideline harvest ranges (GHR) with allocation between fishing sectors and areas (Olson et al. 2017). In Cook Inlet (Central region), the GHL is set at 52,500 lb, which is based on 75% of the average harvest during 1992 to 1996 (Rumble et al. 2016). Taken together, these suggest that lingcod management and implementation is highly effective, despite lacking a quantitative stock assessment.

Salmon

Coho salmon landed with lingcod, as either primary targets or retained bycatch, exhibit low to high concern over abundance (Shaul et al. 2011) (Olson et al. 2016). Chinook salmon is actively managed under several

Action Plans because eight of nine indicator stocks are below target escapement goals (ADFG 2013) (NPFMC 2017). The North Pacific Fishery Management Council, which managed Chinook salmon, is actively revising the Fishery Management Plan for this species (NPFMC 2017). The number of Coho salmon indicator stocks in Southeast Alaska that met or exceed escapement goals averaged 94% from 2001 to 2016 (Munro and Volk 2010)(Munro and Volk 2017), indicating that management has been effective. For Chinook salmon in the Southeast region, an average of 73% of indicator stocks have met or exceeded escapement goals during the same time period (Munro and Volk 2010) (Munro and Volk 2017). However, many of these Chinook may be from overfished populations, since a large portion of Chinook captured in this fishery are migrating through the area on their way to natal streams (Gilk-Baumer et al. 2017) (Gilk-Baumer et al. 2017b). Because this may include some endangered or threatened populations (Blyth-Skyrme et al. 2013), it is unclear if management is protective of these populations.

Black Rockfish

Black rockfish are part of the pelagic shelf rockfish (PSR) assemblage and are targeted alongside lingcod. Other PSR species include dusky rockfish, dark rockfish, yellowtail rockfish, widow rockfish, and blue rockfish (Rumble et al. 2016), but only black rockfish is considered a main species according to the Seafood Watch Standard. Black rockfish is managed by the state of Alaska. Management measures for all rockfish within Cook Inlet include a GHL of 150,000 lb, mandatory retention, 5-day trip limits, bycatch limits in other fisheries, season closures, logbook and registration requirements, and gear restrictions (Rumble et al. 2016). Overall, the directed fisheries in both Central and Southeast regions are small and conservatively managed (ADFG 2017c)

Species like lingcod and black rockfish lack reference points, but are managed conservatively. Coho salmon stocks are rarely below escapement goals, indicating highly effective management. Chinook salmon is overfished, and it is unclear if management is protective of endangered or threatened stocks that may be retained in this fishery. For the two main species with reference points established, precautionary policies are in place (e.g., escapement goals) and Action Plans are mandated for stocks of concern. Appropriate management strategies for data-poor stocks like lingcod. Because at least 70% of the main species have highly effective management strategies, we award a score of "highly effective."

Justification:

The following rules are outlined in the Salmon Troll Fishery Management Plan (Hagerman and Ehresmann 2018): Salmon troll fishers are allowed to take lingcod from 16 May to 30 November; any lingcod retained in the excess of bycatch allowances must be reported as overage and forfeited to the State; commercial salmon trollers may only possess two lingcod for personal use, only while actively fishing for salmon within the Sitka Sound Local Area Management Plan during the CSEO lingcod season.

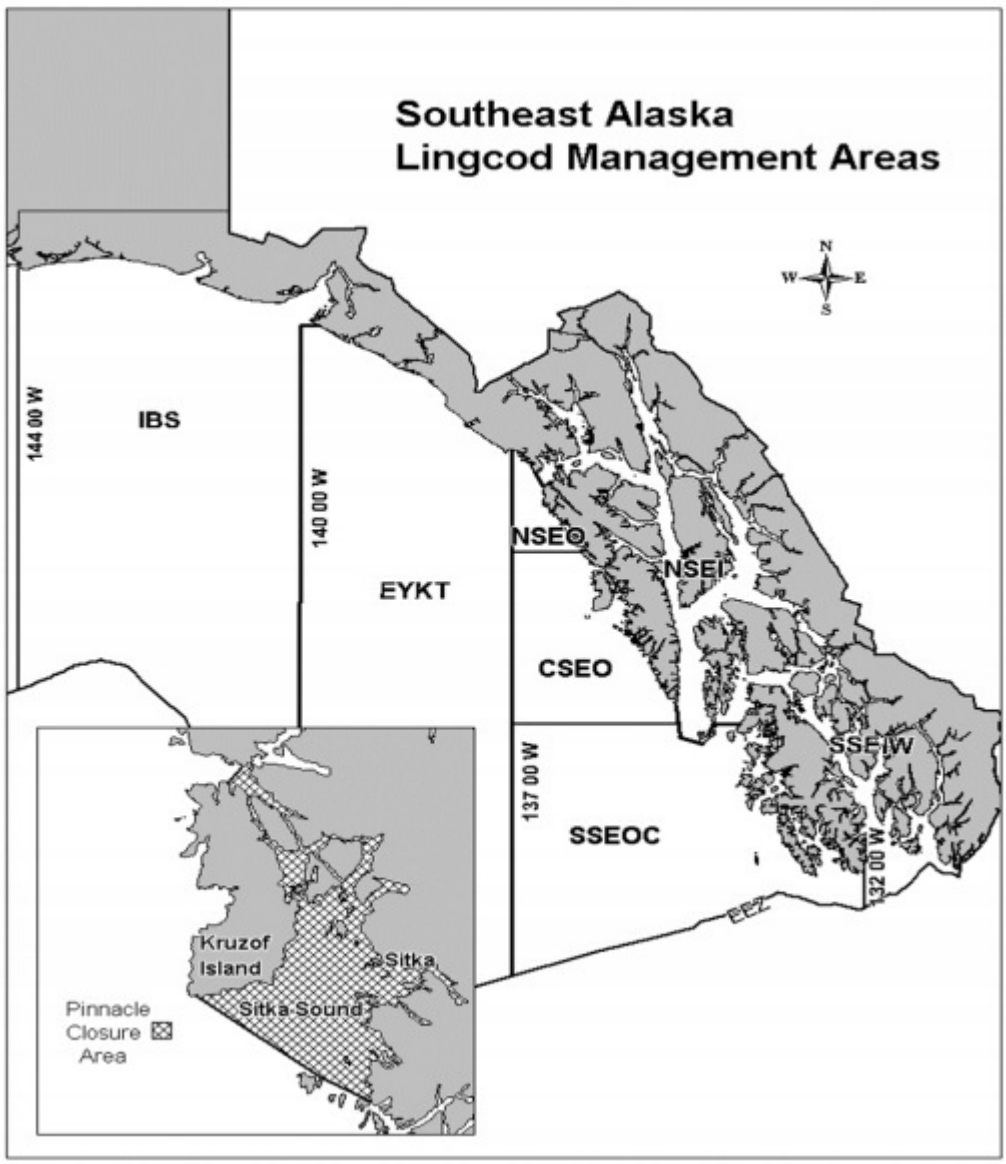

Figure 16 Alaska Lingcod Management Areas and Restricted Waters of Sitka Sound, Southeast Alaska. From: Hagerman and Ehresmann 2018.

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.

UNITED STATES OF AMERICA / GULF OF ALASKA, JIG

Highly Effective

Jig fisheries generally have few discards of unintended finfish species (NPFMC 2013) (2016 Seafood Watch Criteria) (Gordon 1994). All rockfish must be retained because those caught in deep water suffer barotrauma, which leads to a high rate of mortality (Rumble et al. 2016). Some susceptible areas with coral thickets have been closed to fishing activity in the eastern Gulf of Alaska to help protect these habitats and reduce

invertebrate bycatch and damage to species like coral. However, there is generally little to no damage expected from jig gear to coral habitats (Stone & Shotwell 2009) (Stone et al. 2015).

Because bycatch is expected to be low for jig fisheries we have awarded a score of "highly effective."

UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES, PACIFIC HALIBUT LONGLINE

Highly Effective

Discards of unintended finfish species are expected to be low to moderate for benthic longline fisheries (NPFMC 2013) (2016 Seafood Watch Criteria). Strict regulations in the benthic longline fisheries for seabird bycatch reduction have been incredibly effective in reducing gear interactions over the past decade (Dietrich and Fitzgerald 2010) (Eich et al. 2016) (WSG 2016), but considerable numbers of seabirds are still taken (i.e., nearly 600 albatrosses, and >4,500 non-albatrosses across all Alaskan longline fisheries in 2015) (WSG 2016). All longline vessels >55 ft in length must use paired streamer lines, while vessels from 26 to 55 ft have to use single streamer lines or a buoy bag. Additionally, offal is required to be discarded in a manner that distracts the seabirds from baited hooks (Eich et al. 2016). Mandatory observer coverage was implemented for the halibut longline fleet in 2013. Since the observer program was initiated, annual seabird bycatch off Alaska in halibut longline fisheries is estimated to be 193 birds per year (Eich et al. 2016). Coral and other biogenic habitat (i.e., sponges and anemones) may be damaged, primarily by longline gear (Stone and Shotwell 2009). Some susceptible areas with coral thickets have been closed to fishing activity in the eastern Gulf of Alaska to help protect these habitats and reduce invertebrate bycatch (Stone and Shotwell 2009) (Stone et al. 2015).

Because bycatch is expected to be, or is relatively low, and mitigation measures have been effective at reducing bycatch of vulnerable species, we have awarded a score of "highly effective."

UNITED STATES OF AMERICA / GULF OF ALASKA, TROLLING LINES

Moderately Effective

Troll fisheries generally have few discards of unintended finfish species (NPFMC 2013) (2016 Seafood Watch Criteria) (Gordon 1994). All rockfish must be retained because those caught in deep water suffer barotrauma, which leads to a high rate of mortality (Rumble et al. 2016). Some susceptible areas with coral thickets have been closed to fishing activity in the eastern Gulf of Alaska to help protect these habitats and reduce invertebrate bycatch and damage to species like coral. However, there is generally little to no damage expected from handlines to coral habitats (Stone and Shotwell 2009) (Stone et al. 2015).

Chinook salmon caught in this fishery are demonstrated to originate from outside southeast Alaska, and there is a significant contribution by ESA-listed salmon populations (Blyth-Skyrme et al. 2013). Landings in southeast Alaska have contributed from <1% of a given ESA-listed run's stock total return to >7% (Blyth-Skyrme et al. 2013). There is uncertainty regarding whether the measures in place to reduce impacts on ESA listed salmon species to allow for recovery.

Because bycatch is expected to be low for handline fisheries, but ESA-listed Chinook are caught in this fishery, we have awarded a score of "moderately effective."

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.

UNITED STATES OF AMERICA / GULF OF ALASKA, JIG
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES, PACIFIC HALIBUT LONGLINE
UNITED STATES OF AMERICA / GULF OF ALASKA, TROLLING LINES

Moderately Effective

Lingcod
The directed fishery for lingcod began in 1987 (Gordon 1994), and life history attributes such as migratory patterns and size structure have been studied since the mid 1990s (Jagielo et al. 1996) (ADFG 2015). Lingcod has not been formally assessed to quantify abundance or fishing pressure, however, and recent scientific lingcod research appears to be minimal.

Dockside sampling in the directed lingcod commercial fishery occurs in the Southeast region in major ports, and both skipper interviews and portside surveys are conducted at three ports in the Central region (ADFG 2014) (ADFG 2015). Monitoring of landings including size, sex, and other life history attributes are collected from recreational fisheries at numerous ports throughout the Southeast and Central Gulf of Alaska regions (ADFG 2015). A tagging study is underway to determine movements and exploitation status of lingcod in southeast Alaska where there is a targeted commercial fishery (ADFG 2017d). The State of Alaska is also working to assess levels of pollutants in lingcod tissue (ADEC 2017).

Co-landed species
Other species co-landed with lingcod in the jig and troll fisheries have had formal stock assessments (yelloweye rockfish and coho salmon), although others lack formal evaluation (black rockfish and chinook salmon). Despite this lack of data, the Alaska Dept. of Fish and game does have current research programs in place to monitor factors like black rockfish migration patterns and recompression success in the recreational fishery (ADFG 2017c) and populations dynamics and genetics of chinook salmon (ADFG 2017h). Vessel monitoring systems are not required for the lingcod dinglebar fishery (Federal Register 2009). However, dockside monitoring is commonplace throughout the Gulf of Alaska to monitor jig fisheries and several studies are in place to gather more information about lingcod biology and population status at these monitoring stations (ADFG 2016a).

Co-landed species caught with longlines all have been formally assessed, although uncertainty remains around some of the estimates of abundance and fishing mortality for a few of these species (Pacific halibut, shortraker and yelloweye rockfish). The North Pacific Fishery Management Council oversees management of the majority of fish targeted in the longline fisheries, with research priorities that cover all the species in this report, including current and ongoing studies (NPFMC 2017d). Halibut and other longline fisheries in the Gulf of Alaska currently use electronic monitoring (NPOP 2017), but these vessel monitoring systems are likely to be expanded into use in other fisheries in the coming years (Alaska Dispatch News 2017).

Bycatch monitoring
Observers and vessel monitoring systems are not required in many fixed gear fisheries, including the directed dinglebar fishery for lingcod (NMFS 2015). However, all vessels participating in the longline sablefish and halibut fisheries are required to take part in the observer program (NPFMC 2016b). Bycatch in all these fisheries must be reported in logbooks (ADFG 2016b). However, self-reported bycatch data in logbooks is likely

to be underreported (M. Vaughn, personal communication 2016).

Lingcod is managed conservatively in Alaska (ADFG 2007) with seasonal spawning closures and other facets designed to protect biomass (ADFG 2016a), but only some data on abundance and stock health are collected. Other co-landed species also have data collection in place, but lack formal assessments. Additionally, bycatch monitoring is minimal to moderate. Therefore, we awarded a score of "moderate concern."

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.

UNITED STATES OF AMERICA / GULF OF ALASKA, JIG
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES, PACIFIC HALIBUT LONGLINE
UNITED STATES OF AMERICA / GULF OF ALASKA, TROLLING LINES

Highly Effective

Groundfish fishing permits and vessel registration are required for all boats that land lingcod, along with associated species (ADFG 2016b). Enforcement in the Gulf of Alaska is undertaken by the Alaska Department of Public Safety/Division of Wildlife Troopers in state waters (Grabacki 2008). There are numerous troopers, vessels, and patrol missions to ensure sufficient enforcement of commercial and recreational fishing regulations. NOAA Fisheries Office of Law Enforcement patrols fisheries within federal waters and therefore enforces regulations for a majority of the species in the longline fisheries. In 2015, 95% of NOAA's Office of Enforcement (OE), Alaska investigations focused on enforcement of the Magnuson-Stevens Act and the Northern Pacific Halibut Act (NOAA 2015b). For example, this led to prosecution of illegally caught and sold halibut from Alaskan waters. Both state and federal agencies work closely with the At-Sea Observer Program to ensure regulations are enforced, or illegal activity is reported (Grabacki 2008). Because dockside or at-sea observers independently verify landings with appropriate coverage and regulations are regularly enforced, we have awarded a score of "highly effective."

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.

UNITED STATES OF AMERICA / GULF OF ALASKA, JIG
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES, PACIFIC HALIBUT LONGLINE
UNITED STATES OF AMERICA / GULF OF ALASKA, TROLLING LINES

Highly Effective

The North Pacific Fishery Management Council and NOAA manage many of the fisheries that land lingcod as bycatch, and are inclusive of all stakeholders in their decision making (NOAA Fisheries 2015) (NPFMC 2017b). The Alaska Department of Fish and Game holds regular stakeholder meetings concerning fisheries under their jurisdiction (ADFG 2017f) and manages user conflict in fisheries when it arises (ADFG 2010). We have awarded a score of "highly effective."

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*

Rating cannot be Critical for Criterion 4.

Criterion 4 Summary

Region / Method	Gear Type and Substrate	Mitigation of Gear Impacts	EBFM	Score
United States of America / Gulf of Alaska / Set longlines	2	0	Moderate Concern	Yellow (2.449)
United States of America / Gulf of Alaska / Set longlines / Pacific halibut longline	2	0	Moderate Concern	Yellow (2.449)
United States of America / Gulf of Alaska / Jig	3	0	Moderate Concern	Yellow (3.000)
United States of America / Gulf of Alaska / Trolling lines	5	0	Moderate Concern	Green (3.873)

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 - Physical Impact of Fishing Gear on the Habitat/Substrate

UNITED STATES OF AMERICA / GULF OF ALASKA, JIG

3

The directed fishery for lingcod uses a dinglebar troll; this is modified troll gear using a heavy lead bar that is dragged along the bottom (Figure 16). However, the National Marine Fisheries Service considers the potential

impact to be "minor and insufficient to justify the costs of VMS (Vessel Monitoring Systems)." Logbook data from lingcod dinglebar fisheries suggest that fishing areas do not overlap with most sensitive coral habitat or with rocky reef habitat (Federal Register 2009). However, because this gear comes into near constant contact with the benthos while in use, it has the potential to disrupt and damage benthic habitat and organisms (NPFMC 2016). Because dinglebar trolling has additional contact with bottom than do typical "jig gear," we awarded a score of "3" for moderate impacts.

Justification:

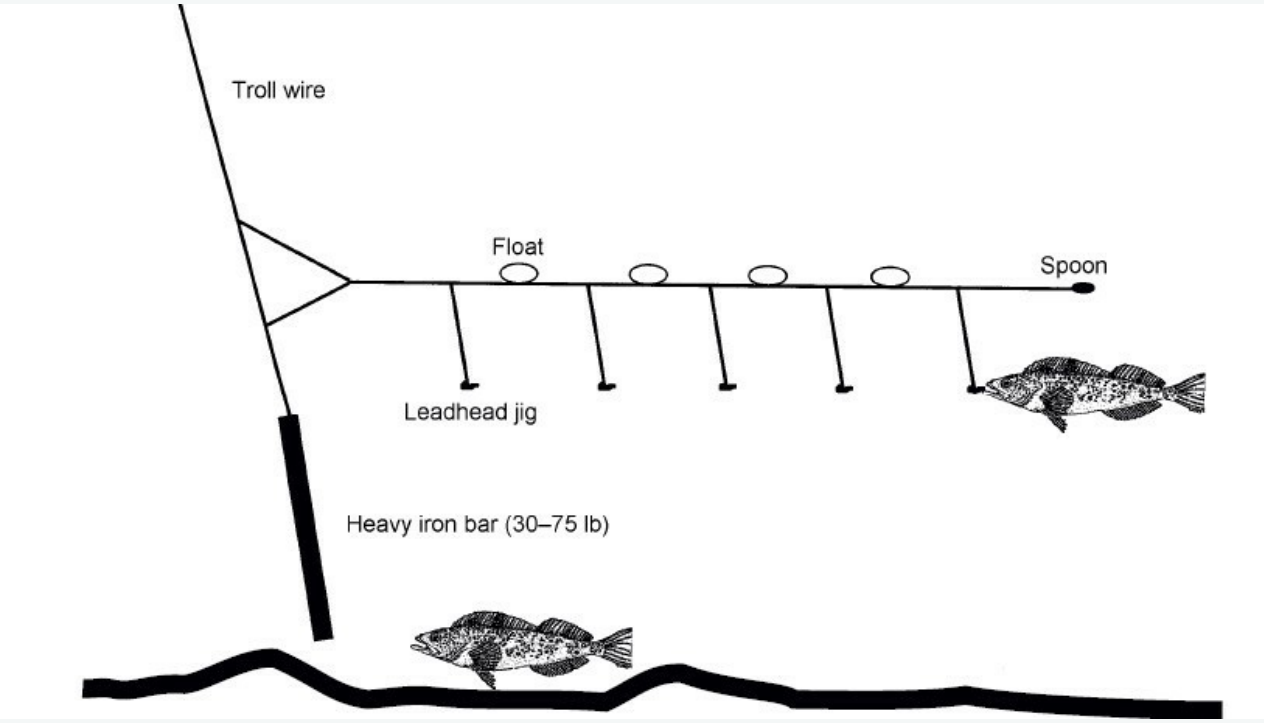

Figure 17 The modified troll called "dinglebar" which uses a heavy iron rod that is dragged across the bottom to keep jigs near the bottom. From: Gordon 1994.

UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES, PACIFIC HALIBUT LONGLINE

2

Longline gear in the Gulf of Alaska has the potential to come into contact with sensitive benthic habitat and negatively impact organisms like soft and hard corals and sponges (NPFMC 2016) (Stone and Shotwell 2009). Longlines are often fished in regions of coral habitat and fisheries for sablefish and other groundfish, which also land lingcod and have documented interactions with coral habitat (Stone and Shotwell 2009). Derelict longline gear also have the potential to interact with sensitive habitats (Stone and Shotwell 2009). We have awarded a score of "2" to account for these moderate, negative impacts.

UNITED STATES OF AMERICA / GULF OF ALASKA, TROLLING LINES

5

Troll lines for salmon may fish near the bottom for Chinook salmon, but gear contact with the seabed is infrequent and impact to bottom habitat is likely negligible.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

UNITED STATES OF AMERICA / GULF OF ALASKA, JIG
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES, PACIFIC HALIBUT LONGLINE

0

In the Southeast Gulf of Alaska, where dinglebar trolling is used to target lingcod, approximately 20% of the coral habitat designated as a Habitat Area of Particular Concern (HAPC) is protected from all fishing gear that comes into contact with the bottom (NPFMC 2017c), protecting a potential bycatch group of organisms within this fishery. An additional 5,329 nm^2 of seamount habitat is protected, of which 15 occur in the Gulf of Alaska (NPFMC 2017c). Lingcod and rockfish may be found in habitat at depths in which these seamounts occur (ADFG 2017c) (ADFG 2007) (ADFG 2017g). The halibut longline and salmon troll fisheries also occur within the Southeast region. Although these measures show that vulnerable habitats are protected, there is no substantial proportion of all representative habitats that are protected, and no mitigation credit is awarded.

UNITED STATES OF AMERICA / GULF OF ALASKA, TROLLING LINES

0

Not applicable because troll fishery received a score of "5" for 4.1

Factor 4.3 - Ecosystem-Based Fisheries Management

UNITED STATES OF AMERICA / GULF OF ALASKA, JIG
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES, PACIFIC HALIBUT LONGLINE
UNITED STATES OF AMERICA / GULF OF ALASKA, TROLLING LINES

Moderate Concern

As generalist predators similar to other groundfish species (Shaw and Hassler 1989), lingcod population changes are not expected to cause any exceptional food web impacts. A few food web studies have indicated no obvious detrimental impacts of current fishery management to groundfish like Pacific cod and sablefish (Marsh et al. 2015) (Livingston et al. 2017), while others indicate potential detrimental impacts to marine mammals with the loss of species like rockfish and salmon (Surma and Pitcher 2015) (Okey and Wright 2004). Salmon escapement levels are set to ensure that it is highly unlikely that ecosystem structure and function are irreversibly compromised (Blyth-Skyrme et al. 2013). Pacific halibut are high trophic-level predators who may be prey for pinnipeds and large sharks, but there is evidence that the fishery is unlikely to cause ecosystem disruptions (Morgan et al. 2016).

Spatial management is in place to protect ecosystem functioning in the Gulf of Alaska. Examples include prohibition of bottom-contact fishing gear in 15 Alaska Seamount Habitat Protection Areas in the Gulf of Alaska (total area 5,329 NM^2), a no-take zone (3.1 mi^2) in the Edgecumbe Pinnacles Marine Reserve that protects critical habitat for lingcod and other bottomfish, and seasonal fisheries closures to protect nest-guarding males (NPFMC 2017c). The North Pacific Fishery Management Council (NPFMC) produces an annual Ecosystem Considerations report to provide stronger links between ecosystem research and fishery management, which would affect species managed by the Council (Zador et al. 2017).

Ecosystem function and the role of some, but not all, species in these fisheries have been factored into management; detrimental food web impacts are possible, and the effectiveness of these measures is unknown; therefore, we awarded a score of "moderate" concern.

Justification:

Alaska is considered to be a US leader in terms of ecosystem-based management (EBM) in their management of fisheries (Zador et al. 2017). The Gulf of Alaska is considered a Large Marine Ecosystem (LME), and within this system, much of the management decisions are made by the North Pacific Fisheries Management Council (NPFMC) or by the state of Alaska, as in the case of the lingcod fishery. The state manages lingcod in three distinct regions in the Gulf of Alaska, which is a complex system where regional processes can be more important than those that are basin-wide (Zador et al. 2017).

The North Pacific Fishery Management Council takes Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (HAPC) into account in their management of groundfish fisheries that also land lingcod (NPFMC 2017c), such that Gulf of Alaska fisheries management is considered an "ecosystem approach to fisheries management (EAFM)" (Zador et al. 2017). Many aspects of EBM are currently incorporated into the fisheries in the region (Witherell et al. 2000), including consideration for habitat and forage species (NPFMC 2016b). Groundfish fisheries in the Gulf of Alaska are currently managed using optimum yield (OY), but EBM has not yet been fully implemented (Patrick and Link 2015).

Acknowledgements

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

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

References

ADEC (Alaska Department of Environmental Conservation). 2017. State Veterinarian Fish Monitoring Program. Availabl http://dec.alaska.gov/eh/vet/fish.htme at:

ADFG. 2007. Lingcod species profile. 1 pg, text by Doug Vincent-Lang, updated 2007.

ADFG. 2010. Alaska Fish and Wildlife News, Changes coming for Alaska's charter halibut fishery. October, 2010. Available at: http://www.adfg.alaska.gov/index.cfm?adfg=wildlifenews.view_article&articles_id=482

Alaska Department of Fish & Game Chinook Salmon Research Team. 2013. Chinook salmon stock assessment and research plan, 2013. ADFG Special Publication No. 13-01, Anchorage, AK.

ADFG. 2014. State of Alaska groundfish fisheries; associated investigations in 2014. Alaska Dept. of Fish and Game, Division of Commercial Fisheries & Division of Sportfish. April 2014, 46 pp.

ADFG. 2015. State of Alaska groundfish fisheries; associated investigations in 2014. Alaska Dept. of Fish and Game, Division of Commercial Fisheries & Division of Sportfish. April 2015, 46 pp.

ADFG. 2016a. State of Alaska groundfish fisheries; associated investigations in 2015. Alaska Dept. of Fish and Game, Division of Commercial Fisheries & Division of Sportfish. April 2016, 55 pp.

ADFG. 2016b. 2016 Southeast Alaska directed lingcod fishery announcement. 2/25/2016. 4 pp.

ADFG. 2016c. Commercial data request for lingcod and associated landings in the western Gulf of Alaska. Provided by Nathaniel Nichols, Western Region, Alaska Dept. of Fish and Game, 12/16/16.

ADFG. 2016d. Commercial data request for lingcod and associated landings in the southeast Gulf of Alaska. Provided by Mike Vaughn, Southeast Region, Alaska Dept. of Fish and Game, 12/2/16.

ADFG. 2017c. Black Rockfish (Sebastes melonops) Species Profile. State of Alaska. Available at: http://www.adfg.alaska.gov/index.cfm?adfg=blackrockfish.main

ADFG. 2017a. Commercial data request for lingcod and associated landings for the central Gulf of Alaska. Provided by Christopher Russ, Central Region, Alaska Dept. of Fish and Game, 1/26/17.

ADFG. 2017b. Alaska Sportfishing Survey, recreational data request. Accessed 7/14/17.

ADFG. 2017d. Alaska Dept. of Fish and Game research description for lingcod. Available at: http://www.adfg.alaska.gov/index.cfm?adfg=lingcod.research

ADFG. 2017e. Commercial data request for lingcod, chinook salmon, and coho salmon in Southeastern Gulf of Alaska. Provided by Rhea Ehresmann, Southeast Region, Alaska Dept. of Fish and Game, 07/18/17.

ADFG. 2017f. Alaska Dept. of Fish and Game website. Available at: http://www.adfg.alaska.gov/

ADFG. 2017g. Species profile: Yelloweye Rockfish (Sebastes ruberrimus). Alaska Dept. of Fish and Game. Available at: http://www.adfg.alaska.gov/index.cfm?adfg=yelloweyerockfish.main

ADFG. 2017h. Species profile for chinook salmon (Oncorhynchus tshawytscha). Available at: http://www.adfg.alaska.gov/index.cfm?adfg=chinook.main

ADFG 2018. State of Alaska groundfish fisheries; associated investigations in 2017. Alaska Dept. of Fish and Game, Division of Commercial Fisheries & Division of Sportfish. April 2018, 48 pp.

AFSC 2018. New information on how long some rockfish live and how often they spawn will help ensure healthy populations.

Alaska Dispatch News. 2017. Electronic monitoring finally catching on among Alaska commercial fishermen. Author: Laine Welch, April 8, 2017.

Barbeaux S., A'mar T. and Palsson W. 2016. Assessment of the Pacific cod stock in the Gulf of Alaska. Alaska Fisheries Science Center, NMFS, NOAA.

Barbeaux, S., Aydin, K., Fissel, B., Holsman, K., Palsson, W., Shotwell, K., Yang, Q., and Zador, S. 2017. Chapter 2: Assessment of the Pacific cod stock in the Gulf of Alaska. Alaska Fisheries Science Center, December 2017. 144 pp.

BirdLife International. 2017b. Phoebastria nigripes. (amended version published in 2016) The IUCN Red List of Threatened Species 2017: e.T22698350A111620625.

BirdLife International. 2017a. Phoebastria immutabilis. (amended version published in 2016) The IUCN Red List of Threatened Species 2017: e.T22698365A112069781.

Bishop M.A., Reynolds, B.F., & Powers, S.P. 2010. An In Situ, Individual-Based Approach to Quantify Connectivity of Marine Fish: Ontogenetic Movements and Residency of Lingcod. PLoS ONE 5(12): e14267. doi:10.1371/journal.pone.0014267

Blyth-Skyrme, R., Ruggerone, G., Schmidt, D., Seeb, J., and Knapman, P. 2013. Marine Stewardship Council Alaska Salmon Fishery Public Certification Report.

Blyth-Skyrme, R., Ruggerone, G., Schmidt, D., Seeb, J., and Knapman, P. 2013. Alaska Salmon Fishery Public Certification Report. Intertek Moody Marine, November 2013, ref: 82540. 583 pp.

Bobko, S.J., & Berkeley, S.A. 2004. Maturity, ovarian cycle, fecundity, and age-specific parturition of black rockfish (Sebastes melanops). Fishery Bulletin, 102(3): 418-429.

Cailliet, G.M., Andrews, A.H., Burton, E.J., Watters, D.L., Kline, D.E., & Ferry-Graham, L.A. 2001. Age determination and validation studies of marine fishes: do deep-dwellers live longer? Experimental Gerontology, 36: 739-764.

Conrath, C.L. 2017. Maturity, spawning omission, and reproductive complexity of deepwater rockfish. Transactions of the American Fisheries Society, 146(3): 495-507.

COSEWIC 2007. Assessment and Status Report on the rougheye rockfish Sebastes sp.

DFO 1999. Rougheye Rockfish British Columbia Coast. DFO Stock Status report A6-15

DiCosimo, J., Cunningham, S., and Brannan, D. 2015. Pacific Halibut Bycatch Management in Gulf of Alaska Groundfish Trawl Fisheries. In: G.H. Kruse, H.C. An, J. DiCosimo, C.A. Eichens, G.S. Gislason, D.N. McBride, C.S. Rose, and C.E. Siddon (eds.), Fisheries Bycatch: Global Issues and Creative Solutions. Alaska Sea Grant, University of Alaska Fairbanks.

Dietrich, K. S., and S. M. Fitzgerald. 2010. Analysis of 2004-2007 vessel-specific seabird bycatch data in Alaska demersal longline fisheries. AFSC Processed Rep. 2010-04, 52 p. Alaska Fish. Sci. Cent., NOAA, Natl. Mar. Fish. Serv., 7600 Sand Point Way NE, Seattle WA 98115.

Doherty, B., Johnson, S.D.N., and Cox, S.P. 2017. Using autonomous video to estimate the bottom-contact area of longline trap gear and presence-absence of sensitive benthic habitat. Canadian Journal of Fisheries and Aquatic Sciences, 00:1-16.

Echave K.B. and Hulson P.J.F. 2017. Assessment of the Shortraker Rockfish stock in the Gulf of Alaska. Alaska Fisheries Science Center, NMFS, NOAA. November, 2017, 48 pp.

Echave K.B. and Hulson P.J.F. 2017. Assessment of the Thornyhead stock complex in the Gulf of Alaska. Alaska Fisheries Science Center, NMFS, NOAA.

Echave K.B., Shotwell S.K., and Hulson P.J.F. 2016. Assessment of the Thornyhead stock complex in the Gulf of Alaska. Alaska Fisheries Science Center, NMFS, NOAA.

Rhea Ehresmann, Personal Communication. 2018. Communication regarding bait use in troll fisheries. Rhea Ehresmann, Assistant Troll Management Biologist, Alaska Department of Fish and Game- Sitka, October 15, 2018.

Eich, A.M., K.R. Mabry, S.K. Wright, and S.M. Fitzgerald. 2016. Seabird Bycatch and Mitigation Efforts in Alaska Fisheries Summary Report: 2007 through 2015. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-F/AKR-12, 47p.

Else, P., Haldorson, L., and Krieger, K. 2002. Shortspine thornyhead (Sebastolobus alascanus) abundance and habitat associations in the Gulf of Alaska. Fisheries Bulletin 100: 193-199.

FDA. 2016. Food and Drug Administration Food List: Ophiodon elongatus (Lingcod). Available at: https://www.accessdata.fda.gov/scripts/fdcc/index.cfm?set=seafoodlist&id=Ophiodon_elongatus

Federal Register. 2009. NOAA, Fisheries of the Exclusive Economic Zone off Alaska, groundfish of the Gulf of Alaska. Vol. 74, No. 12, Wednesday, January 21, 2009. Rules and Regulations.

Fishwatch. 2016. Lingcod, Ophiodon elongatus profile. Accessed on 9/16. Available at: http://www.fishwatch.gov/profiles/lingcod

Fissel, B, Dalton M, Garber-Yonts B, Haynie A, Kasperski S, Lee J, Lew D, Lavoie A, Seung C, Sparks K, Wise S. 2017. Stock assessment and fishery evaluation report for the groundfish fisheries of the Gulf of Alaska and Bering Sea/Aleutian Islands Area: Economic status f the groundfish fisheries off Alaska, 2016. 425 pp, December 2017.

Froese, R and D. Pauly. 2016. FishBase. Worldwide web electronic publication. Available at: www.fishbase.org.

Gilk-Baumer, S., D. F. Evenson, K. Shedd, and E. L. Jones. 2017. Mixed stock analysis of Chinook salmon harvested in Southeast Alaska commercial troll and sport fisheries, 2016. Alaska Department of Fish and Game, Fishery Data Series No. 18-01, Anchorage.

Gilk-Baumer, S., D. F. Evenson, and W. D. Templin. 2017. Mixed stock analysis of Chinook salmon harvested in Southeast Alaska commercial troll fisheries, 2010–2014. Alaska Department of Fish and Game, Fishery Data Series No. 17-37, Anchorage.

Gordon, D.A. 1994. Lingcod fishery and fishery monitoring in Southeast Alaska. Alaska Fishery Research Bulleting I(2):140-152.

Grabacki, S.T. 2008. Sustainable management of Alaska's fisheries: a primer. GRAYSTAR Pacific Seafood, Ltd. 24 pp.

Green K, Carlile D, Jaenicke M, and Meyer S. 2012. Assessment of the demersal shelf rockfish stock complex in the southeast outside district of the Gulf of Alaska. November 2012, 8 pp.

Hagerman and Ehresmann 2018. 2018 Summer Troll Fishery Management Plan. Alaska Department of Fish and Game, Regional Information Report No. 1J18-11, Douglas, Alaska.

Hagerman, G., R. Ehresmann, and L. Shaul. 2017. Annual management report for the 2017 Southeast Alaska/Yakutat salmon troll fisheries. Alaska Department of Fish and Game, Fishery Management Report No. 18-02, Anchorage.

Hannah, R.W., & Rankin, P.S. 2011. Site fidelity and movement of eight species of Pacific rockfish at a high-relief rocky reef on the Oregon Coast. North American Journal of Fisheries Management, 31(3): 483-494.

Hanselman D.H., Lunsford C.R., Rodgveller C.J., and Peterson M.J. 2016. Assessment of the Sablefish stock in Alaska. Alaska Fisheries Science Center, NMFS, NOAA.

Hanselman, D.H., Lunsford, C.R., and Rodgveller, C.J. 2014. Chapter 3. Assessment of the sablefish stock in Alaska. NPFMC Bering Sea, Aleutian Islands and Gulf of Alaska SAFE. 142 pp.

Heifetz, J. 2003. Effects of fishing activities on benthic habitat; proposed research plan for the Alaska region. Alaska Fisheries Science Center. March 2000, revised May 2003. 10 pp.

Heinl, S. C., E. L. Jones III, A. W. Piston, P. J. Richards, L. D. Shaul, B. W. Elliott, S. E. Miller, R. E. Brenner, and J. V. Nichols. 2017. Review of salmon escapement goals in Southeast Alaska, 2017. Alaska Department of Fish and Game, Fishery Manuscript Series No. 17-11, Anchorage.

Heinl, S. C., Jones III, E.L., Piston, A.L., Richards, P.J., and Shaul, L.D.. 2014. Review of salmon escapement goals in Southeast Alaska, 2014. Alaska Department of Fish and Game, Fishery Manuscript Series No. 14-07, Anchorage. Available at: www.adfg.alaska.gov/FedAidPDFs/FMS14-07.pdf

Helfield, J. M., Naiman, R. J. 2006. Keystone interactions: salmon and bear in riparian forests of Alaska. Ecosystems, 9(2), 167-180.

International Pacific Halibut Commission. 2017. Commercial Catch Data, Commercial Catch by Regulatory Area and Year. Available at: http://www.iphc.int/commercial/catch-data/45-fisheries/statistics/197-comm-cat-yr.html

Jagielo, T.H., Leclair, L.L., & Vorderstrasse, B.A. 1996. Genetic Variation and Population Structure of Lingcod, Transactions of the American Fisheries Society, 125:3, 372-386.

Kerr, L.A., Andrews, A.H., Frantz, B.R., Coale, K.H., Brown, T.A., & Cailliet, G.M. 2004. Radiocarbon in otoliths of yelloweye rockfish (Sebastes ruberrrimus): a reference time series for the coastal waters of southeast Alaska. Canadian Journal of Fisheries and Aquatic Science, 61:443-451.

King, J.R., & Withler, R.E. 2005. Male nest site fidelity and female serial polyandry in lingcod (Ophiodon elongatus, Hexagrammidae). Molecular Ecology, 14:653-660.

King, J.R., M. McAllister, K.R. Holt and P.J. Starr. 2012. Lingcod (Ophiodon elongatus) stock assessment and yield advice for outside stocks in British Columbia. DFO Can. Sci. Advis. Sec. Res. Doc. 2011/124. viii + 177p.

Kronlund, A.R., and Yamanaka, K.L. 2001. Yelloweye rockfish (Sebastes ruberrimus) life history parameters assessed from areas with contrasting fishing histories. Edited by: Kruse, GH; Bez, N; Booth, A; et al. Conference: Symposium on Spatial Processes and Management of Marine Populations Location: ANCHORAGE, AK Date: OCT 27-30, 1999 In: Spatial processes and management of marine populations: 17, 257-280.

Livingston, P.A., Aydin, K., Buckley, T.W., Lang, G.M., Yang., M-S., and Miller, B.S. 2017. Quantifying food web interactions in the North Pacific - a data-based approach. Environmental Biology of Fishes, 100:443-470.

Marko, P.B., Rogers-Bennett, L., & Dennis, A.B. 2007. MtDNA population structure and gene flow in lingcod (Ophiodon elongatus): limited connectivity despite long-lived pelagic larvae. Marine Biology, 150: 1301-1311.

Marsh, J.M., Foy, R.J., Hillguber, N., and Kruse, G.H. 2015. Variability in trophic positions of four commercially important groundfish species in the Gulf of Alaska. Fisheries Research, 165: 100-114.

McGreer, M., & Frid, A. 2017. Declining size and age of rockfishes (Sebastes spp.) inherent to indigenous cultures of Pacific Canada. Ocean and Coastal Management, 145:14-20.

Mecklenburg, C. W., Mecklenburg, T. A. & Thorsteinson, L,K. 2002. Fishes of Alaska. American Fisheries Society, Bethesda, Maryland.

Moore, J.W., and Schindler, D.E. 2004. Nutrient export form freshwater ecosystems by anadromous sockeye salmon (Oncorhynchus nerka). Canadian Journal of Fisheries and Aquatic Science, 61: 1582-1589.

Morgan, S., Jagielo, T., Hallenbeck, T., and Humberstone, J. 2016. US North Pacific Halibut MSC Fishery 2nd Re-assessment Report.

Moser, HG. 1996. Scorpaenidae: Scorpionfishes and rockfishes. In, The early stages of fishes in the California current region, California Cooperative, Oceanic fisheries investigations. Atlas No. 33, April 1996. 1505 pp. Available at: http://calcofi.org/publications/atlases/CalCOFI_Atlas_33.pdf

Munro, A. R., and E. C. Volk. 2010. Summary of Pacific salmon escapement goals in Alaska with a review of escapements from 2001 to 2009. Alaska Department of Fish and Game, Special Publication No. 10-12, Anchorage.

Munro, A.R., and Volk, E.C. 2015. Summary of Pacific salmon escapement goals in Alaska with a review of escapements from 2006 to 2014. Fishery Manuscript Series No. 15-04, Alaska Dept. of Fish and Game. 83 pp.

Munro, A. R., and E. C. Volk. 2017. Summary of Pacific salmon escapement goals in Alaska with a review of escapements from 2008 to 2016. Alaska Department of Fish and Game, Fishery Manuscript Series No. 17- 05, Anchorage.

NMFS. 2015. Alaska region electronic technologies implementation plan. January, 2015. 33 pp.

Commercial Fisheries Statistics. National Marine Fisheries Service. Available at: http://www.st.nmfs.noaa.gov/commercial-fisheries/index

NOAA. 2015. Summary of the North Pacific groundfish and halibut observer program. Updated 12/21/15. 3pp.

NOAA. 2015b. Alaska fisheries under close watch to ensure compliance. Available at: https://www.fisheries.noaa.gov/feature-story/alaska-fisheries-under-close-watch-ensure-compliance

NOAA. 2017. Commercial fisheries statistics, National Oceanographic and Atmospheric Administration.

NOAA 2018. Status of Fisheries: Stock Status Updates, NOAA Fisheries. Available at: http://www.nmfs.noaa.gov/sfa/fisheries_eco/status_of_fisheries/status_updates.html

NOAA (NMFS). 2018. Third quarter stock status update. 57 pp.

NOAA. 2018b. Commercial fisheries statistics, Annual Trade Data by Product, Country/Association. National Oceanographic and Atmospheric Administration.

NOAA. 2018c. Commercial fisheries statistics, Annual Commercial Landing Statistics. National Oceanographic and Atmospheric Administration.

NOAA Fisheries. 2014. Current fishery statistics no. 2014-2. Imports and exports of fishery products, annual summary, 2014 revised. 28 pp.

NOAA Fisheries. 2015. Alaska regional office strategic plan, 2016-2020. 24 pp.

NPFMC (North Pacific Fishery Management Council). 2013. Reducing bycatch in Alaska. Pamphlet: downloaded 8/2017.

NPFMC. 2016. Fishery management plan for groundfish of the Gulf of Alaska. Appendices. 263 pp.

NPFMC. 2016b. Fishery management plan for groundfish of the Gulf of Alaska. North Pacific Fishery Management Council. November, 2016. 150 pp.

NPFMC (North Pacific Fishery Management Council). 2017. Discussion paper for revisions to the fishery management plan for the salmon fisheries in the EEZ off Alaska, March 2017. 123 pp.

NPFMC. 2017b. North Pacific Fishery Management Council, How do I get involved?. Available at:https://www.npfmc.org/how-do-i-get-involved/

NPFMC. 2017c. North Pacific Fishery Management Council habitat protections. Accessed on 8/30/17. Available at: https://www.npfmc.org/habitat-protections/

NPFMC. 2017d. North Pacific Fishery Management Council research priorities for 2018-2022. 16 pp.

NPFMC (North Pacific Fishery Management Council). 2017b. Fishery Management Plan for the groundfish of the Gulf of Alaska, Appendices. October 2017. 256 pp.

NPOP (North Pacific Observer Program). 2017. North Pacific Observer Program, Frequently asked questions and small entity compliance guide. Sustainable Fisheries Alaska Region. April 24, 2017. 17 pp.

Okey, T.A., and Wright, B.A. 2004. Toward ecosystem-based extraction policies for Prince William Sound, Alaska: Integrating conflicting objectives and rebuilding pinnipeds. Bulletin of Marine Science, 74(3): 727-747.

Olson A., Stahl J., Van Kirk K., Jaenicke M., and Meyer S. 2016. Assessment of the Demersal Shelf Rockfish stock complex in the Southeast Outside District of the Gulf of Alaska. Alaska Fisheries Science Center, NMFS, NOAA.

Olson, A., Williams, B., and Jaenicke, M. 2018. Assessment of the demersal shelf rockfish stock complex in the Southeast Outside Subdistrict of the Gulf of Alaska. GOA Demersal shelf rockfish December 2018.

Olson, A., J. Stahl, M. Vaughn, K. Carroll, and A. Baldwin. 2017. Annual management report for the Southeast Alaska and Yakutat groundfish fisheries, 2017. Alaska Department of Fish and Game, Fishery Management Report No. 17-54, Anchorage.

Orlov, A.M. and Abramov, A.A. 2010. New data on the reproductive biology of shortspine thornyhead Sebastolobus alascanus (Sebastidae) in the Northwestern Pacific. Journal of Ichthyology 50(8): 632-639.

Parker, S.J., Rankin, P.S., Hannah, R.W., & Schreck, C.B. 2003. Discard Mortality of Trawl-Caught Lingcod in Relation to Tow Duration and Time on Deck. North American Journal of Fisheries Management, 23:2, 530-542.

Patrick, W.S., & Link, J.S. 2015. Hidden in plain sight: using optimum yield as a policy framework to operationalize ecosystem-based fisheries management. Marine Policy, 62, 74-81.

Pearson, K.E. and Gunderson, D.R. 2003. Reproductive Biology and Ecology of Shortspine Thornyhead Rockfish, Sebastolobus alascanus, and longspine thornyhead rockfish, S. altivelis, from the northeastern Pacific Ocean. Environmental Biology of Fishes 67: 117-136.

Petrie, M.E., & Ryer, C.H. 2006. Laboratory and field evidence for structural habitat affinity of young-of-the-year lingcod. Transactions of the American Fisheries Socieity. 135(6):1622-1630.

Pham, C.K., Diogo, H., Menezes, G., Porteiro, F., Braga-Henriques, A., Vanderperre, F., and Morato, T. 2014. Deep-water longline fishing has reduced impact on Vulnerable Marine Ecosystems. Scientific Reports, 4:4837. DOI: 10.1038/srep04837.

PSC (Pacific Salmon Commission). 2017. Thirty-First Annual Report 2015/2016. 246 pp.

Queriolo, L.E., Fritz, L.W., Livingston, P.A., Loefflad, M.R., Colpo, D.A., &deReynier, Y.L. 1995. Bycatch, utilization, and discards in the commercial groundfish fisheries of the Gulf of Alaska, eastern Bering Sea, and Aleutian Islands. U.S. Dept. Commerce, NOAA Technical Memo. NMFS-AFSC-58, 148 pp.

Reynolds, B.F., Powers, S.P., Bishop, M.A. 2010. Application of Acoustic Telemetry to Assess Residency and Movements of Rockfish and Lingcod at Created and Natural Habitats in Prince William Sound. PLoS ONE 5(8): e12130. doi:10.1371/journal.pone.0012130

Rumble, J., Russ, E., and Russ, C. 2016. Cook Inlet area groundfish managmenet report, 2012–2015. Alaska Department of Fish and Game, Fishery Management Report No. 16-29, Anchorage.

Seeb, LW., A. Antonovich, M. A. Banks, T. D. Beacham, M. R. Bellinger, S. M. Blankenship, M. R. Campbell, N. A. Decovich, J. C. Garza, C. M. Guthrie III, T. A. Lundrigan, P. Moran, S. R. Narum, J. J. Stephenson, K. J. Supernault, D. J. Teel, W. D. Templin, J. K. Wenburg, S. F. Young & C. T. Smith (2007): Development of a Standardized DNA Database for Chinook Salmon, Fisheries, 32:11, 540-552

Shaul L., Crabtree K., Jones E., McCurdy S., and Elliott B. 2011. Coho Salmon Stock Status and Escapement Goals in Southeast Alaska. Alaska Department of Fish & Game Special Publication No. 11-23, ADFG, Anchorage, AK.

Shaw, W.N. & Hassler, T.J. 1989. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Northwest) - lingcod. U.S. Fish and Wildlife Service Biol. Rep. 82(11.119). U.S.

Army Corps of Engineers, TR EL-82-4. 19 pp.

Shotwell S.K., Hanselman D.H., Heifetz J., and Hulson P.J.F. 2016. Assessment of the Rougheye and Blackspotted rockfish stock complex in the Gulf of Alaska. Alaska Fisheries Science Center, NMFS, NOAA.

Shotwell, S.K., Hanselman, D.H., and Heifetz, J. 2017. Assessment of the rougheye and blackspotted rockfish stock complex in the Gulf of Alaska. December 2017.

Silberberg, K.S., Laidig, T.E., & Adams, P.B. 2001. Analysis of maturity in lingcod, Ophiodon elongatus. California Fish and Game, 87(4):139-152.

Skannes, P., G. Hagerman, and L. Shaul. 2016. Annual management report for the 2015 Southeast Alaska/Yakutat salmon troll fisheries. Alaska Department of Fish and Game, Fishery Management Report No. 16-05, Anchorage.

Starr, R.M., O'Connell, V., Ralson, S., & Breaker, L. 2005. Use of acoustic tags to estimate natural mortality, spillover, and movements of lingcod (Ophiodon elongatus) in a marine reserve. Marine Technology Society Journal, 39(1): 19-30.

Stehn, R.A., Rivera, K.S., Fitzgerald, S., & Wohl, K.D. 2001. Incidental catch of seabirds by longline fisheries in Alaska. Proceedings-Seabird Bycatch: Trends, Roadblocks, and Solutions. University of Alaska Seagrant, AK-SG-01, 2001. 17 pp.

Stewart I.J. and Hicks, I. 2017. Assessment of the Pacific halibut stock at the end of 2017. Report of Assessment and Research Activities, International Pacific Halibut Commission. 25 pp.

Stone, R.P. and Shotwell, K. 2009. State of deep coral ecosystems in the Alaska region: Gulf of Alaska, Bering Sea and the Aleutian Islands. Auke Bay Laboratory, NMFS. 44 pp.

Stone, R.P., Masuda, M.M., and Karinen, J.F. 2015. Assessing the ecological importance of red tree coral thickets in the eastern Gulf of Alaska. ICES Journal of Marine Science, 72(3): 900-915.

Surma, S., and Pitcher, T.J. Predicting the effects of whale population recovery on Northeast Pacific food webs and fisheries: an ecosystem modelling approach. Fisheries Oceanography, 24(3): 291-305.

Taylor, I.G. and Stephens, A. 2014. Stock assessment of shortspine thornyhead in 2013. NOAA Northwest Fisheries Science Center. 159pp.

Tinus, C.A. 2012. Prey preference of lingcod (Ophiodon elongatus), a top marine predator: implications for ecosystem-based fisheries management. Fishery Bulletin, 110:193-2014.

Vaughn, Mike. Pers. comm. 2018. Personal communication regarding bait use in lingcod directed fisheries. Mike Vaughn, Assistant Groundfish Biologist, Alaska Dept. of Fish and Game - Sitka. October 15, 2018.

Witherell, D., Pautzke, C., and Fluharty, D. An ecosystem-based approach for Alaska groundfish fisheries. ICES Journal of Marine Science, 57: 771-777.

Woodby, D., D. Carlile, S. Siddeek, F. Funk, J. H. Clark, and L. Hulbert. 2005. Commercial Fisheries of Alaska. Alaska Department of Fish and Game, Special Publication No. 05-09, Anchorage.

WSG (Washington Sea Grant). 2016. Trends in seabird bycatch in Alaska longline fisheries, 1993-2015. WSG-AS

16-05, 2 pp.

Zador, S. and Yasumiishi, E. 2017. Status of the Gulf of Alaska Marine Ecosystem.

Zador, S.G., Holsman, K.K., Aydin, K.Y., and Gaichas, S.K. 2017. Ecosystem considerations in Alaska: the value of qualitative assessments. ICES Journal of Marine Science, 74(1), 421-430.

Appendix A: Extra By Catch Species

PACIFIC HALIBUT

Factor 2.1 - Abundance

UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES, PACIFIC HALIBUT LONGLINE

Moderate Concern

The Pacific halibut (*Hippoglossus stenolepis*) stock experienced long term declines beginning in the late 1990s, then increases between 2010 and 2017 due to increased recruitment. The International Pacific Halibut Commission (IPHC) reports considerable uncertainty in models of abundance, but a relatively low chance (6%) that stock is below the $SB_{30\%}$ limit reference point (Stewart and Martell 2017). Abundance is also expected to decline in the next few years (Stewart and Martell 2017). Given the high model uncertainty around abundance estimates and an overall history of decline in recent decades, but a small likelihood that abundance is below the limit reference point, we have rated the abundance of Pacific halibut as "moderate" concern.

Justification:

Pacific halibut are managed jointly in US and Canadian waters by the IPHC, and are considered a single stock from Northern California to the Aleutian Islands and Bering Sea. The IPHC stock assessment does not give a determination of "overfished" status, but reports that female spawning biomass is estimated to be 202 million lb in 2018, or 40% of the equilibrium biomass in the absence of fishing (Stewart and Martell 2017). Pacific halibut declined rapidly from the late 1990s through 2011, possibly due to large climatic fluctuations (Pacific Decadal Oscillation (Stewart and Martell 2014).

Factor 2.2 - Fishing Mortality

UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES, PACIFIC HALIBUT LONGLINE

Low Concern

Pacific halibut are targeted by commercial fishers using longlines, trawls, and traps/pots. Commercial landings for the entire fishery (Northern California to Alaska) was a total of 24.3 million lb in 2015 (NOAA 2017), with approximately one third coming from the Gulf of Alaska region (IPHC 2017). Recreational data were not available for this species. The IPHC set fishing intensity for 2017 at $F_{40\%}$ indicating a relative reduction of 40% in spawning biomass from fishing mortality (Stewart and Martell 2017). Fishing intensity declined to 25% in the mid-2000s with declining stock abundance, and has recently increased from 2011 to 2017. IPHC reports that fishing intensity is at or below target reference points and is below the target reference point of $F_{46\%}$ in 2018 (Stewart and Martell 2017). Because it is probable that fishing mortality from all sources is at or below a sustainable level, we have rated fishing mortality on Pacific halibut as "low" concern.

Factor 2.3 - Discard Rate

UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES, PACIFIC HALIBUT LONGLINE

< 100%

The longline fishery in the Gulf of Alaska targets Pacific cod, halibut, rockfish, sablefish, and various flatfish, but few data exist on discard to landings ratios and bait use. In 2012, the North Pacific Fishery Management

Council decreased halibut bycatch limits in longline fisheries by 15% in an attempt to curb bycatch in this fishery (NPFMC 2013). In the early 1990's, NOAA estimated bycatch rates in the Gulf of Alaska groundfish fisheries, which include bottom longlines, to be between 4 and 22% (Queirolo, et al. 1995). Longlines use lures and bait, but are likely to include herring and squid/octopus (NPFMC 2017b) (Woodby et al. 2005). Bait use in this fishery is not quantified, but it is unlikely to increase the discard to landings ratio substantially. Given that there is no evidence that discards have increased substantially since NOAA's assessment, or that bait use is generally unknown, we have awarded a score of "1" or <100%.

PACIFIC COD

Factor 2.1 - Abundance

UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES, PACIFIC HALIBUT LONGLINE

Moderate Concern

Pacific cod (*Gadus macrocephalus*) in the US North Pacific is managed by the North Pacific Fishery Management Council under the Gulf of Alaska Groundfish Fishery Management Plan. Pacific cod demonstrate decades-long declines in both total and spawning biomass (Barbeaux et al. 2016). However, NOAA Fisheries lists the Gulf of Alaska Pacific cod as not overfished in their recent stock status update (B/B_{MSY} = 1.32, (NOAA 2018) as does the assessment of biomass in the most recent full stock assessment (Barbeaux et al. 2017). The target reference point, Maximum Sustainable Yield (MSY), for this fishery is defined at the female spawning biomass ($B_{35\%}$; or 58,984 t). Currently, the stock biomass is below 75% of this reference point at 36,209 t in 2018. In the most recent assessment, most model scenarios agreed that biomass would remain below $B_{35\%}$ until 2023, but that biomass is currently above, or likely to remain at or above the limit reference point of $B_{20\%}$.

Because of substantial declines in abundance in recent decades, and biomass is less than 75% of the target reference point, we awarded a score of "moderate" concern.

Justification:

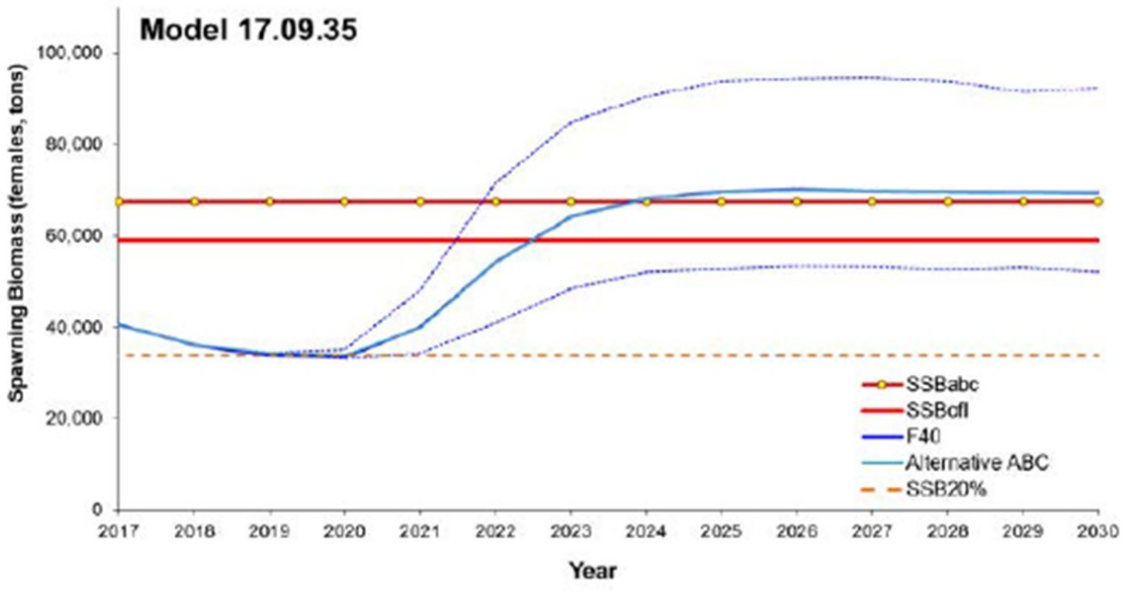

Figure 13 Model projections of Pacific cod spawning stock biomass. The solid red line represents the SSB at the overfishing limit. From: Barbeaux et al. 2018.

Factor 2.2 - Fishing Mortality

UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES, PACIFIC HALIBUT LONGLINE

Moderate Concern

In 2017, the estimated catch of Pacific cod in the Gulf of Alaska was 35,509 MT, or 0.40 of the ABC. Catches of Pacific cod in the Gulf of Alaska have exceeded the total allowable catch (TAC) in most years from 2003 to 2015, which includes both federal and state fisheries. However, TAC has been consistently under the overfishing limit (OFL (Barbeaux et al. 2016)) and NOAA Fisheries lists Pacific cod in the Gulf of Alaska as not subject to overfishing (NOAA 2018). This apparent discrepancy exists because it is a bi-jurisdictional fishery with quota allotted to both the state and Federal fisheries. TAC from both fisheries has not exceeded the acceptable biological catch (ABC) nor the OFL (Barbeaux et al. 2017). The ABC has been set at the maximum permissible level per the Tier 3 status of the stock since 2008 and was lowered in 2018 to increase the probability that the stock will not fall below 20% of unfished spawning biomass for 2019 and 2020 (Barbeaux et al. 2017). Model-estimated F increased steadily with the decline in abundance from 1990 to 2008, with continued high F through 2016, associated with increased catches and declining recruitment. Because F is fluctuating around target reference points, increasing since the early 2000s, we award a score of "moderate" concern.

Justification:

In the most recent stock assessment, landings of Pacific cod in the Gulf of Alaska were estimated to be 65% of the overfishing limit for 2018 (Barbeaux et al. 2017), and the overfishing level was defined as the fishing mortality that would "reduce spawning biomass to 35% of the level obtained in the absence of fishing." Pacific cod are commonly targeted by commercial fishers using longlines, traps/pots, and trawls. Landings in Alaska for the commercial fishery were 316,241 MT in 2015 (NMFS 2017a), although recreational data were not available for this species. Less than half of these landings (42%) were in the Gulf of Alaska, with the remainder coming from the Bering Sea and Aleutian Islands (Barbeaux et al. 2016). F was greater than F_{MSY} in 2007, 2008, 2015, and 2017 and above Tier 3 target reference points set by managers.

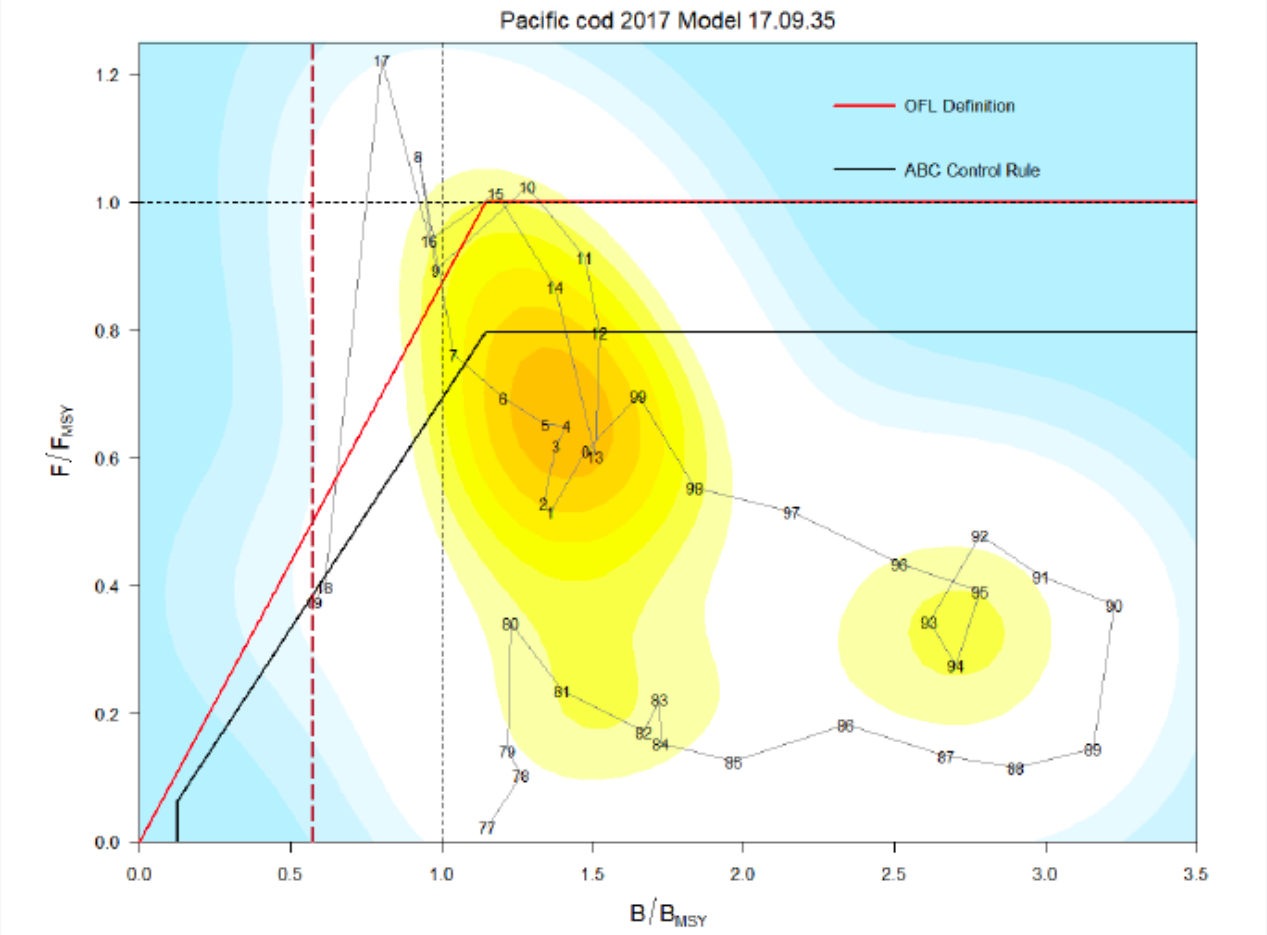

Figure 14 Ratio of historical F/FMSY verse female SSB/BMSY for GOA Pacific cod, 1977-2019. Note that proxies for FMSY and BMSY are F35% and B35%, respectively. The Fs presented here are the sum of the full Fs across fleets. Dashed line is at B20%, Steller sea lion closure rule for GOA Pacific cod (Barbeaux et al. 2017)

Factor 2.3 - Discard Rate

UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES, PACIFIC HALIBUT LONGLINE

< 100%

The longline fishery in the Gulf of Alaska targets Pacific cod, halibut, rockfish, sablefish, and various flatfish, but few data exist on discard to landings ratios and bait use. In 2012, the North Pacific Fishery Management Council decreased halibut bycatch limits in longline fisheries by 15% in an attempt to curb bycatch in this fishery (NPFMC 2013). In the early 1990's, NOAA estimated bycatch rates in the Gulf of Alaska groundfish fisheries, which include bottom longlines, to be between 4 and 22% (Queirolo, et al. 1995). Longlines use lures and bait, but are likely to include herring and squid/octopus (NPFMC 2017b) (Woodby et al. 2005). Bait use in this fishery is not quantified, but it is unlikely to increase the discard to landings ratio substantially. Given that there is no evidence that discards have increased substantially since NOAA's assessment, or that bait use is generally unknown, we have awarded a score of "1" or <100%.

ROUGHEYE ROCKFISH

Factor 2.1 - Abundance

UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES, PACIFIC HALIBUT LONGLINE

Moderate Concern

Rougheye rockfish (*Sebastes aleutianus*) is managed by the North Pacific Fishery Management Council under the Gulf of Alaska Groundfish Fishery Management Plan. Rougheye rockfish is managed in a complex with blackspotted rockfish, the complex is considered as a single stock and is assessed biennially using an age-structured model as a Tier 3a species. The most recent stock assessment and NOAA Fisheries lists Gulf of Alaska rougheye and blackspotted rockfish as not overfished. The projected spawning stock biomass (SSB) for 2018 is 15,059 MT, or 66% of unfished SSB; the ratio of SSB:SSB_{40} is 1.67. Abundance of the rougheye/blackspotted rockfish complex appears to be stable over the past two decades (Shotwell et al. 2017). Although the biomass is thought to be above the target level, there are issues with the speciation of rougheye and blackspotted rockfish and their high vulnerability status (see table below); therefore, we have rated the abundance of this species as "moderate" concern.

Justification:

The PSA score for rougheye rockfish = 3.24. For this reason, the species is deemed as having a "high vulnerability." Detailed scoring of each attribute is shown below.

Productivity analysis for rougheye rockfish, *Sebastes aleutianus*

PRODUCTIVITY ATTRIBUTE	PRODUCTIVITY DATA (REFERENCE)	PRODUCTIVITY SCORE
AVG. AGE AT MATURITY	20 (ASFC 2018)	3
AVG. MAXIMUM AGE	205 years (COSEWIC 2007)	3
FECUNDITY	N/A	N/A
AVG. MAXIMUM SIZE	97 cm (fishbase.org)	1
AVG. SIZE AT MATURITY	40 cm (DFO 1999)	2
REPRODUCTIVE STRATEGY	Live bearer	3
TROPHIC LEVEL	3.5 (fishbase.org)	3
HABITAT QUALITY	Moderately altered (Shotwell et al. 2017)	2

SUSCEPTIBILITY ATTRIBUTE	SUSCEPTIBILITY DATA (AND REFERENCE)	SUSCEPTIBILITY SCORE
AREAL OVERLAP	No data	3
VERTICAL OVERLAP	Present in narrow band in steep waters, 300 to 500 m (Echave and Hulson 2017)	3
SELECTIVITY OF FISHERY	No data	2

POST-CAPTURE MORTALITY	Retained or barotrauma possible due to depth distribution	3

Factor 2.2 - Fishing Mortality

UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES, PACIFIC HALIBUT LONGLINE

Low Concern

NOAA Fisheries lists the rougheye and blackspotted rockfish complex in the Gulf of Alaska as not subject to overfishing (NOAA 2016a). In the most recent stock assessment, landings of this rockfish complex in 2016 was estimated to be 46% of the allowable biological catch and only 38% of the overfishing limit (Shotwell et al. 2016). Rougheye rockfish are targeted by commercial fishers using long lines and trawls. Landings in the Gulf of Alaska for the commercial fishery were 613 t in 2016 (NMFS 2017a), well below the allowable biological catch and the overfishing limit (Shotwell et al. 2016). Due to the fishing mortality well below the overfishing limit, we have rated this species as "low" concern in the Gulf of Alaska.

Factor 2.3 - Discard Rate

UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES, PACIFIC HALIBUT LONGLINE

< 100%

The longline fishery in the Gulf of Alaska targets Pacific cod, halibut, rockfish, sablefish, and various flatfish, but few data exist on discard to landings ratios and bait use. In 2012, the North Pacific Fishery Management Council decreased halibut bycatch limits in longline fisheries by 15% in an attempt to curb bycatch in this fishery (NPFMC 2013). In the early 1990's, NOAA estimated bycatch rates in the Gulf of Alaska groundfish fisheries, which include bottom longlines, to be between 4 and 22% (Queirolo, et al. 1995). Longlines use lures and bait, but are likely to include herring and squid/octopus (NPFMC 2017b) (Woodby et al. 2005). Bait use in this fishery is not quantified, but it is unlikely to increase the discard to landings ratio substantially. Given that there is no evidence that discards have increased substantially since NOAA's assessment, or that bait use is generally unknown, we have awarded a score of "1" or <100%.

SHORTRAKER ROCKFISH

Factor 2.1 - Abundance

UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES, PACIFIC HALIBUT LONGLINE

High Concern

Shortraker rockfish (*Sebastes borealis*) in the US North Pacific is managed by the North Pacific Fishery Management Council under the Gulf of Alaska Groundfish Fishery Management Plan. NOAA Fisheries lists biomass of this species as unknown (NOAA 2016a). The most recent stock assessment (Echave and Hulson 2017) states that biomass estimates are variable due to difficulty of sampling techniques, with a general upward trend in Gulf of Alaska biomass since 1990, but some recent declines in the Western and Central Gulf

of Alaska regions since 2009. Life history data are sparse, but shortraker rockfish are likely long-lived and slow-growing, indicating possible life history vulnerability to overfishing (Echave and Hulson 2017). The Productivity-Susceptibility Analysis (see PSA, below) indicate a high vulnerability with a score of 3.49. Due to the unknown biomass and a high vulnerability to overfishing, we have rated abundance as "high" concern.

Justification:

The PSA score for shortraker rockfish = 3.49. For this reason, the species is deemed as having a "high vulnerability." Detailed scoring of each attribute is shown below.

Productivity Analysis for shortraker rockfish, *Sebastes borealis*

PRODUCTIVITY ATTRIBUTE	PRODUCTIVITY DATA (REFERENCE)	PRODUCTIVITY SCORE
AVG. AGE AT MATURITY	N/A (data limited)	N/A
AVG. MAXIMUM AGE	157 years (Echave and Hulson 2017)	3
FECUNDITY	N/A (data limited)	N/A
AVG. MAXIMUM SIZE	120 cm (Echave and Hulson 2017)	2
AVG. SIZE AT MATURITY	50 cm (Conrath 2017)	2
REPRODUCTIVE STRATEGY	Live bearer (Conrath 2017)	3
TROPHIC LEVEL	4.3 (Froese and Pauly 2016)	3
HABITAT QUALITY	Unknown	-

Susceptibility analysis for shortraker rockfish, *Sebastes borealis*

SUSCEPTIBILITY ATTRIBUTE	SUSCEPTIBILITY DATA (AND REFERENCE)	SUSCEPTIBILITY SCORE
AREAL OVERLAP	No data	3
VERTICAL OVERLAP	Present in narrow band in steep waters, 300 to 500 m (Echave and Hulson 2017)	3
SELECTIVITY OF FISHERY	No data	2
POST-CAPTURE MORTALITY	Retained or barotrauma possible due to depth distribution	3

Factor 2.2 - Fishing Mortality

UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES, PACIFIC HALIBUT LONGLINE

Low Concern

NOAA Fisheries and the NPFMC list shortraker rockfish in the Gulf of Alaska as not subject to overfishing ((NOAA 2016a)(Echave and Hulson 2017)). Directed fishing for this species has been prohibited since the mid-1990s, and shortraker rockfish is considered a "bycatch only" species and not a targeted fishery (Echave and Hulson 2017). Shortraker rockfish are caught as bycatch in trawls and longlines targeting other rockfish, sablefish, and Pacific halibut. In 2016, the total catch of 776 t was well below acceptable biological catch (ABC) of 1,286 t and the overishing limit (OFL) of 1,715 t (Echave and Hulson 2017). Also, in the most recent stock assessment, the ABC for 2018 was reduced by 33% from 2017 (Echave and Hulson 2017). It is probable that fishing mortality is below a sustainable level and we have rated this species as "low concern."

Factor 2.3 - Discard Rate

UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES, PACIFIC HALIBUT LONGLINE

< 100%

The longline fishery in the Gulf of Alaska targets Pacific cod, halibut, rockfish, sablefish, and various flatfish, but few data exist on discard to landings ratios and bait use. In 2012, the North Pacific Fishery Management Council decreased halibut bycatch limits in longline fisheries by 15% in an attempt to curb bycatch in this fishery (NPFMC 2013). In the early 1990's, NOAA estimated bycatch rates in the Gulf of Alaska groundfish fisheries, which include bottom longlines, to be between 4 and 22% (Queirolo, et al. 1995). Longlines use lures and bait, but are likely to include herring and squid/octopus (NPFMC 2017b) (Woodby et al. 2005). Bait use in this fishery is not quantified, but it is unlikely to increase the discard to landings ratio substantially. Given that there is no evidence that discards have increased substantially since NOAA's assessment, or that bait use is generally unknown, we have awarded a score of "1" or <100%.

SHORTSPINE THORNYHEAD ROCKFISH

Factor 2.1 - Abundance

UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES, PACIFIC HALIBUT LONGLINE

Moderate Concern

The most recent stock assessment evaluated the thornyhead rockfish complex in the Gulf of Alaska as a Tier 5 stock (Echave and Hulson 2017). The random effects model used for this rockfish complex estimates exploitable biomass at 90,570 t, and well above the long-germ mean in the Gulf of Alaska (Echave and Hulson 2017). However, no abundance reference points have been defined. Shortspine thornyhead score 2.89, medium vulnerability in our Productivity Susceptibility Analysis (PSA) (see below). Because shortspine thornyhead rockfish lack abundance reference points and is not highly vulnerable to fishing, we award a score of "moderate" concern.

Justification:

Shortspine thornyhead rockfish (*Sebastolobus alascanus*) is managed by the North Pacific Fishery Management Council under the Gulf of Alaska Groundfish Fishery Management Plan. Shortspine thornyhead rockfish is considered part of a complex with longspine thornyhead rockfish, which is managed as a single stock (Echave et al. 2016). The NPFMC report notes that the two species in the thornyhead complex have life history characteristics, such as slow growth and site fidelity, which make them more vulnerable to overfishing (Echave et al. 2016).

The PSA score for shortraker rockfish = 2.89. For this reason, the species is deemed as having a "medium

vulnerability." Detailed scoring of each attribute is shown below.

Productivity Analysis for shortraker rockfish, *Sebastolobus alascanus*

PRODUCTIVITY ATTRIBUTE	PRODUCTIVITY DATA (REFERENCE)	PRODUCTIVITY SCORE
AVG. AGE AT MATURITY	12 years (Else et al. 2002)	2
AVG. MAXIMUM AGE	80 to 160 years (Pearson and Gunderson 2003)	3
FECUNDITY	392,500 eggs (Orlov and Abramov 2010)	1
AVG. MAXIMUM SIZE	80 cm (Echave et al. 2016)	1
AVG. SIZE AT MATURITY	21.5 cm (Pearson and Gunderson 2003)	1
REPRODUCTIVE STRATEGY	Pelagic fertilized egg masses (Pearson and Gunderson 2003)	1
TROPHIC LEVEL	3.6 (Froese and Pauly 2016)	3
HABITAT QUALITY	Unknown	-

Susceptibility analysis for shortspine thornyhead rockfish, *Sebastolobus alascanus*

SUSCEPTIBILITY ATTRIBUTE	SUSCEPTIBILITY DATA (AND REFERENCE)	SUSCEPTIBILITY SCORE
AREAL OVERLAP	>30% of species concentration is fished (Taylor and Stephens 2014) (Echave et al. 2016)	3
VERTICAL OVERLAP	Unknown. Occur in trawlable and untrawlable habitats (Echave et al. 2016)	3
SELECTIVITY OF FISHERY	Default score	2
POST-CAPTURE MORTALITY	Retained	3

Factor 2.2 - Fishing Mortality

UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES, PACIFIC HALIBUT LONGLINE

Low Concern

The thornyhead rockfish complex (including shortspine thornyhead) in the Gulf of Alaska is not subject to overfishing and the total allowable catch (TAC) hasn't been fully taken since 1995 (Echave and Hulson 2017). In the most recent stock assessment, the catch of Gulf of Alaska thornyheads in 2016 was estimated to be 56% of the allowable biological catch and 40% of the overfishing limit (Echave et al. 2016b). Because fishing mortality is well below the overfishing limit, we have rated this species as "low" concern in the Gulf of Alaska.

Justification:

Thornyhead rockfish are caught by commercial fishers using long lines and trawls, and shortspine thornyhead is considered to be the target species in the thornyhead complex. Landings in the Gulf of Alaska for the thornyhead complex were 1,033 t in 2015 (NMFS 2017a).

Factor 2.3 - Discard Rate

UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES, PACIFIC HALIBUT LONGLINE

< 100%

The longline fishery in the Gulf of Alaska targets Pacific cod, halibut, rockfish, sablefish, and various flatfish, but few data exist on discard to landings ratios and bait use. In 2012, the North Pacific Fishery Management Council decreased halibut bycatch limits in longline fisheries by 15% in an attempt to curb bycatch in this fishery (NPFMC 2013). In the early 1990's, NOAA estimated bycatch rates in the Gulf of Alaska groundfish fisheries, which include bottom longlines, to be between 4 and 22% (Queirolo, et al. 1995). Longlines use lures and bait, but are likely to include herring and squid/octopus (NPFMC 2017b) (Woodby et al. 2005). Bait use in this fishery is not quantified, but it is unlikely to increase the discard to landings ratio substantially. Given that there is no evidence that discards have increased substantially since NOAA's assessment, or that bait use is generally unknown, we have awarded a score of "1" or <100%.

SABLEFISH

Factor 2.1 - Abundance

UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES, PACIFIC HALIBUT LONGLINE

Very Low Concern

Sablefish (*Anoplopoma fimbria*) in the US North Pacific is managed by the North Pacific Fishery Management Council under the Gulf of Alaska Groundfish Fishery Management Plan. Sablefish is managed as a single stock for all of Alaska, including the Gulf of Alaska, Bering Sea, and Aleutian Islands. The most recent stock assessment (Hanselman et al. 2016) and NOAA Fisheries list Alaska sablefish as not overfished, with biomass at the target level (B/B_{MSY} = 1.00 (NOAA 2016a)). Biomass estimates have been stable since the 1990s (Hanselman et al. 2016). Due to stable biomass at the target level, we have rated the abundance of these species as “very low" concern.

Factor 2.2 - Fishing Mortality

UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES, PACIFIC HALIBUT LONGLINE

Low Concern

NOAA Fisheries lists sablefish in Alaska as not subject to overfishing (NOAA 2016a). Landings for this species have been managed under an individual fishing quota (IFQ) system since 1995 (Hanselman et al. 2016). In the most recent stock assessment, catch of sablefish in 2015 was estimated to be 80% of the allowable biological catch and 68% of the overfishing limit (Hanselman et al. 2016). Sablefish are targeted by commercial fishers using long lines and traps/pots, and caught as bycatch in trawls. Total catch in the Gulf of Alaska was 10,971 t in 2015 (Hanselman et al. 2016). Because the fishing mortality is well below the overfishing limit, we have rated this species as “low" concern in the Gulf of Alaska.

Factor 2.3 - Discard Rate

UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES
UNITED STATES OF AMERICA / GULF OF ALASKA, SET LONGLINES, PACIFIC HALIBUT LONGLINE

< 100%

The longline fishery in the Gulf of Alaska targets Pacific cod, halibut, rockfish, sablefish, and various flatfish, but few data exist on discard to landings ratios and bait use. In 2012, the North Pacific Fishery Management Council decreased halibut bycatch limits in longline fisheries by 15% in an attempt to curb bycatch in this fishery (NPFMC 2013). In the early 1990's, NOAA estimated bycatch rates in the Gulf of Alaska groundfish fisheries, which include bottom longlines, to be between 4 and 22% (Queirolo, et al. 1995). Longlines use lures and bait, but are likely to include herring and squid/octopus (NPFMC 2017b) (Woodby et al. 2005). Bait use in this fishery is not quantified, but it is unlikely to increase the discard to landings ratio substantially. Given that there is no evidence that discards have increased substantially since NOAA's assessment, or that bait use is generally unknown, we have awarded a score of "1" or <100%.

COHO SALMON

Factor 2.1 - Abundance

UNITED STATES OF AMERICA / GULF OF ALASKA, TROLLING LINES

Low Concern

Coho salmon (*Oncorhynchus kisutch*) is managed by the Alaska Department of Fish and Game (ADFG). Fourteen river systems are monitored as wild indicator stocks in southeast Alaska where lingcod and coho salmon are co-landed; hatchery fish are also considered significant contributors to catch of coho salmon (Shaul et al. 2011). The ADFG sets these escapement goals, which are measured in numbers of primarily wild (not hatchery raised) coho salmon (Hagerman et al. 2017) (Heinl 2017) (Skannes et al. 2016). All indicator stocks met or exceeded escapement goals more than 50% of the time (most meeting or exceeding the goal 85%+ of time time over 15 years (2002 to 2016 (Munro and Volk 2017) (Munro and Volk 2010)). ADFG notes that survival in the marine stage is a more important determinant of abundance than smolt production (Shaul et al. 2011).

Due to relatively stable abundance of coho salmon from 2002 to 2016, and because most, but not all, indicator stocks met or exceeded escapement goals goal 50%, but not 75%, of the time, we have rated the abundance of this species as "low" concern.

Factor 2.2 - Fishing Mortality

UNITED STATES OF AMERICA / GULF OF ALASKA, TROLLING LINES

Moderate Concern

Exploitation of indicator stocks has been consistent and stable over 2000 to 2010, suggesting fishing mortality is at or near F_{MSY} (Shaul et al. 2011). Trends in escapement suggest increasing abundance or level production for a majority of stocks, although some stocks have experienced recent decline in the last few years (Munro and Volk 2015) (Munro and Volk 2017). The decline is generally thought to be due to decreased marine survival, rather than overfishing (Heinl et al. 2014). In Southeast Alaska, exploitation rates for coho salmon are considered to be low to moderate (25 to 52%), and have been in decline between 2000 and 2014 (PSC 2017). Because recent fishing mortality is unknown, abundance varies among stocks in recent years but is mostly stable or increasing, and prior estimates indicated F was near F_{MSY}, we have rated fishing mortality as

"moderate" concern.

Justification:

Coho salmon are mostly caught in the ocean habitat by commercial, recreational, and subsistence fishers using a variety of methods. ADFG sets catch limits of commercial harvest and will close the fishery if catch limits are exceeded (Shaul et al. 2011). ADFG estimates that commercial catch declined from 64% of the abundance index during 1982 to 1999 to 50% of the abundance index of indicator stocks from 2000 to 2010, although the abundance index is calculated based on commercial catch, so it is difficult to get an independent measure of fishing mortality (Shaul et al. 2011).

Factor 2.3 - Discard Rate

UNITED STATES OF AMERICA / GULF OF ALASKA, TROLLING LINES

< 100%

Trolling gear included in this report are primarily used to capture salmon, but lingcod may be landed as bycatch. Limited discard or bait use data exist for this fishery to quantify a discard to landings ratio. Salted herring is a common bait used to target chinook salmon, but lures are also used to target other salmonids (R. Ehresmann, personal communication 2018). Because handline fisheries generally have low discard rates, there is evidence to suggest that landings of non-target species are well below 100%, and bait use is unknown but unlikely to increase the discard+bait use/landings ratio substantially, we have awarded a score of "1" or <100%.

BLACK ROCKFISH

Factor 2.1 - Abundance

UNITED STATES OF AMERICA / GULF OF ALASKA, TROLLING LINES
UNITED STATES OF AMERICA / GULF OF ALASKA, JIG

Moderate Concern

Black rockfish (*Sebastes melanops*) in the US North Pacific are managed by the Alaska Department of Fish and Game. There is no formal stock assessment for this species. The IUCN has not yet evaluated this species, but a Productivity-Susceptibility Analysis (PSA) indicated a medium vulnerability (below) with a score of 3.16. Black rockfish has life history characteristics that make this species vulnerable to overfishing, such as slow growth, late maturity, site fidelity, and large feeding aggregations (ADFG 2017c). Due to the lack of stock assessment, unknown biomass, and life history vulnerabilities for this species, we have rated it as "moderate" concern.

Justification:

The PSA score for black rockfish = 3.16. For this reason, the species is deemed as having a "medium vulnerability." Detailed scoring of each attribute is shown below.

Productivity Analysis for black rockfish, *Sebastes melanops*

PRODUCTIVITY ATTRIBUTE	PRODUCTIVITY DATA (AND REFERENCE)	PRODUCTIVITY SCORE
AVG. AGE AT MATURITY	6 to 8 years (Bobko and Berkeley 2004)	2
AVG. MAXIMUM AGE	50 years (ADFG 2017c)	3
FECUNDITY	125,000 to 1.2 million/year (ADFG 2017c) (Bobko and Berkeley 2004)	1
AVG. MAXIMUM SIZE	63 cm (Froese and Pauly 2016)	1
AVG. SIZE AT MATURITY	38 to 42 cm (ADFG 2017c)	2
REPRODUCTIVE STRATEGY	Live bearers (Moser 1996)	3
TROPHIC LEVEL	4.4 (Froese and Pauly 2017)	3
HABITAT QUALITY	Unknown	-

Susceptibility Analysis for black rockfish, *Sebastes melanops*

SUSCEPTIBILITY ATTRIBUTE	SUSCEPTIBILITY DATA (AND REFERENCE)	SUSCEPTIBILITY SCORE
AREAL OVERLAP	Gulf of Alaska to Southern California (Moser 1996)	3
VERTICAL OVERLAP	Surface to 360 m (most <150m) (ADFG 2017c)	3
SELECTIVITY OF FISHERY	Intermediate site fidelity, no suggested exceptional selectivity (Hannah and Rankin 2011)	2
POST-CAPTURE MORTALITY	Retained, or possibility of barotrauma (ADFG 2017c)	3

Factor 2.2 - Fishing Mortality

UNITED STATES OF AMERICA / GULF OF ALASKA, TROLLING LINES
UNITED STATES OF AMERICA / GULF OF ALASKA, JIG

Moderate Concern

There is no formal stock assessment for black rockfish, so sustainability of fishing mortality is considered unknown. The ADFG sets catch limits for this species for the Southeast Alaska and Yakutat regions, and closes

the fishery when the catch limits are reached (ADFG 2017c). Black rockfish are typically targeted in inshore waters using hook and line gear (trolling or jigging) (ADFG 2017c) and directed landings totalled 5.2 MT in the Southeast Outside District (SEO) in 2017, while bycatch of black rockfish in all groundfish, halibut, and salmon troll fisheries reached 10.6 MT in SEO (ADFG 2018). Due to the lack of stock assessment for this species and unknown fishing mortality, we have rated it as “moderate" concern.

Factor 2.3 - Discard Rate

UNITED STATES OF AMERICA / GULF OF ALASKA, TROLLING LINES

< 100%

Trolling gear included in this report are primarily used to capture salmon, but lingcod may be landed as bycatch. Limited discard or bait use data exist for this fishery to quantify a discard to landings ratio. Salted herring is a common bait used to target chinook salmon, but lures are also used to target other salmonids (R. Ehresmann, personal communication 2018). Because handline fisheries generally have low discard rates, there is evidence to suggest that landings of non-target species are well below 100%, and bait use is unknown but unlikely to increase the discard+bait use/landings ratio substantially, we have awarded a score of "1" or <100%.

UNITED STATES OF AMERICA / GULF OF ALASKA, JIG

< 100%

Jig gear in this report includes rod and reel and dinglebar troll gear, both of which are relatively species-specific. Limited discard and bait use data exist for these fisheries to quantify a discard to landings ratio. In targeted jig (dinglebar troll) fishery for lingcod, species like rockfish account for 3 to 7% of the landings (ADFG 2016d) and either lures, bait, or lures soaked in bait to scent the lures may be used (ADFG 2016a) (Vaughn, personal communication 2018). In the Western region, very few lingcod are discarded in the jig fishery, which primarily focuses on rockfish; in most years discards of lingcod are zero in this fishery (ADFG 2016c). Because jig fisheries generally have low discard rates, there is evidence to suggest that landings of non-target species are well below 100%, and there is no evidence to suggest bait use would increase the discard rate substantially, we have awarded a score of "1" or <100%.