BSAI Halibut Abundance-based Management (ABM) Amendment 80 of PSC Limit

Initial Review Draft

March 2021[1]

This document analyzes a proposed management measure to link the Pacific halibut prohibited species catch (PSC) limit for the Amendment 80 commercial groundfish trawl fleet in the Bering Sea and Aleutian Islands (BSAI) groundfish fisheries to halibut abundance. The objectives of linking the PSC limit are to minimize halibut PSC to the extent practicable under the Magnuson-Stevens Fishery Conservation and Management Act (MSA) National Standard 9 and to achieve optimum yield in the BSAI groundfish fisheries on a continuing basis under MSA National Standard 1. This would also be expected to provide incentives for the Amendment 80 fleet to minimize halibut mortality at all times. Achievement of these objectives could result in additional harvest opportunities in the commercial halibut fishery.

This document is a preliminary draft Environmental Impact Statement (DEIS). An EIS provides assessments of the environmental impacts of an action and its reasonable alternatives as well as the economic benefits and costs of the action alternatives and their distribution. This preliminary DEIS addresses the statutory requirements of the MSA, the National Environmental Policy Act, and Presidential Executive Order 12866. A preliminary DEIS is a document produced by the North Pacific Fishery Management Council and the National Marine Fisheries Service Alaska Region to provide the analytical background for decision-making.

[1] Prepared by Diana Stram, Sam Cunningham, and Anna Henry, NPFMC staff; Mike Downs (Wislow Research); Anne Marie Eich and Joe Krieger of NMFS Alaska Region, Sustainable Fisheries; Dana Hanselman, Carey McGilliard, and Jim Ianelli of NMFS Alaska Fisheries Science Center; and Allan Hicks of the International Pacific Halibut Commission. Authorship does not imply endorsement by their associated agency.

List of Acronyms and Abbreviations

Acronym or Abbreviation	Meaning
AAC	Alaska Administrative Code
ABC	acceptable biological catch
ABM	Abundance-based management
ADF&G	Alaska Department of Fish and Game
AFA	American Fisheries Act
AFSC	Alaska Fisheries Science Center
AKFIN	Alaska Fisheries Information Network
BSAI	Bering Sea and Aleutian Islands
BTS	Bottom Trawl Survey
CAS	Catch Accounting System
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
COAR	Commercial Operators Annual Report
Council	North Pacific Fishery Management Council
CP	catcher/processor
CV	catcher vessel
DPS	distinct population segment
E.O.	Executive Order
EA	Environmental Assessment
EEZ	Exclusive Economic Zone
EFH	essential fish habitat
EIS	Environmental Impact Statement
ESA	Endangered Species Act
ESU	endangered species unit
FMA	Fisheries Monitoring and Analysis
FMP	fishery management plan
FONSI	Finding of No Significant Impact
FR	*Federal Register*
FRFA	Final Regulatory Flexibility Analysis
ft	foot or feet
GOA	Gulf of Alaska
IPHC	International Pacific Halibut Commission
IPA	Incentive Plan Agreement
JAM	jeopardy or adverse modification
lb(s)	pound(s)
LEI	long-term effect index
LLP	license limitation program
LOA	length overall
m	meter or meters
Magnuson-Stevens Act	Magnuson-Stevens Fishery Conservation and Management Act
MMPA	Marine Mammal Protection Act
MSST	minimum stock size threshold
t	tonne, or metric ton
NAICS	North American Industry Classification System
NAO	NOAA Administrative Order
NEPA	National Environmental Policy Act

Acronym or Abbreviation	Meaning
NMFS	National Marine Fishery Service
NOAA	National Oceanic and Atmospheric Administration
NPFMC	North Pacific Fishery Management Council
NPPSD	North Pacific Pelagic Seabird Database
Observer Program	North Pacific Groundfish and Halibut Observer Program
OMB	Office of Management and Budget
O26	Over 26” halibut
PBR	potential biological removal
PSC	prohibited species catch
PPA	Preliminary preferred alternative
PRA	Paperwork Reduction Act
PSEIS	Programmatic Supplemental Environmental Impact Statement
RFA	Regulatory Flexibility Act
RFFA	reasonably foreseeable future action
RIR	Regulatory Impact Review
RPA	reasonable and prudent alternative
SAFE	Stock Assessment and Fishery Evaluation
SAR	stock assessment report
SBA	Small Business Act
Secretary	Secretary of Commerce
SPLASH	Structure of Populations, Levels of Abundance, and Status of Humpbacks
SRKW	Southern Resident killer whales
TAC	total allowable catch
TCEY	Total constant exploitation yield
U.S.	United States
USCG	United States Coast Guard
USFWS	United States Fish and Wildlife Service
VMS	vessel monitoring system

Table of Contents

List of Tables

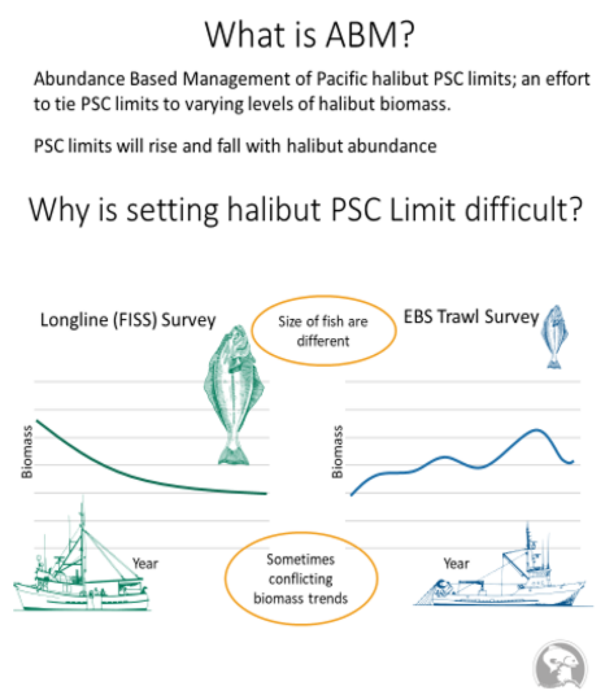
List of Figures

Executive Summary

This document analyzes proposed management measures to link the Amendment 80 commercial groundfish trawl fleet's (Amendment 80 sector) Pacific halibut prohibited species catch (PSC) limits in the Bering Sea and Aleutian Islands (BSAI) groundfish fisheries to halibut abundance. The Amendment 80 sector comprises trawl catcher/processor vessels in the BSAI that target groundfish species other than pollock. The North Pacific Fishery Management Council (Council) is considering a program that links the Amendment 80 sector PSC limit to halibut abundance and provides incentives for the fleet to minimize halibut mortality at all times. This action could also promote conservation of the halibut stock and may provide additional opportunities for the directed halibut fishery.

Pacific halibut (*Hippoglossus stenolepis*) is utilized in Alaska as a target species in subsistence, personal use, recreational (sport), and commercial halibut fisheries. Halibut has significant social, cultural, and economic importance to fishery participants and fishing communities throughout the geographical range of the resource. Halibut is also incidentally taken as bycatch in groundfish fisheries.

The Council is examining abundance-based approaches to set halibut PSC limits for the Amendment 80 sector in the BSAI. Currently halibut PSC limits for groundfish fisheries are set in the BSAI Groundfish FMP at a fixed amount of halibut mortality, in metric tons (t). When halibut abundance declines, halibut PSC becomes a larger proportion of total halibut removals and can result in lower catch limits for directed halibut fisheries. While other groundfish sectors are also subject to PSC limits, this action is limited to the Amendment 80 sector because that sector is responsible for the majority of BSAI halibut mortality in the groundfish fisheries. Both the Council and the International Pacific Halibut Commission (IPHC) have expressed concern about impacts on directed halibut fisheries under the status quo in light of the continued decline in the halibut stock and identified abundance-based halibut PSC limits as a potential management approach to address these concerns.



The Council has set other PSC limits (crab, herring) based upon abundance of the stock in the BSAI. However, this action was complicated by consideration of how to index the BSAI portion of the coastwide halibut stock (see inset on What is ABM). In October 2017, the SSC recommended, and the Council selected two abundance indices to track Pacific halibut abundance and guide setting PSC limits in the BSAI groundfish fisheries These indices are derived from the NMFS Alaska Fisheries Science Center (AFSC) eastern Bering Sea (EBS) shelf bottom trawl survey and from the IPHC setline survey covering IPHC Areas 4ABCDE. Both indices represent the best available scientific information on halibut abundance.

Purpose and Need

The Council has been managing Pacific halibut bycatch by a range of measures since the inception of the BSAI FMP (Figure ES 1). The most recent action was taken by the Council in 2015 to reduce the PSC limits for all sectors. After that action the Council signaled its intent to pursue abundance-based management alternatives to set halibut PSC limits.

The Council's purpose and need statement for this action is the following as amended in October 2020:

Halibut is an important resource in the Bering Sea and Aleutian Islands (BSAI), supporting commercial halibut fisheries, recreational fisheries, subsistence fisheries, and groundfish fisheries. The International Pacific Halibut Commission (IPHC) is responsible for assessing the Pacific halibut stock and establishing total annual catch limits for directed fisheries and the North Pacific Fishery Management Council (Council) is responsible for managing prohibited species catch (PSC) in U.S. commercial groundfish fisheries managed by the Council. The Amendment 80 sector is accountable for the majority of the annual halibut PSC mortality in the BSAI groundfish fisheries. While the Amendment 80 fleet has reduced halibut mortality in recent years, continued decline in the halibut stock requires consideration of additional measures for management of halibut PSC in the Amendment 80 fisheries.

When BSAI halibut abundance declines, PSC in Amendment 80 fisheries can become a larger proportion of total halibut removals in the BSAI, particularly in Area 4CDE, and can reduce the proportion of halibut available for harvest in directed halibut fisheries. The Council intends to establish an abundance-based halibut PSC management program in the BSAI for the Amendment 80 sector that meets the requirements of the Magnuson-Stevens Act, particularly to minimize halibut PSC to the extent practicable under National Standard 9 and to achieve optimum yield in the BSAI groundfish fisheries on a continuing basis under National Standard 1. The Council is considering a program that links the Amendment 80 sector PSC limit to halibut abundance and provides incentives for the fleet to minimize halibut mortality at all times. This action could also promote conservation of the halibut stock and may provide additional opportunities for the directed halibut fishery.

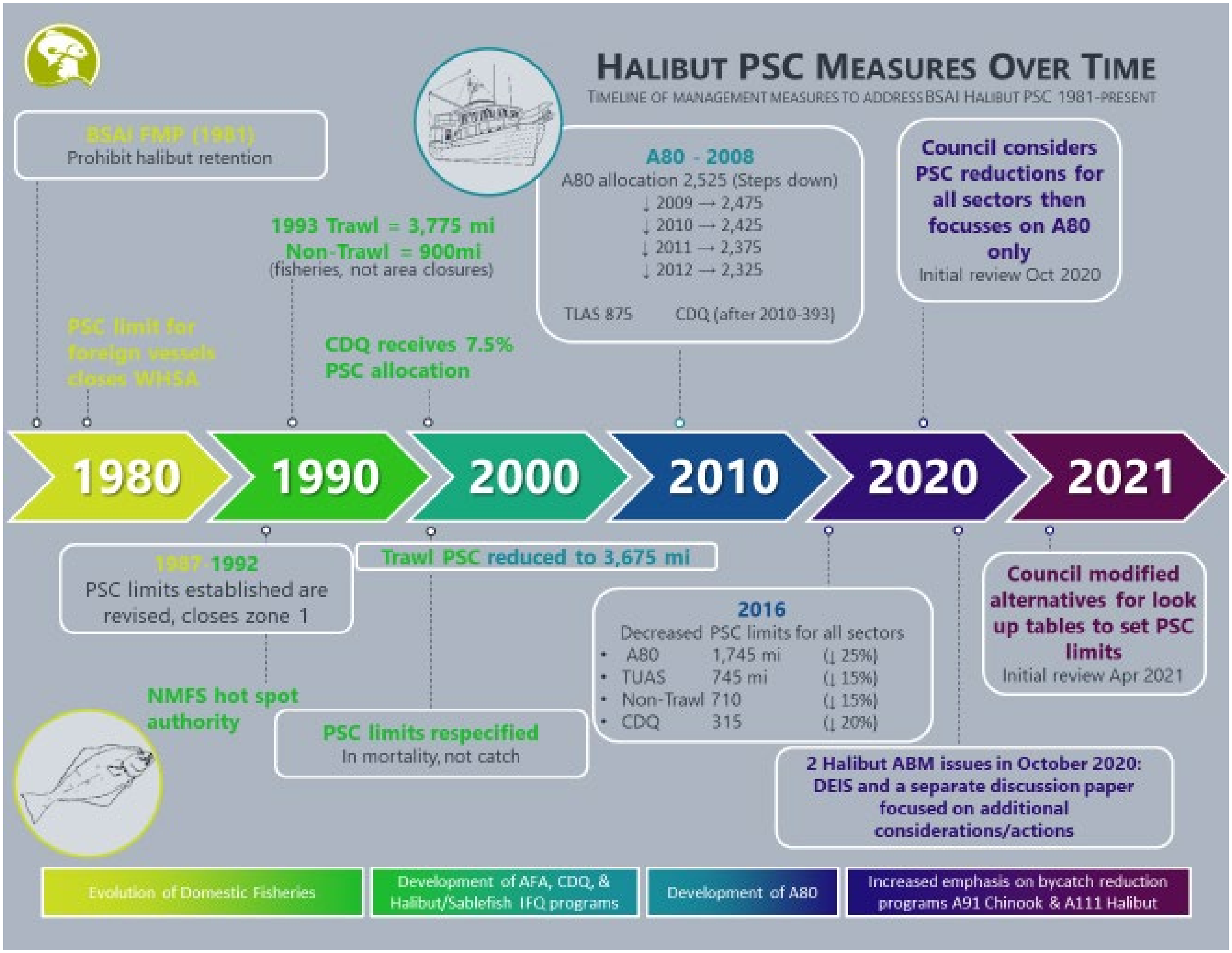


Figure ES 1 Timeline of BSAI halibut PSC management

What has changed since the previous draft analysis in October 2020?

This analysis was last reviewed by the Council in October. There have been many major and minor changes since that time. Major changes are listed by subject heading below while Table ES-1 indicates all sections where some changes (as a result of SSC requests, modifications to alternatives, data updates and impact analysis) have also been made.

Purpose and Need

The Council made substantive changes to the Purpose and Need statement at the October 2020 meeting. These changes reflect both the modification in the Alternative set as well as the focus upon balancing the National Standards in selecting an appropriate management action. In doing so, the Council's new Purpose and Need supersedes the previously inferred '5 Overarching Objectives'. These had been used to frame management objectives for purposes of characterizing performance metrics in the previous, management strategy evaluation (MSE) type analysis (see below on methodological changes).

Alternatives

The Alternative set has been substantially modified from one in which one or two indices were used to formulate control rules with optional features of slope, floors, ceilings, etc. to a more streamlined alternative set with the current three action alternatives. These alternatives use a lookup table approach to set the PSC limit based on the status of halibut indexed in both the IPHC setline and EBS trawl surveys. Additionally options have been added to dampen the variability of the PSC limit from one year to the next (Options 1 and 2) and to provide additional provisions for incentives to operate below the PSC limit and potential to rollover unused PSC to the following year (Options 3 and 4).

Methodology for impact analysis

The Council requested that this next version of the preliminary draft Environmental Impact Statement (DEIS) shift the analytical focus from a management strategy evaluation (MSE) approach centered on the use of a closed loop simulation model to evaluate impacts and objectives with respect to performance metrics, to a more traditional impacts analysis on the affected fishing sectors and other affected resource components. Therefore while some of the impact analysis as it relates to impacts to halibut abundance and spawning stock biomass (SSB) draw upon previous modeling efforts much of the impact analysis on the affected fishing sectors and the policy tradeoffs do not rely on the closed-loop modeling outputs nor are policy level tradeoffs framed in response to addressing performance metrics but rather to balancing across the National Standards.

The following analyses were added to the groundfish revenue estimation. First, two additional year combinations were added to this analysis to more fully estimate the possible range of outcomes: data from 2017-2018 were combined to capture the years where PSC was low and revenue was high. This provides an upper bound example from the "best case" in the data. Data from 2013-14 were combined to capture the years where PSC was high and revenue was low to provide a lower bound example from the "worst case" in the data. Second, a stratified resampling approach was added to the document in response to SSC comments. This method stratifies the data by the month in which the haul occurred and resamples a number of hauls equal to the maximum hauls that occurred in that month during the years of the dataset. Annual total revenues, groundfish, and PSC are summed over hauls in the order of the month in which they occur (starting with January), until the PSC limit or groundfish catch limit is reached.

Policy tradeoffs

This section is new and provides a comparison of Alternatives and estimated impacts as it relates to balancing the different considerations in the National Standards, with a particular focus on differences in balancing aspects of National Standards 1, 4, 8 and 9.

Summary of all revised sections

Table ES-1 provides an overview of the document by Section number where major or minor modifications were made as well as the main impetus for that change.

Table ES-1 Summary of modified sections of revised DEIS

Chapter	Section	Nature of Change		Origin
		Major	Minor	
1	1.2 Purpose and Need	X		Council
	1.3 History of Action		X	Update for consistency
	1.4 Process		X	Update for consistency
	1.6.2 IPHC Survey		X	Update for new information and clarifications
2	Overview	X		Update for new alternatives
	2.1 Alternative 1		X	Streamlined description
	2.2 Alternatives 2 through 4	X		New Alternatives
	2.3 Options	X		New Options
	2.4 Historical comparison	X		New alternatives and options
	2.5 Annual process for PSC Setting		X	Update for consistency with New alternatives and options
	2.8 Policy tradeoffs	X		New Section
3	3.1		X	Update
	3.3		X	Update
4	4.1-4.2		X	Update
	4.4		X	Update
5	5.2-5.3 Impacts to halibut indices and SSB	X		Update and synthesis from previous modeling efforts
	5.5 Revenue impact estimation	X		Update of previous analysis as well as new revenue estimation
6	6.1-6.2		X	Update
7	7.1 National Standards	X		New sections addressing National Standards for Alternative set
8-9				Update for consistency
10	Appendices	X		Appx 1 SIA updated with new information and Alternatives (see separate ES for SIA for listing of updated information). Appx 2: Synthesized information from October 2020 Modeling

Alternatives

There are four Alternatives under consideration by the Council. These have been developed through multiple discussion papers, Council considerations, and consultation with stakeholders. These Alternatives range from status quo with fixed halibut PSC limit for the Amendment 80 sector to a range of PSC limits indexed to BSAI halibut abundance, where the limits can be selected values derived from two surveys (IPHC Setline Survey and EBS Trawl survey). This action modifies the PSC limit for the Amendment 80 sector only.

Alternative 1: Status Quo. The Amendment 80 (A80) PSC limit set at 1,745 t.

Alternatives 2-4: PSC limit is determined annually based on EBS shelf trawl and IPHC setline survey using look up tables of a combination of survey states and PSC limits. For the EBS trawl survey only two survey states “High” (≥ 150,000 t) and “Low” (<150,000 t) are considered (Figure ES-1, top panel) under each Alternative. For the IPHC setline survey, a range of states are considered by Alternative. For the setline survey under all alternatives, there is a ‘High’ state (≥11,000 WPUE), and a “Medium’ state (8,000-10,999 WPUE) (Figure ES-1, bottom panel). The difference between Alternative 2 (3x2) and Alternatives 3 and 4 (4x2) as it relates to the setline survey states is the distinction between ‘Low’ in Alternative 2 (<8,000 WPUE) and the inclusion of both ‘Low’ (6,000-7,999 WPUE) and ‘Very Low’ (<6,000 WPUE) in Alternatives 3 and 4.

PSC limits are defined within the boxes of the Look up tables and vary by Alternative (Table ES-2).

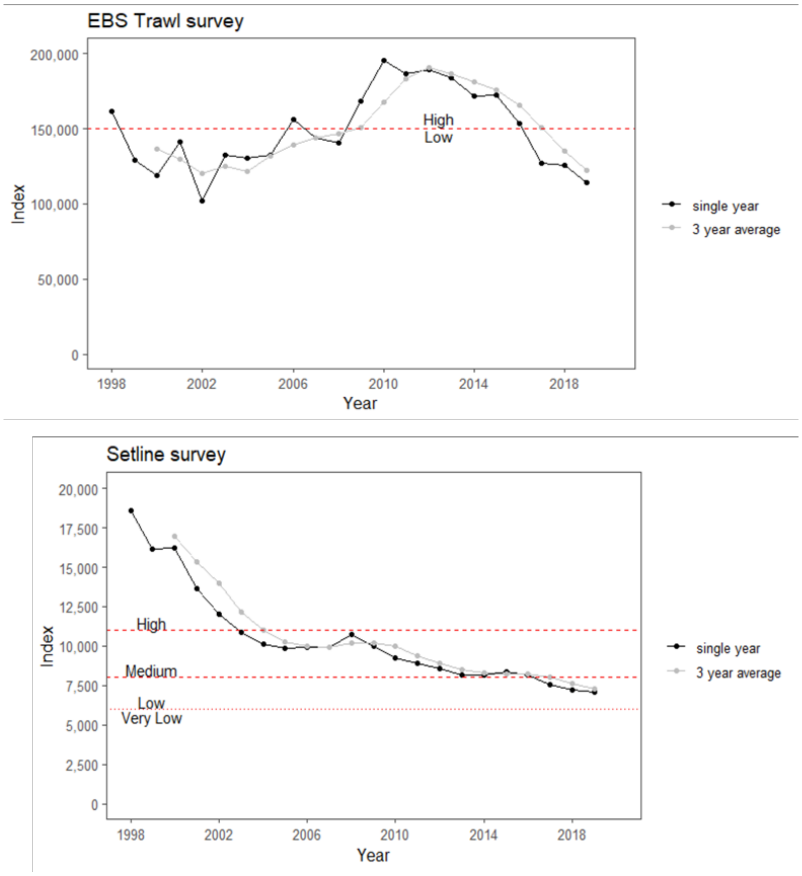


Figure ES-1 Survey states for Alternatives 2,3,4. Top panel: EBS trawl survey (1998-2019) with 'survey state' delineation (dotted line) between 'High' and 'Low" at 150,000 t. Bottom panel: IPHC Setline survey 1998-2019 WPUE with 'survey' state delineations for 'High', 'Medium', 'Low' and 'Very low'. Both single within year data (black line) as well as the rolling three-year survey average (grey line) are shown.

Alternative 2: PSC limit is determined annually based on EBS shelf trawl and IPHC setline survey values from the most recent year available, using a 3x2 look-up table with PSC limits that range from the current limit (1,745 t) to 20 percent below the current limit.

Alternative 3: PSC limit is determined annually based on EBS shelf trawl and IPHC setline survey values from the most recent year available, using a 4x2 look-up table with PSC limits that range from the 15 percent above the current limit to 30 percent below the current limit.

Alternative 4: PSC limit is determined annually based on EBS shelf trawl and IPHC setline survey values from the most recent year available, using a 4x2 look-up table with PSC limits that range from the current limit to 45 percent below the current limit.

Table ES-2 Look up tables for use in setting PSC limits based upon PSC limits associated with the intersection of different states of the EBS trawl survey and the IPHC setline survey. Alternatives 2,3,4.

Alternative 2		EBS shelf trawl survey index (t)	
		Low < 150,000	**High ≥ 150,000**
IPHC setline survey index in Area 4ABCDE (WPUE)	**High ≥ 11,000**	1,571 mt (10% below current)	1,745 mt (current limit)
	Medium 8,000 – 10,999	1,483 mt (15% below current)	1,571 mt (10% below current)
	Low < 8,000	1,396 mt (20% below current)	1,483 mt (15% below current)

Alternative 3		EBS shelf trawl survey index (t)	
		Low < 150,000	**High ≥ 150,000**
IPHC setline survey index in Area 4ABCDE (WPUE)	**High ≥ 11,000**	1,745 mt (current limit)	2,007 mt (15% above current)
	Medium 8,000 – 10,999	1,396 mt (20% below current)	1,745 mt (current limit)
	Low 6,000-7,999	1,309 mt (25% below current)	1,396 mt (20% below current)
	Very Low < 6,000	1,222 mt (30% below current)	1,309 mt (25% below current)

Alternative 4		EBS shelf trawl survey index (t)	
		Low < 150,000	**High ≥ 150,000**
IPHC setline survey index in Area 4ABCDE (WPUE)	**High ≥ 11,000**	1,396 mt (20% below current)	1,745 mt (current limit)
	Medium 8,000 – 10,999	1,222 mt (30% below current)	1,396 mt (20% below current)
	Low 6,000-7,999	1,047 mt (40% below current)	1,222 mt (30% below current)
	Very Low < 6,000	960 mt (45% below current)	1,047 mt (40% below current)

Options that may be applied to any Alternative

The Council also adopted four options, applicable under any of Alternatives 2 through 4, which could affect how the PSC limits would be calculated and managed. ***Option 1*** would use the three-year rolling average of the survey estimate instead of the most recent year available for the look up table.

Option 2 constrains the variability of the inter-annual PSC limit to 10-15 percent regardless of the value indicated by the Look up table. Options 3 and 4 provide additional incentive measures for the Amendment 80 sector to operate at PSC levels below those specified by the Look up table PSC limits.

Option 3 provides an annual limit set at 80-90 percent of the PSC limit. This annual limit is a benchmark that is intended to be avoided and thus provide incentive to remain below it. This annual limit however is not binding even when reached until it is reached for the 3rd time in a rolling 7-year time frame. At the point that it is reached for the 3rd time it then becomes a hard cap until the sector is able to operate below the annual limit for a sufficient amount of years to drop below the 3 in 7 designation at which point the annual limit will cease as a hard cap unless the standard is exceeded again.

Option 4 provides for a rollover provisions of unused PSC up to but not to exceed 20% of the in-year PSC limit. Any unused PSC above the 20% rollover would remain in the water. Option 4 is mutually exclusive with the selection of either Options 2 or 3.

Comparison of Alternatives

In recent years the EBS trawl survey has been in a "Low' state (Figure ES-1) under all Alternatives. Despite the distinction between 'Low' and 'Very low' in Alternatives 2-4 the setline survey is in the 'Low' state currently under all three alternatives based on the 2019 survey estimates (and not including the Option 1 rolling three-year average). An historical comparison of the PSC limits as a result of status quo with the proposed bands to indicate PSC limits across the action alternatives (Figure ES-2) shows that PSC limits historically have fallen within the upper limits of the proposed alternatives but not the lower bands included in the Look up tables.

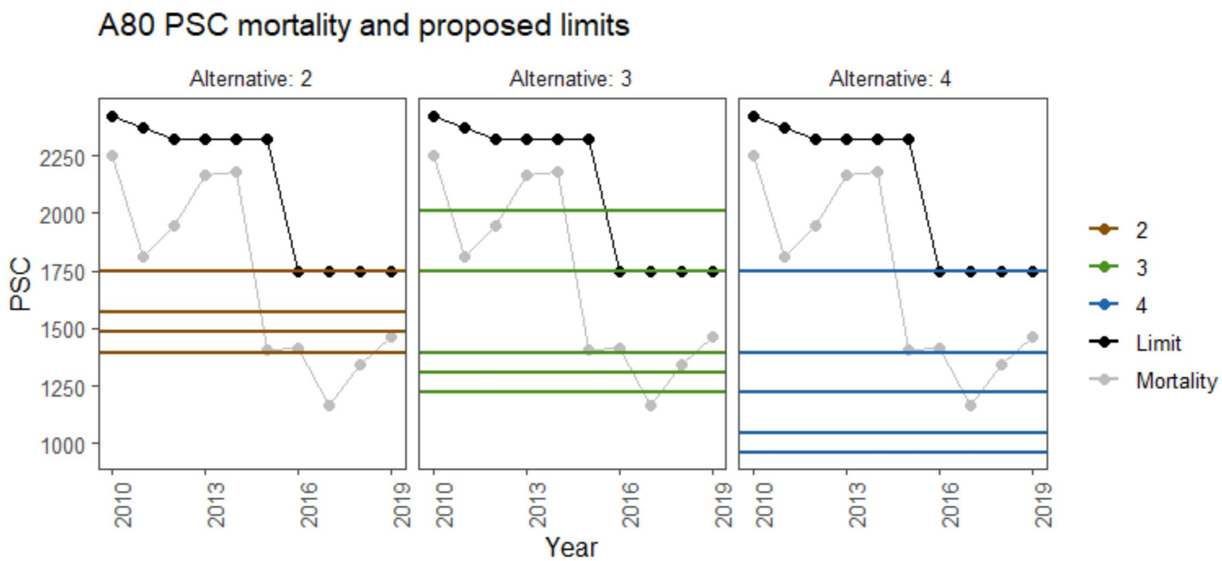


Figure ES-2 Historical comparison of the status quo PSC limits compared with the solid bands (brown Alt 2; green Alt 3; blue Alt 4) which indicate proposed PSC limit range across the look up table for each action alternative. Black line is the historical limit while grey indicates the actual PSC mortality. The status quo limit from 2016-present is 1,750 mt.

The simulation model results for the survey indices of Pacific halibut in the BSAI were used to illustrate the probabilities of the survey combinations resulting from the look-up tables (Table ES-3). These cells represent different combinations of categorized IPHC setline survey and the EBS bottom trawl survey values. For the short-term simulation, 25% of the simulations were in the low BTS and very low setline survey state combination while for the long-term simulation this drops to 18%.

Table ES-3 Survey states, percentage of time model simulations over a range of time frames resulted in that combination of survey states and the PSC limits that result from those across alternatives

EBS		Setline		Proportion of simulations in each combination of survey states under status quo PSC				PSC limits		
State	Index	State	Index	2021-2030	2031-2060	2061-2100	2021-2100	Alt 2	Alt 3	Alt 4
low	<150,000	very low	<6,000	25%	14%	20%	18%	NA	1222	960
low	<150,000	low	6,000-7,999	17%	10%	11%	11%	1396	1309	1047
low	<150,000	medium	8,000-10,999	2%	7%	6%	6%	1483	1396	1222
low	<150,000	high	≥11,000	0%	2%	1%	1%	1571	1745	1396
high	>150,000	very low	<6,000	16%	4%	7%	7%	NA	1309	1047
high	>150,000	low	6,000-7,999	22%	11%	15%	14%	1483	1396	1222
high	>150,000	medium	8,000-10,999	12%	24%	22%	21%	1571	1745	1396
high	>150,000	high	≥11,000	6%	28%	19%	21%	1745	2007	1745

Roadmap for understanding EIS structure and RIR and MSA requirements

This document is a preliminary DEIS. A preliminary DEIS provides assessments of the environmental impacts of an action and its reasonable alternatives as well as the economic benefits and costs of the action alternatives and their distribution. This preliminary DEIS addresses the statutory requirements of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), the National Environmental Policy Act, and Presidential Executive Order 12866. A preliminary DEIS is a document produced by the Council and the National Marine Fisheries Service (NMFS) Alaska Region to provide the analytical background for decision-making. A Social Impact Assessment (SIA) appended separately has also been prepared for this document.

This preliminary draft EIS is being prepared using the 1978 Council on Environmental Quality (CEQ) National Environmental Policy Act (NEPA) Regulations. NEPA reviews initiated prior to the effective date of the revised CEQ regulations may be conducted using the 1978 version of the regulations. The effective date of the 2020 CEQ NEPA Regulations was September 14, 2020. A Notice of Intent to publish an Environmental Impact Statement (EIS) for the proposed management measures was published in the Federal Register on December 12, 2017 (82 FR 58374). This review began on that date, and the agency has decided to proceed under the 1978 regulations.

The document is structured to streamline information required in a DEIS and to organize it to be most easily understood by the reader. **Chapters 1 and 2** contain a description of the purpose and need for the action, followed by a description of the alternatives. **Chapters 3 and 4** of this preliminary DEIS contain background information on the Amendment 80 groundfish fishery and the commercial halibut fisheries in IPHC Area 4 (IFQ and CDQ). Those sections characterize the fisheries as they exist under status quo management and provide the context within which the alternative management measures should be considered. **Chapter 5** contains the impact analysis on the groundfish fishery and halibut fishery from these alternatives as well as the methodology for the both the impacts to the halibut stock from the closed-loop simulation and impacts to groundfish and halibut fisheries from the revenue estimation. **Chapter 6** contains information and impacts to other affected resources.

Appended separately (**Appendix 1**) is a social impact assessment (SIA) that evaluates community and regional patterns of engagement in and dependency on the BSAI Amendment 80 groundfish commercial fishery and the BSAI/Area 4 halibut commercial fishery as well as the potential for community level impacts under the no-action and action alternatives. Potential impacts to regional subsistence and sport halibut fisheries in Alaska are also evaluated. Myriad communities in Alaska and the Pacific Northwest participate directly and/or indirectly in one or both commercial fisheries. Within Alaska, more communities participate directly in the BSAI/Area 4 commercial halibut fishery than in the Amendment 80 fishery; however, the Amendment 80 fishery touches multiple Alaska communities directly or indirectly in several ways including: being the location of product transfers, which generate tax revenues realized at the state and local level; being ports of call, which may generate local support service sector economic activity; and/or being industry partners for the harvest of CDQ multispecies groundfish quota, among others. The BSAI/Area 4 halibut fishery, on the other hand, is fundamentally important to the local fleets of multiple Alaska communities and regions and, in some cases, provides one of the few options for private sector employment and income opportunities in those communities. The findings of the SIA are summarized in the "Social and Environmental Justice" section of the DEIS.

Summary of Impacts

Impacts of PSC on halibut SSB

The previous simulation model results for Pacific halibut SSB in the BSAI across a range of Alternatives bookending those under consideration (i.e. status quo and no PSC) indicate that SSB is largely insensitive to the range of PSC limits under consideration.

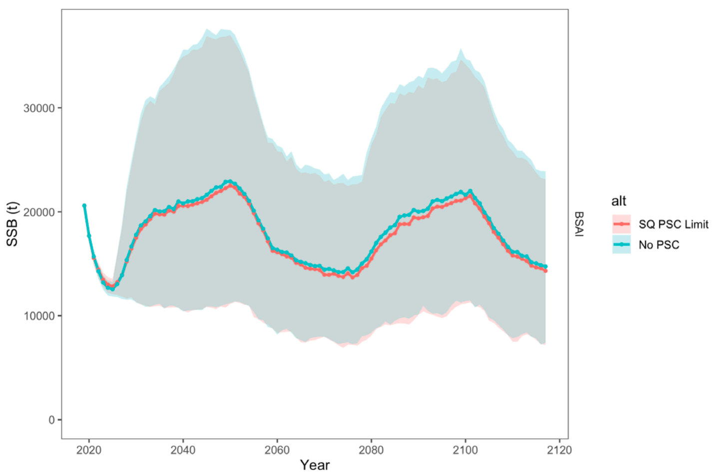


Figure ES-3 Projected Pacific halibut SSB for the BSAI region under status quo and zero PSC Pacific halibut mortality. Solid lines are median values and 90 out of 100 model realizations fall within the shaded areas.

Groundfish fishery impacts

The range of estimated catch and revenue outcomes under each alternative is related to the range of the PSC limits associated with the alternatives (Table 5-3) and the probability of being in a given look-up table state in a given year. Alternative 2 has the narrowest range of PSC limits (1,396-1,745 t) and thus the narrowest range of revenue estimates. Alternative 3 includes a wider range of PSC limits (1,222-2,007 t) than Alternative 2 and is the only alternative that includes a limit that could be higher than status quo (2,007 t). The range of PSC limits under Alternative 4 (960-1,745 t) includes the lowest possible values and peaks at the status quo limit.

For each PSC limit and imposed groundfish catch limit – analogous to total A80 TAC – the Table 5-3 results shown by rows differ depending on the historical fishery data (haul-level catch, revenue, and PSC) that were used to simulate the fishery. Data are drawn for separate simulation runs from five different time periods that select sets of years spanning the 2010 through 2019 period. Earlier years stand in for an era with higher A80 PSC while more recent years stand in for lower PSC use, better reflecting the present state of the fishery. Simulations were done either by drawing random hauls from the distribution or by stratifying haul-selection by month and maintaining historic monthly effort levels such that effort is constrained from the end of a fishing year backward rather than proportionally across the whole year.

Figure ES-4 displays the A80 groundfish revenue simulation results for the five sets of historical years for each combination of PSC limit and groundfish catch limit (random draw method). The colors of the results distributions (ridges) correspond to a specific PSC limit, noting that some limits appear in the look-up table for more than one alternative. For example, yellow only appears once in each panel because the PSC limit of 2,007 t is only part of one look-up table (Alt 3).

Currently, both the setline and the trawl surveys are in the Low categories, which correspond to PSC limits that represent immediate reductions from the status quo PSC limit of 1,745 t. Revenue estimates under the resulting PSC limits using the 2016-19 dataset range from no change to a reduction of 3% under Alternative 2, reductions of 3% to 9% under Alternative 3, and reductions of 22% to 32% under Alternative 4. The analysis estimates the probability of being in different survey/look-up table states in the near-term (through 2030) (Table ES-3). There is an estimated 17% probability of staying in a Low/Low state. The highest probability (25%) is to move to a Low/Very Low combination of survey states, resulting in the lowest PSC limit under each alternative, with revenue reductions of 0% to 3% under Alternative 2, 10% to 15% under Alternative 3, and 29% to 41% under Alternative 4 (revenue estimation based on 2016-19 historical haul data). It is almost just as likely (22% probability) to be in a High trawl survey state and a Low setline survey state, which would result in an increase to the next highest PSC limit for each alternative. In that event, revenue changes range from no change under Alternative 2, 0% to -3% under Alternative 3, and -9% to -15% under Alternative 4 (again using 2016-19 dataset estimates). Estimates over longer time horizons show the possibility of improved survey states based on the ABM operating model analysis.

Table ES-4 Average estimated A80 groundfish catch (1,000 t; top panel) and revenue (million wholesale 2018$; bottom panel) by PSC limit and Alternative using different estimation methods. Green shading indicates the results were constrained by the PSC limit, blue shading indicates the results were constrained by the imposed groundfish limit (290,000 or 310,000 t).

Estimation method	PSC limit	960		1047		1222		1309		1396		1483		1571		1745		2007	
	Alternative(s)	4		4		3		3		2,3,4		2		2		1,2,3,4		3	
	GF limit (1,000 t)	290	310	290	310	290	310	290	310	290	310	290	310	290	310	290	310	290	310
Random	2010-14	141.87	142.08	154.64	154.84	180.30	180.60	193.62	193.18	206.31	206.06	219.45	218.93	232.20	232.01	257.39	257.73	289.83	296.41
	2010-19	163.68	164.03	178.98	178.64	208.84	208.68	223.74	223.47	238.37	238.53	253.43	253.17	268.16	267.55	289.89	297.92	289.98	309.98
	2016-19	206.15	206.20	225.00	225.06	262.45	262.51	280.97	281.14	289.99	299.95	289.98	309.98	289.99	309.99	289.99	309.99	289.99	309.99
	2013-14	135.87	135.96	148.12	148.27	173.09	172.68	185.01	185.05	197.65	197.23	209.83	209.77	222.39	222.41	247.19	247.13	283.86	283.97
	2017-18	217.60	217.53	237.19	237.22	277.07	276.67	289.96	296.63	289.99	309.97	289.99	309.99	289.99	309.99	289.99	309.99	289.99	309.99
Stratified	2010-14	167.26	167.25	179.74	179.73	199.56	199.38	209.93	209.99	223.89	224.00	240.13	239.85	252.87	252.54	278.24	278.01	289.98	309.98
	2010-19	179.03	178.93	191.50	191.57	214.87	214.88	226.38	226.65	243.07	243.71	264.26	264.35	281.00	281.28	289.98	309.59	289.98	309.98
	2016-19	184.07	184.22	210.79	210.86	264.14	264.04	283.60	283.57	289.99	304.60	289.99	309.98	289.99	309.98	289.99	309.99	289.99	309.98

Estimation	PSC limit	960		1047		1222		1309		1396		1483		1571		1745		2007	
	Alternative(s)	4		4		3		3		2,3,4		2		2		1,2,3,4		3	
	GF limit (1,000 mt)	290	310	290	310	290	310	290	310	290	310	290	310	290	310	290	310	290	310
Random	2010-14	160.582	160.815	174.982	175.215	204.050	204.313	219.181	218.550	233.493	233.235	248.384	247.668	262.813	262.705	291.338	291.603	327.968	335.497
	2010-19	189.686	190.121	207.396	206.935	241.993	241.715	259.314	258.923	276.215	276.468	293.723	293.380	310.690	310.046	335.887	345.264	335.937	359.123
	2016-19	246.206	246.385	268.807	268.887	313.489	313.519	335.524	335.829	346.417	358.232	346.366	370.300	346.425	370.269	346.417	370.311	346.454	370.271
	2013-14	137.994	138.184	150.453	150.591	175.812	175.384	187.950	187.992	200.795	200.295	213.141	213.202	225.934	225.979	251.137	251.123	288.273	288.545
	2017-18	282.581	282.479	307.928	308.073	359.795	359.146	376.517	385.223	376.582	402.458	376.509	402.584	376.623	402.591	376.558	402.546	376.604	402.554
Stratified	2010-14	182.258	182.272	195.088	195.065	216.307	216.059	227.666	227.668	246.072	246.276	268.338	267.997	283.966	283.479	313.799	313.520	327.054	349.666
	2010-19	202.931	202.828	216.382	216.445	242.752	242.719	255.780	256.090	277.083	277.964	305.385	305.515	326.047	326.307	336.782	360.053	336.793	360.511
	2016-19	218.741	218.978	253.143	253.251	319.090	318.907	341.704	341.720	349.070	366.178	349.027	372.528	349.165	372.536	349.034	372.499	349.147	372.479

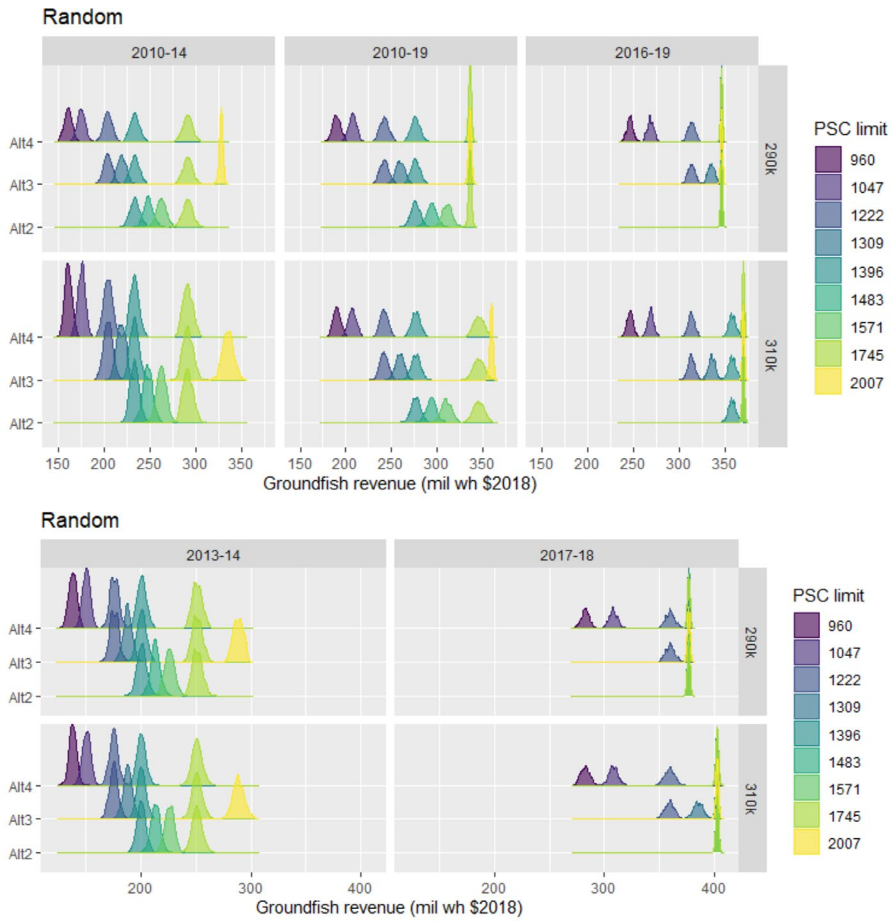


Figure ES-4 Estimated Amendment 80 sector gross wholesale revenue (2018$) associated with PSC limits specified in the look-up tables by Alternative (colors). Dataset (historical years) is listed across top and groundfish limit is listed on the right of each panel.

The assumption that 100% PSC use is possible may contribute to less uncertainty in the revenue estimates for scenarios where the PSC limit is constraining. This assumption may also lead to relatively higher PSC use estimates than are likely, given that the fleet has not used 100 percent of the PSC limit in any of the past 10 years. This is not an uncommon challenge in PSC limit analyses and the Council has historically understood that in this case the analysts are presenting an estimate of the maximum adverse impact. It makes sense to consider all types of relationships between the PSC limit and use – random, constant, or scaled (i.e. higher use-rate at a lower limit). Ultimately, for purposes of presentation, the analysts concluded that the results are most easily understood by showing 100% use as a maximum-impact and allowing the reader to adjust downward based on what is qualitatively understood. The implementation of a groundfish limit in this analysis also mutes the cases in which 100% of the PSC limit is attained, as at higher PSC limits, the groundfish limit is constraining before the PSC limit is met. It is not impossible that expected PSC use would be higher, all else equal, if halibut are more abundant in the BSAI; this document discusses the multiple, complex determinants of PSC encounter and mortality throughout (see Section 3). Another reason not to take the 100% use assumption at face-value is that the marginal impact of a ton of PSC limit reduction (or increase) is not linear and is not experienced the same across A80 companies per their groundfish quota portfolios. These are fleet-wide estimates and they do not account for distributional impacts within the sector based on operational differences and fishing portfolios. The analysts expect that an A80 operator's behavior would be modified in the same manner if expected use relative to the PSC limit is, say, 85%, 95%, or 100%. Therefore revenue estimates reported in this section should be read for comparison across alternatives. These results are not stand-alone predictions of future A80 revenue under each PSC limit as harvesters are expected to make strategic choices that are different from the randomized or stratified selection of hauls used in this analysis. Finally, it is important to note that these estimates represent gross revenues and do not attempt to estimate the costs associated with changing fishing operations to avoid halibut, which are described in Section 3.

Directed halibut fishery impacts

Table ES-5 uses relationships between the PSC limits in the alternatives and projected BSAI directed halibut catch limits to calculate potential changes in directed halibut catch resulting from the PSC limit changes that could occur. Median estimated PSC limits are compared to median estimated BSAI directed catch limits for 2021 through 2030[2]. A range of ratios was calculated for the difference in PSC (in million net pounds) to the difference in BSAI directed halibut limits (in million net pounds). The estimated PSC limits used to calculate the ratio ranged from 849 t to 2,325 t, representing a larger range than the current proposed alternatives that spans 960 t to 2,007 t. The BSAI halibut catch limits ranged from 4.44 million to 7.52 million pounds. Analysts use the minimum, median, and maximum values of the calculated ratios to estimate a range of potential changes to the directed halibut catch limit associated with each PSC limit in the current range of alternatives. These ratios range from a directed catch limit change of 0.094 to 0.609 net pounds per net pound of PSC limit reduction.

The calculation of the ratios may have asymmetric effects that are not fully captured by reporting a range. For example, a PSC limit of 960 t may be more congruent with one end of the range while a higher PSC may be more representative of the opposite end of the range. Additionally, the ratio will vary over time depending on the halibut population age-structure and the relative availability of different age groups to the directed fishery and those halibut taken as PSC. Therefore, interpretation of these results should be done by looking across the entire table and possibly interpolating beyond the ratios presented. Nevertheless, this approach provides a thought process to understand the direction and approximate magnitude of the relationship between PSC and commercial catch in the BSAI. Given the many uncertainties, these results are best used for looking *across* the table to compare the PSC limits embedded in the alternatives to one another on a relative basis.

Table ES-5 Change from status quo (SQ) BSAI directed catch limits (million net pounds) resulting from proposed PSC limits (t). The bottom three rows display change from status quo directed BSAI catch limits resulting from the PSC listed at top, calculated using the minimum, median and maximum ratios.

PSC Limit (t)			960	1047	1222	1309	1396	1483	1571	1745	2007
Difference from SQ PSC limit (t)			-785	-698	-523	-436	-349	-262	-174	0	262
Difference from SQ PSC limit (mil. net pounds)			-1.298	-1.154	-0.865	-0.721	-0.577	-0.433	-0.288	0	0.433
Change in directed catch limit (million net pounds)	Min. ratio	0.094	0.122	0.109	0.082	0.068	0.054	0.041	0.027	0	-0.041
	Median ratio	0.327	0.424	0.377	0.283	0.236	0.189	0.142	0.094	0	-0.142
	Max. ratio	0.609	0.790	0.703	0.526	0.439	0.351	0.264	0.175	0	-0.264

Table 5-9 shows the range of potential changes in directed catch limits, relative to the BSAI status quo estimate developed in the ABM closed loop simulation model, that are associated with each survey state across the current set of PSC limits in the alternatives.

[2] From previous results of the closed loop simulation model

Table ES-6 Estimated percent change in BSAI directed catch limit from status quo by survey state and alternative

EBS Trawl Survey	**Low**			**High**			**Low**			**High**			**Low**			**High**			**Low**			**High**		
Setline survey	**Very Low**			**Very Low**			**Low**			**Low**			**Medium**			**Medium**			**High**			**High**		
ratio	low	med	max	low	med	max	low	med	max	low	med	max	low	med	max	low	med	max	low	med	max	low	med	max
Alternative 2		**1396**			**1483**			**1396**			**1483**			**1483**			**1571**			**1571**			**1745**	
	1%	5%	9%	1%	3%	6%	1%	5%	9%	1%	3%	6%	1%	3%	6%	1%	2%	4%	1%	2%	4%	0%	0%	0%
Alternative 3		**1222**			**1309**			**1309**			**1396**			**1396**			**1745**			**1745**			**2007**	
	2%	7%	13%	2%	6%	11%	2%	6%	11%	1%	5%	9%	1%	5%	9%	0%	0%	0%	0%	0%	0%	-1%	-3%	-6%
Alternative 4		**960**			**1047**			**1047**			**1222**			**1222**			**1396**			**1396**			**1745**	
	3%	10%	19%	3%	9%	17%	3%	9%	17%	2%	7%	13%	2%	7%	13%	1%	5%	9%	1%	5%	9%	0%	0%	0%
Legend	-50%	-25%	0%	25%	50%																			

Social Impact Assessment

Appended separately (**Appendix 1**) is a social impact assessment (SIA) that evaluates community and regional patterns of engagement in and dependency on the BSAI Amendment 80 groundfish commercial fishery and the BSAI/Area 4 halibut commercial fishery as well as the potential for community level impacts under the no-action and action alternatives. Potential impacts to regional subsistence and sport halibut fisheries in Alaska are also evaluated. Myriad communities in Alaska and the Pacific Northwest participate directly and/or indirectly in one or both commercial fisheries. Within Alaska, more communities participate directly in the BSAI/Area 4 commercial halibut fishery than in the Amendment 80 fishery; however, the Amendment 80 fishery touches multiple Alaska communities directly or indirectly in several ways including: being the location of product transfers, which generate tax revenues realized at the state and local level; being ports of call, which may generate local support service sector economic activity; and/or being industry partners for the harvest of CDQ multispecies groundfish quota, among others. The BSAI/Area 4 halibut fishery, on the other hand, is fundamentally important to the local fleets of multiple Alaska communities and regions and, in some cases, provides one of the few options for private sector employment and income opportunities in those communities. The findings of the SIA are summarized in the "Social and Environmental Justice" section of the DEIS.

Policy tradeoffs/National standards

In constructing a preferred alternative (PA) or a preliminary preferred alternative (PPA), there are a number of Alternatives and options to select from as well as policy tradeoffs to be considered. A decision-tree is provided for the construction of a PPA and further discussion of the policy-level considerations with respect to the MSA National Standards in doing so. Up to three steps are necessary to create a PPA as shown in Figure 2-9. As described previously, there are three action alternatives in this analysis, in addition to the No Action alternative (Alternative 1: status quo). These action alternatives, if selected, would modify the Amendment 80 PSC limit to establish an annual process for PSC limit-setting based on a Look up table informed by survey data. Next, the Council may choose to select additional options in addition to the specific action alternative to either smooth the inter-annual variability in the PSC limit (Options 1 and 2) or add additional incentives or flexibility regarding PSC usage (Options 3 or 4). Option 4 is mutually exclusive with the selection of either Options 2 or 3. Finally, Options 2 and 3, if selected, require the Council to select a specific suboption.

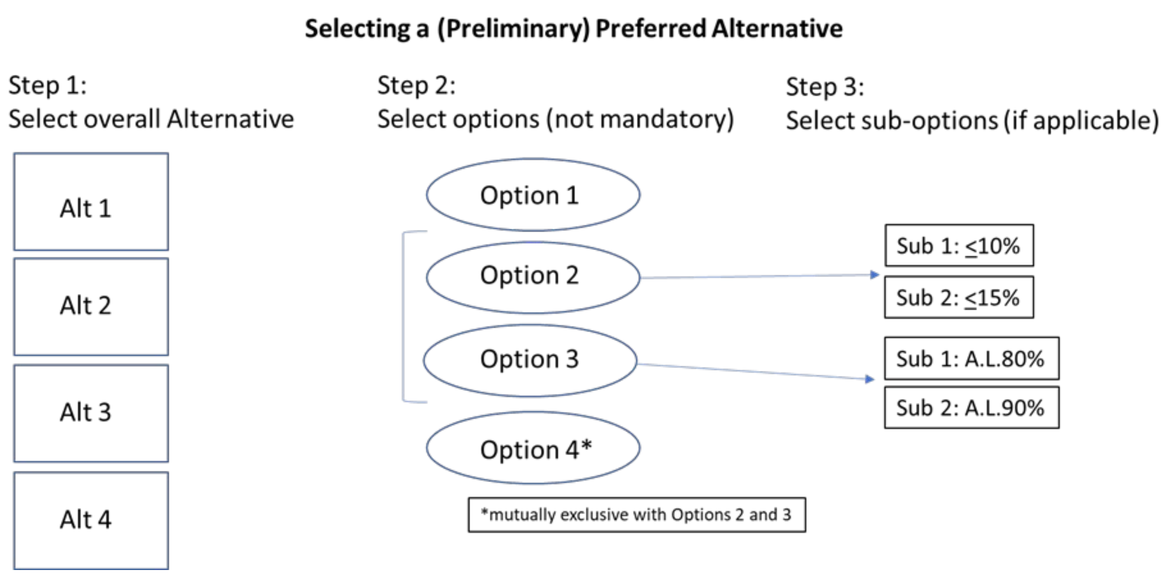


Figure ES-5 Iterative steps in selecting amongst Alternatives and Options for creating a preferred alternative. Note that neither Option 1 nor 4 have additional sub-options associated with them and that the selection of Option 4 is mutually exclusive with the selection of Options 2 and 3.

One of the policy tradeoffs of this management action is the relative trade-off between National Standard 1 (achieve Optimum Yield, in this case for groundfish harvest) and National Standard 9 (minimize bycatch to the extent practicable, in this case bycatch of halibut). Based on evaluations in Chapter 5.5, and as a gross approximation, under the assumption of random or average usage from 2016-2019, the Amendment 80 sector is most likely to be limited by PSC usage below cap levels of 1,396 t and more likely to be limited by TAC constraints at levels of 1,396 t and above. None of the possible PSC limit outcomes under Alternative 2 fall below 1,396 t, while under Alternative 3 those outcomes occur only at the two lowest tiers of the IPHC setline survey index. Therefore, Alternatives 2 and 3 provide the most flexibility for A80 fishing operations to achieve optimum yield both at lower halibut biomass levels and particularly at higher biomass survey states. Alternative 4 is more likely to result in a PSC limit below 1,396 t except at the higher levels of both surveys. Options 3 and 4 provide incentives for the A80 fleet to reduce halibut bycatch beyond what is provided by the PSC limit to avoid forgone harvest opportunities throughout the sector's multispecies fishing year. Additional context for considering the practicability of fishing operations at lower PSC limits is provided in Chapters 3 and 5, and policy decisions balancing National Standard 1 and National Standard 9 must address the ability of the fleet to catch their quota while minimizing bycatch to the extent practicable.

To provide some additional insight into the likelihood of the state of halibut biomass into the future, survey states and their probability of occurrence were simulated for short-term and long-term time frames (Table 2-14). In the short-term (2021-2030), the most likely survey states will remain at the lower end of the IPHC setline survey and vary between low and high levels of the EBS trawl survey. This means that the lowest levels of PSC limits under all alternatives are likely in the near-term. Figure ES-6 illustrates the cross section of the most likely long- and near-term survey outcomes from the simulation, as well as which levels of PSC limit under the various alternatives are likely to cause the primary constraint on groundfish harvest.

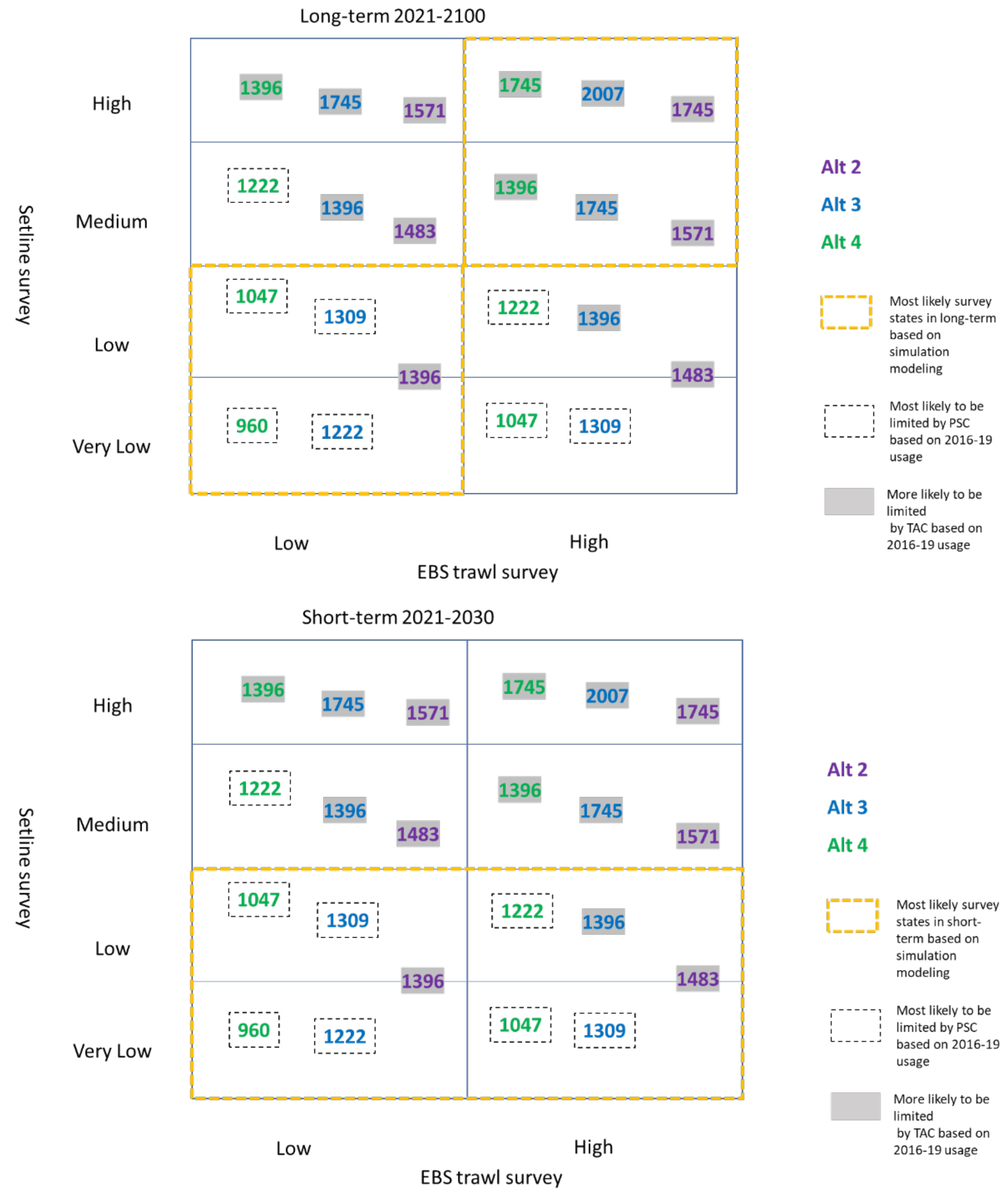


Figure ES-6 Simulated survey states and long-term (upper panel) and short-term (lower panel) PSC limits by Alternative. Here the dotted yellow lone indicates the most likely survey state for that time frame based on the simulation. Based on the groundfish revenue examination in Chapter 5.5, PSC limits (assuming usage from 2016-2019) are more likely to be constraining below 1396 t while TAC is more limiting at PSC limits above 1396 t.

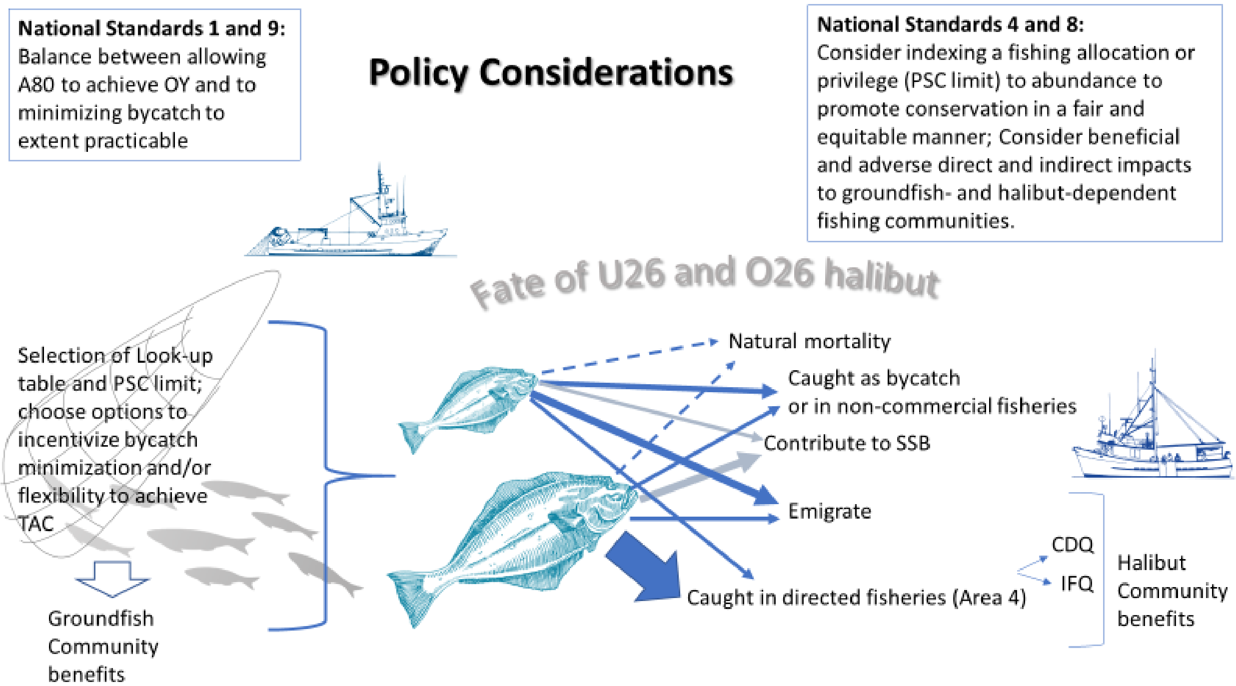


Figure ES-7 Schematic of trade-offs in considerations of some key National Standards based on the relative fate of O26 and U26 halibut. Here the width of the blue arrows represents relative magnitude of removals between O26 and U26 fish. Grey arrows show that contribution to SSB is from both sources but unknown magnitude while dotted lines for natural mortality indicate that it is considered equivalent between older and younger fish but is in fact an unknown quantity.

Other policy tradeoffs stemming from the National Standards include consideration of National Standards 4 (allocate fishing privileges (in this case, a halibut PSC limit that varies with abundance) in a manner that is fair and equitable to all U.S. fishermen) and 8 (take into account the importance of fishery resources to fishing communities, in this case both groundfish- and halibut-dependent communities, and minimize adverse economic impacts on such communities) (Figure ES-7). Options are provided to further incentivize bycatch reduction beyond what is provided by the PSC limit itself in order for the A80 fleet to mitigate their halibut PSC such that they may avoid forgone harvest opportunities throughout the sector's multispecies fishing year. Additional information on how all of the alternatives under consideration address each of the ten National Standards is contained in Section 7.1.

Where are we in the process?

The Council has reviewed several discussion papers and a previous preliminary DEIS when the action was considered for all sectors (October 2019) as well as an analysis in which the action pertains to only the A80 fleet (October 2020). Following the most recent review the alternatives were modified to the more simplified look up table alternatives for setting PSC limits and the Purpose and Need statement was altered to reflect this new focus. This review represents an initial review of these new alternatives. Figure ES-8 shows where this initial review of the DEIS fits into the overall Council and NEPA process and how decisions at this Council meeting might affect scheduling of this action moving forward.

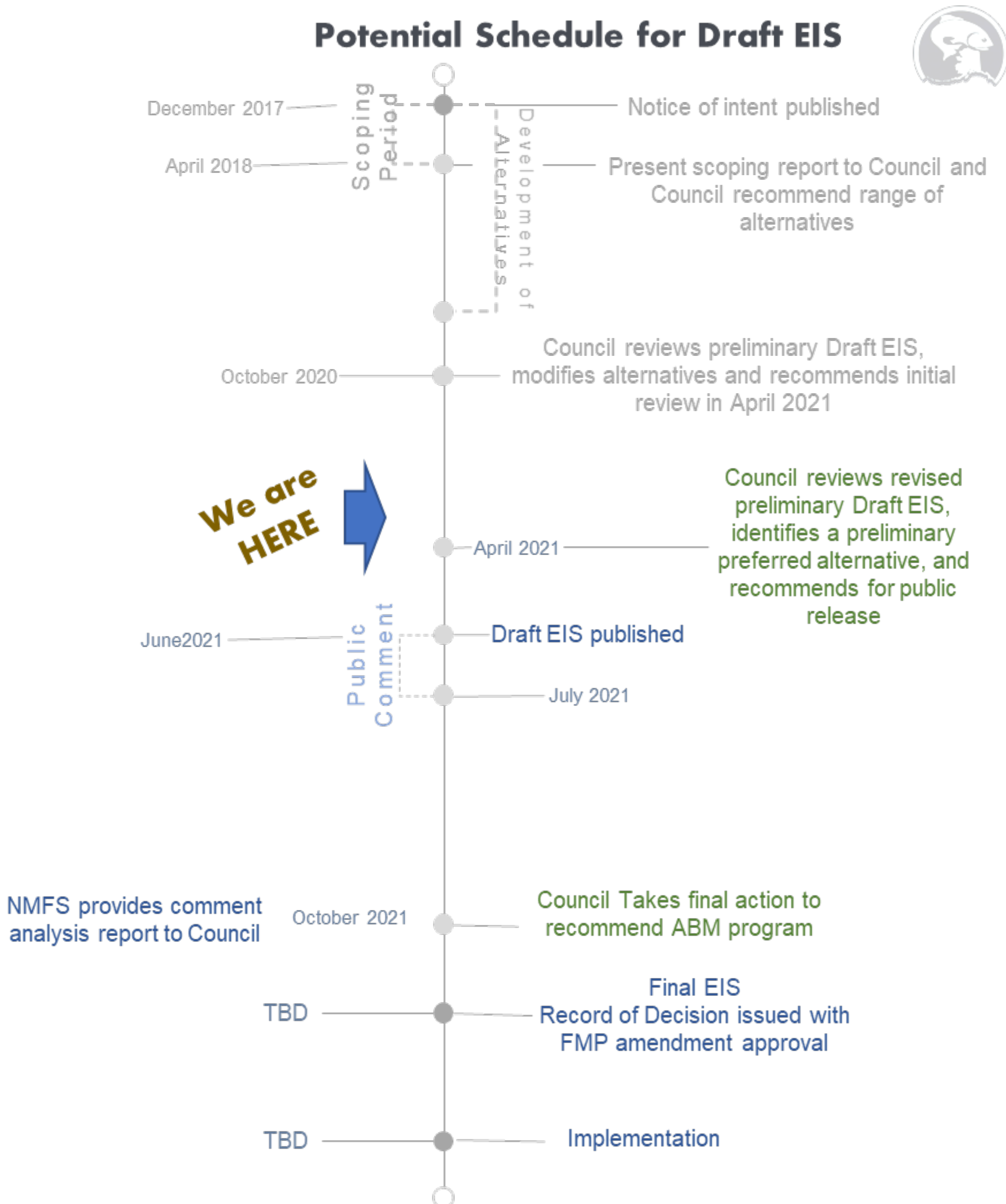


Figure ES-8 Previous Council considerations (grey), future Council considerations (green), proposed NEPA schedule and potential Council schedule for DEIS

1 Introduction

This document analyzes a proposed management measure to link the Pacific halibut prohibited species catch (PSC) limit for the Amendment 80 commercial groundfish trawl fleet in the Bering Sea and Aleutian Islands (BSAI) groundfish fisheries to halibut abundance. The North Pacific Fishery Management Council (Council) is considering a program that provides incentives for the fleet to minimize halibut mortality at all times, that could promote conservation of the halibut stock and may provide additional opportunities for the directed halibut fishery.

This document is a preliminary draft Environmental Impact Statement (DEIS). An EIS provides assessments of the environmental impacts of an action and its reasonable alternatives as well as the economic benefits and costs of the action alternatives and their distribution. This preliminary DEIS addresses the statutory requirements of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), the National Environmental Policy Act (NEPA), and Presidential Executive Order 12866. A preliminary DEIS is a document produced by the Council and the National Marine Fisheries Service (NMFS) Alaska Region to provide the analytical background for decision-making. A Social Impact Assessment (SIA) appended separately has also been prepared for this document.

This preliminary draft EIS is being prepared using the 1978 Council on Environmental Quality (CEQ) NEPA Regulations. NEPA reviews initiated prior to the effective date of the revised CEQ regulations may be conducted using the 1978 version of the regulations. The effective date of the 2020 CEQ NEPA Regulations was September 14, 2020. A Notice of Intent to publish an Environmental Impact Statement (EIS) for the proposed management measures was published in the Federal Register on December 12, 2017 (82 FR 58374). This review began on that date, and the agency has decided to proceed under the 1978 regulations.

Pacific halibut (*Hippoglossus stenolepis*) is targeted in Alaska in subsistence, personal use, recreational (sport), and commercial halibut fisheries. Halibut has significant social, cultural, and economic importance to fishery participants and fishing communities throughout the geographical range of the resource. Halibut is also incidentally taken as bycatch in groundfish fisheries.

The Council is examining abundance-based approaches to set the halibut PSC limit for the Amendment 80 sector in the Bering Sea and Aleutian Islands (BSAI). Currently halibut PSC limits for groundfish fishery sectors are set in the BSAI Groundfish Fishery Management Plan (FMP) at a fixed amount of halibut mortality in metric tons (t). When halibut abundance declines, halibut PSC becomes a larger proportion of total halibut removals and can result in lower catch limits for directed halibut fisheries. This action is limited to the Amendment 80 sector because that sector is responsible for the majority of BSAI halibut mortality in the groundfish fisheries. In light of the continued decline in the halibut stock, both the Council and the International Pacific Halibut Commission (IPHC) have expressed concern about impacts on directed halibut fisheries under the status quo and identified abundance-based halibut PSC limits as a potential management approach to address these concerns.

1.1 Halibut Management Authority

The IPHC and NMFS manage Pacific halibut fisheries through regulations established under the authority of the Northern Pacific Halibut Act of 1982 (Halibut Act) (16 U.S.C. 773-773k). The IPHC adopts regulations governing the target fishery for Pacific halibut under the Convention between the United States of America and Canada for the Preservation of the Halibut Fishery of the Northern Pacific Ocean and Bering Sea (Convention), signed at Ottawa, Ontario, on March 2, 1953, as amended by a Protocol Amending the Convention (signed at Washington, DC, on March 29, 1979). For the United States, regulations governing the fishery for Pacific halibut developed by the IPHC are subject to acceptance by the Secretary of State with concurrence from the Secretary of Commerce. After acceptance by the

Secretary of State and the Secretary of Commerce, NMFS publishes the IPHC regulations in the Federal Register as annual management measures pursuant to 50 CFR 300.62. IPHC and NMFS regulations authorize the harvest of halibut in commercial, personal use, sport and subsistence fisheries by hook-and-line gear and pot gear. In the BSAI (Area 4), halibut is harvested in all of these fisheries.

Section 773c(c) of the Halibut Act also provides the Council with authority to develop regulations that are in addition to, and not in conflict with, approved IPHC regulations. The Council has exercised this authority in the development of Federal regulations for the halibut fishery such as 1) subsistence halibut fishery management measures, codified at § 300.65; 2) the limited access program for charter vessels in the guided sport fishery, codified at § 300.67; and 3) the Individual Fishing Quota (IFQ) Program for the commercial halibut and sablefish fisheries, codified at 50 CFR part 679, under the authority of section 773 of the Halibut Act and section 303(b) of the Magnuson-Stevens Act.

The MSA authorizes the Council and NMFS to manage groundfish fisheries in the Alaska Exclusive Economic Zone (EEZ) that take halibut as bycatch. The MSA defines bycatch as "fish which are harvested in a fishery, but which are not sold or kept for personal use and includes economic discards and regulatory discards. The term does not include fish released alive under a recreational catch and release fishery management program." 16 U.S.C 1802 3(2).

The groundfish fisheries cannot be prosecuted without some level of halibut bycatch because groundfish and halibut occur in the same areas at the same times and no fishing gear or technique has been developed that can avoid all halibut bycatch. However, the Council and NMFS have taken a number of management actions over the past several decades to minimize halibut bycatch in the BSAI groundfish fisheries. Most importantly, the Council has designated Pacific halibut and several other species (herring, salmon and steelhead, king crab, and Tanner crab) as "prohibited species" in the groundfish fisheries (Section 3.6.1 of the BSAI groundfish FMP. By regulation, the operator of any vessel fishing for groundfish in the BSAI must minimize the catch of prohibited species (§ 679.21(a)(2)(i)). The Council has also set catch limits for individual PSC species, which are defined in BSAI FMP section 3.6.2.1.

Although halibut is taken as bycatch in groundfish fisheries by vessels using all types of gear (trawl, hook-and-line, pot, and jig gear), halibut bycatch primarily occurs in the trawl and hook-and-line groundfish fisheries. The Council and NMFS manage halibut bycatch in the BSAI by (1) establishing halibut PSC limits for trawl, non-trawl, and Community Development Quota (CDQ) groundfish fisheries; (2) apportioning those halibut PSC limits to groundfish sectors, and in some cases, target fishery categories and seasons; and (3) managing groundfish fisheries to prevent PSC from exceeding the established limits. Consistent with National Standard 1 and National Standard 9 of the MSA, the Council and NMFS use halibut PSC limits in the BSAI groundfish fisheries to balance the objective to minimize bycatch to the extent practicable with the objective to achieve optimum yield from the groundfish fisheries on a continuing basis. Halibut PSC limits in the groundfish fisheries provide a constraint on halibut PSC mortality and promote conservation of the halibut resource. The halibut PSC limit established for the Amendment 80 sector prohibits further groundfish fishing for the remainder of the year once the halibut PSC limit has been reached. Therefore, halibut PSC limits must be set to balance the needs of fishermen, fishing communities, and U.S. consumers that depend on both halibut and groundfish resources.

1.2 Purpose and Need

The Council amended its purpose and need statement for this action in October 2020 to be the following:

Halibut is an important resource in the Bering Sea and Aleutian Islands (BSAI), supporting commercial halibut fisheries, recreational fisheries, subsistence fisheries, and groundfish fisheries. The International Pacific Halibut Commission (IPHC) is responsible for assessing the Pacific halibut stock and *establishing total annual catch limits for directed fisheries and the North Pacific Fishery Management Council (Council) is responsible for managing prohibited species catch (PSC) in U.S. commercial groundfish fisheries managed by the Council. The Amendment 80 sector is accountable for the majority of the annual halibut PSC mortality in the BSAI groundfish fisheries. While the Amendment 80 fleet has reduced halibut mortality in recent years, continued decline in the halibut stock requires consideration of additional measures for management of halibut PSC in the Amendment 80 fisheries.*

When BSAI halibut abundance declines, PSC in Amendment 80 fisheries can become a larger proportion of total halibut removals in the BSAI, particularly in Area 4CDE, and can reduce the proportion of halibut available for harvest in directed halibut fisheries. The Council intends to establish an abundance-based halibut PSC management program in the BSAI for the Amendment 80 sector that meets the requirements of the Magnuson-Stevens Act, particularly to minimize halibut PSC to the extent practicable under National Standard 9 and to achieve optimum yield in the BSAI groundfish fisheries on a continuing basis under National Standard 1. The Council is considering a program that links the Amendment 80 sector PSC limit to halibut abundance and provides incentives for the fleet to minimize halibut mortality at all times. This action could also promote conservation of the halibut stock and may provide additional opportunities for the directed halibut fishery.

Although fishermen are required by the BSAI groundfish FMP to avoid the capture of any prohibited species in groundfish fisheries, the use of halibut PSC limits in the groundfish fisheries provides a constraint on halibut PSC and promotes conservation of the halibut resource. Halibut PSC limits provide a regulated upper limit to mortality resulting from halibut interceptions, because continued groundfish fishing is prohibited once a halibut PSC limit has been reached for a particular sector and/or season. This management tool is intended to balance the optimum benefit to fishermen, communities, and U.S. consumers that depend on both halibut and groundfish resources.

The IPHC accounts for all sources of halibut mortality, including halibut PSC in the groundfish fisheries, recreational catches, and subsistence catches before setting commercial halibut catch limits each year. Specifically, the IPHC uses the current year's projection of the PSC mortality to establish the following year's commercial halibut fishery catch limit. For several years, there have been concerns raised by stakeholders and the Council about the levels of halibut PSC in the commercial groundfish sectors. The spawning biomass of Pacific halibut in the 1990s was the highest seen in many decades, but in the 2000s, declined to levels that are likely more common since the 1940s. The declining biomass from those unusually high levels resulted in lower Pacific halibut catch limits set by the IPHC for the BSAI commercial halibut fisheries (IPHC Area 4), especially in 2013 and 2014 for the commercial halibut fishery in the northern and eastern Bering Sea (Area 4CDE). The Council addressed this initial concern by reducing trawl, non-trawl, and CDQ sectors' halibut PSC limits for the BSAI groundfish fisheries, implemented in 2016 by Amendment 111 to the FMP.

The Council recognizes efforts by the groundfish industry, and especially the Amendment 80 sector, to reduce total halibut PSC in the BSAI. Concerns persist, however, about continuing lower levels of halibut biomass that result in reduced directed fishery catch limits in Area 4. Based on the IPHC management objectives as well as recent projections of halibut biomass and estimates of PSC mortality, directed fishery stakeholders remain concerned that catch limits will not be sufficient to provide for a directed fishery in the BSAI at the PSC limits implemented under Amendment 111. The Amendment 80 sector fisheries account for the majority of halibut bycatch mortality in the BSAI. Therefore, the Council is considering the new approach described here to link the Amendment 80 PSC limit to halibut abundance.

The Council does not have authority to set catch limits for the directed halibut fisheries. Since that is under the authority of the IPHC. The Council does set halibut PSC limits in the groundfish fisheries, and that is one of the factors that affects harvest limits for the directed halibut fisheries. Halibut PSC in the Amendment 80 groundfish fisheries are a significant portion of total mortality in the BSAI and that PSC affects the IPHC's calculation of catch limits for the directed halibut fisheries in IPHC Area 4. While the short-term impact of halibut PSC reductions on catch limits for directed halibut fisheries is partially dependent on IPHC policy and management decisions, linking current halibut PSC limits in the BSAI to halibut abundance could indirectly provide additional harvest opportunities in the BSAI directed halibut fishery, particularly at low levels of abundance.

Under MSA National Standard 8, the Council must provide for the sustained participation of and minimize adverse economic impacts on fishing communities that depend on both halibut and groundfish resources. BSAI coastal communities are affected by reduced catch limits for the directed halibut fishery, especially in IPHC Area 4CDE. In considering changes to the management of halibut PSC limits in the BSAI, the Council must balance these communities' involvement in and dependence on halibut with community involvement in and dependence on the groundfish fisheries that rely on halibut PSC in order to operate. The Council must also consider MSA National Standard 4 which states that management measures shall not discriminate between residents of different states. National Standard 4 also requires allocations of fishing privileges to be fair and equitable to all fishery participants. To be consistent with the National Standards 1 and 9 of the MSA, a Council action to implement an abundance-based halibut PSC limit must minimize halibut PSC in the Amendment 80 groundfish fisheries to the extent practicable while preserving the potential for the optimum harvest of the groundfish total allowable catch (TACs). An abundance-based halibut PSC limit should minimize halibut PSC to the extent practicable in consideration of the regulatory and operational management measures currently available to the Amendment 80 groundfish fleet and the need to ensure that groundfish catch contributes to the achievement of optimum yield. Minimizing halibut PSC to the extent practicable is necessary to maintain a healthy marine ecosystem, ensure long-term conservation and abundance of the halibut stock, provide optimum benefit to fishermen, communities, and U.S. consumers that depend on both halibut and groundfish resources, and comply with the MSA and other applicable Federal law.

Consistent with the Council's purpose and need statement, an abundance-based halibut PSC limit for Amendment 80 may provide improved harvest opportunities in the Area 4 commercial halibut fishery that meet IPHC and Council management objectives, particularly at low levels of halibut abundance. If halibut PSC is reduced relative to the status quo, benefits to BSAI directed halibut fisheries could result from PSC reductions of halibut that are over 26 inches in length (O26). These O26 halibut could be available to the commercial halibut fishery in the area the PSC reductions occurred in the year following the PSC reductions or when the fish are likely to reach the legal-size limit for the directed halibut fishery (greater than or equal to 32 inches in total length). Longer term benefits to the directed halibut fisheries could accrue throughout the distribution of the halibut stock, from a reduction of halibut PSC mortality to fish that are less than 26 inches (U26). Benefits from reduced mortality of these smaller halibut could occur both in the Bering Sea and elsewhere as these halibut migrate and recruit into the directed halibut fisheries. At higher levels of halibut abundance, an abundance-based halibut PSC limit may provide the Amendment 80 groundfish fisheries with a higher PSC limit and increased groundfish harvests.

1.3 History of this Action

The Council and NMFS have enacted a range of management measures and regulations to address halibut bycatch since the origin of the BSAI Groundfish FMP in 1981 (Figure 1-1). A synopsis of historical management measures in the BSAI FMP and regulations from 1981 through 2012 was provided to the Council in June 2012 (Northern Economics, Inc. 2012). Amendment 80 was implemented in 2008. Table 1-1 shows the changes in the PSC limits by sector from 1981 to present. Step-down provisions reduced the Amendment 80 limit annually from 2008 through 2012. Note that in conjunction with step-down provisions in Amendment 80, the Community Development Quota (CDQ) limit was increased by 50 metric tons in 2010 before a subsequent reduction in 2016 as part of Amendment 111.

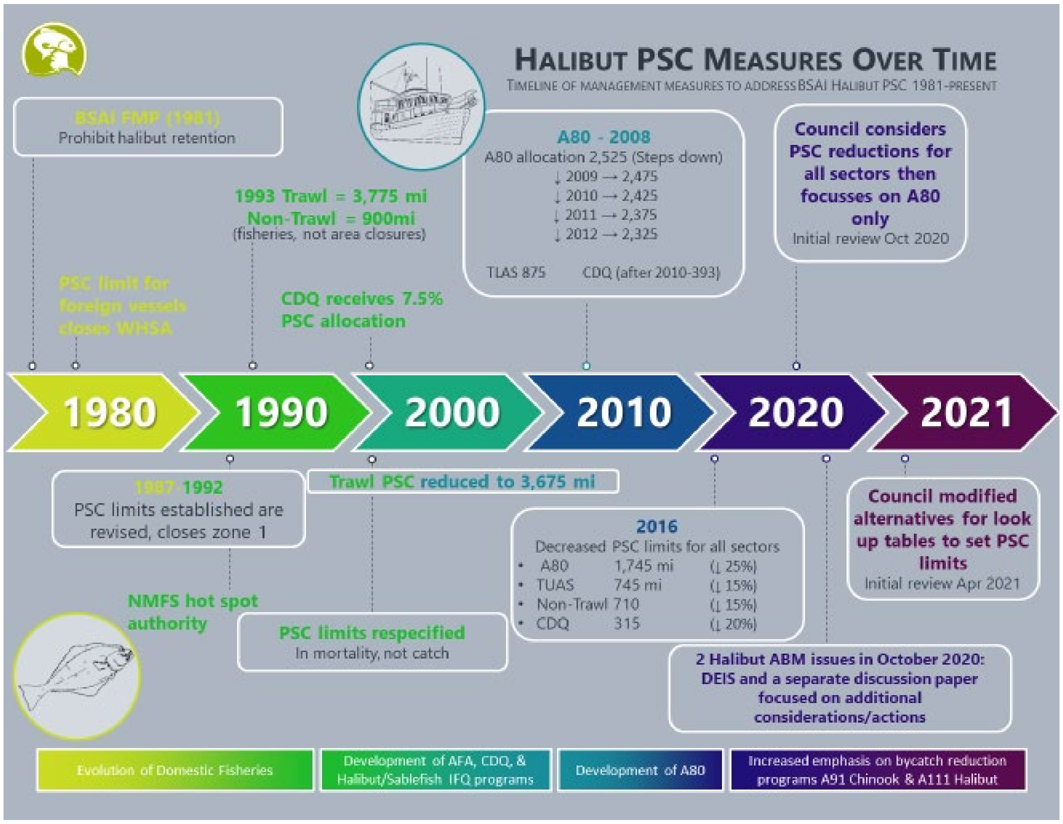


Figure 1-1 **Historical overview of BSAI halibut PSC measures 1981-present.**

Table 1-1 **Evolution of Pacific halibut PSC limits in metric tons (t) of mortality, by main sectors in the BSAI region, 1999-2021 (see Fig. 1-1 for additional information on halibut limits and actions 1981-2016). Here PSC limits for trawl and non-trawl from 2008 to 2015 reflect the reduction for the CDQ limit. Limits for 1999-2007 were also reduced 7.5% for the CDQ but this is not shown in the table.**

	Trawl	Am80	BSAI Trawl Limited Access*	Non-trawl	CDQ	Total PSC limit
1999-2007	3,675	NA	NA	900	**	4,575
2008		2,525	875	833	343	4,576
2009		2,475	875	833	343	4,526
2010		2,425	875	833	393	4,526
2011		2,375	875	833	393	4,476
2012		2,325	875	833	393	4,426
2013-2015		2,325	875	833	393	4,426
2016-2021		1,745	745	710	315	3,515

* The BSAI Trawl Limited Access fisheries encompass all trawl fisheries in the BSAI except Amendment 80 catcher processors (i.e., all trawl catcher vessels in any target fishery, and American Fisheries Act catcher processors).

** Limits for 1999-2007 were reduced by 7.5% for PSC usage by the CDQ sector.

In February 2015, in conjunction with initial review of the analysis prepared for Amendment 111 to the BSAI FMP that considered reductions of BSAI Pacific halibut PSC limits, the Council also requested that Council and IPHC staff evaluate possible approaches to link BSAI halibut PSC limits to data or model-based abundance estimates of halibut. IPHC staff took the lead on drafting a paper examining several aspects of potential abundance-based halibut PSC limits in the BSAI, including a review of harvest policies by both Council and IPHC staff, fishery trends, a range of potential candidate abundance indices, a discussion of basing allocation on yield (biomass) versus spawning capital (relative fishing impact), and a review of research recommendations (Martell et al., 2016).

The Council then initiated subsequent discussion papers and requested that analysts from within the different agencies (IPHC, NMFS AFSC, NMFS Alaska RO and NPFMC staff) collaborate to provide additional information on appropriate indices for use in indexing halibut abundance to PSC in the Bering Sea, how to establish control rules, and the development of performance metrics[3]. In 2017, NMFS published a Notice of Intent to publish an Environmental Impact Statement (EIS) for the proposed management measures. In addition to the formal scoping period, the Council provided considerable opportunities for stakeholder input, including formation of a stakeholder committee in 2018 tasked with providing the analysts with specific scenarios from the broad suite of alternatives, elements, and options for analysis, and to provide feedback on recommended performance metrics. These scenarios were included in the alternatives, and staff provided drafts of the analysis that included performance metrics to address competing objectives in October 2019 and February 2020. Staff developed a model-based analysis of the alternatives to assess the responsiveness of different control rules to establish the PSC limit based on abundance.

At the February 2020 meeting, the Council modified the scope of this analysis to focus exclusively on the Amendment 80 sector, due to that sector comprising the majority of the halibut mortality annually. The analysis was reworked, and in October 2020, the Council reviewed another preliminary draft DEIS. At the October 2020 meeting, the Council revised the purpose and need statement to more directly address the action before the Council and embedded its objectives directly into the purpose and need statement. The Council also revised its alternative set to the current three action alternatives, that all use a lookup table approach to set PSC limits based on the status of halibut has indexed in both the IPHC setline and EBS trawl surveys. The Council requested that this next version of the DEIS shift the analytical focus from a management strategy evaluation (MSE) approach centered on evaluating objectives with respect to performance metrics, to a more traditional impacts analysis on the affected fishing sectors and other affected resource components.

[3] A summary of the papers reviewed by the Council and the focus of those papers from 2016 through 2019 is included in Chapter 1 of the October 2020 DEIS, accessible at: https://meetings.npfmc.org/CommentReview/DownloadFile?p=64175697-f114-4386-943f-3a864ac24361.pdf&fileName=C6%20ABM%20Draft%20DEIS%20Analysis.pdf

Table 1-2 Information contained in previous materials provided April 2016-October 2020

Topic	Information	Link
Initial Review draft DEIS	**Preliminary draft DEIS on previous alternative set**	**October initial review preliminary ABM DEIS**
	Revised Alternative set from October 2020 motion	**October 2020 Council motion**
Preliminary draft EIS	Previous initial review draft which contained alternatives that applied to all sectors	October 2019
Indices	Data sources from which to derive indices including strengths and weaknesses of each	April 2016
	Description of potential abundance indices IPHC assessment; EBS trawl survey; combined and applied in a control rule	April 2016
Fishery characteristics	Halibut PSC by target; observed trawl and longline effort, CPUE, PSC rates	Supplement April 2016
Control rules	Control rule background	April 2016 October 2016 April 2017 April 2018
	Control rule features	April 2016 October 2016 April 2017 April 2018
	Control rule examples already in use	April 2016 April 2017
Quantifying objectives	Performance metrics	February 2017 April 2017
		June 2017
Incentives	Incentives	April 2017
Alternatives and scenarios	Example ABM alternatives	April 2016 October 2016 April 2017 Supplement Apr 17 April 2018
	Management issues and methods	October 2016
	Analytical considerations and example scenarios	April 2016 Supplement ppt October2016 April2017 SupplmntApr17
	Methodology for analysis	June 2018(a)
Performance standard	Proposed O26 performance standard	June 2018 (b)

1.4 Where are we in the process?

As noted in Section 0, the Council has already reviewed several discussion papers, a preliminary review draft EIS, an initial review draft and modified the suite of alternatives for analysis. Figure 1-2 shows where this initial review of the DEIS fits into the overall Council and NEPA process and how decisions at this meeting might affect scheduling moving forward.

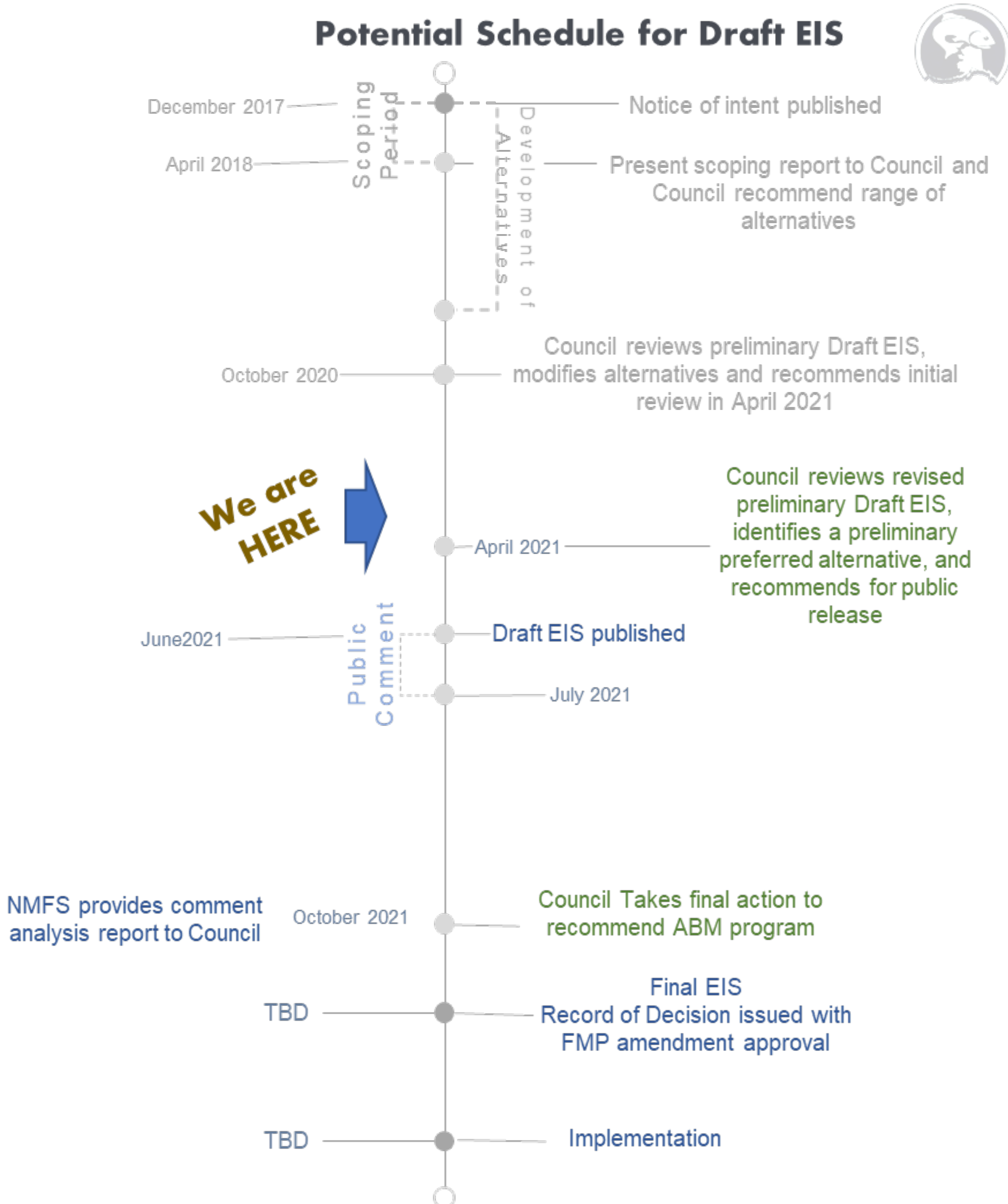


Figure 1-2 **Previous Council considerations (grey), future Council considerations (green), proposed NEPA schedule and potential Council schedule for DEIS**

1.5 Description of Management Area

The proposed action would be implemented in the BSAI groundfish management areas, which overlap IPHC regulatory areas 4A, 4B, 4C, 4D, and 4E (Figure 1-3).

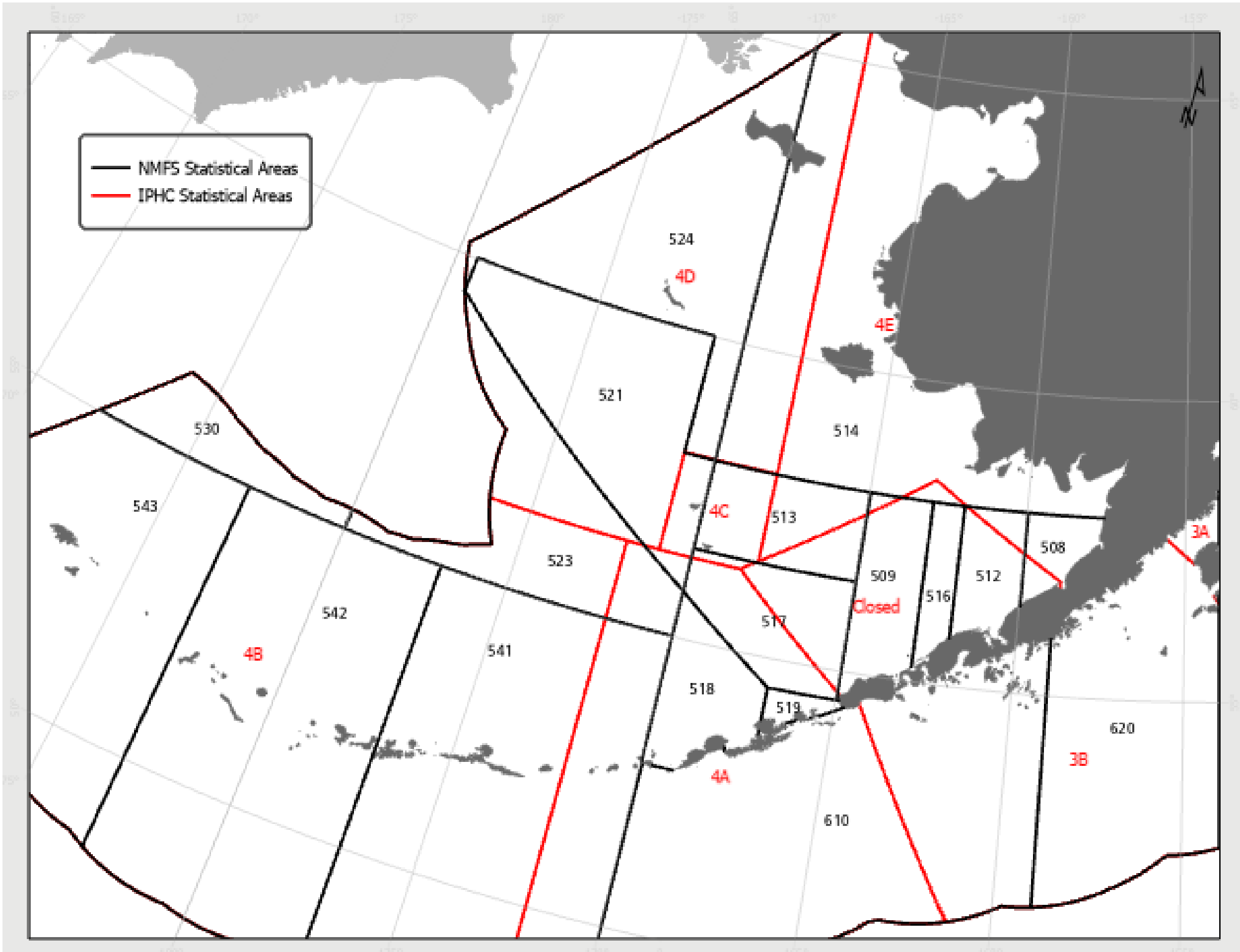


Figure 1-3 **Alaska groundfish reporting areas and IPHC regulatory areas for Pacific halibut. Source: Adapted from NMFS Alaska Region map by Northern Economics Inc.**

NMFS management areas do not match exactly to IPHC regulatory areas (Figure 1-3). In IPHC management, and for the purposes of this analysis, the groundfish BSAI reporting areas are equated with IPHC areas as shown in Table 1-3. Note that IHPC Area 4A includes part of NMFS Area 610, which is part of the Gulf of Alaska (GOA) FMP area.[4]

Table 1-3 **Alaska groundfish reporting areas and IPHC regulatory areas for Pacific halibut. NMFS management area reassignments used to aggregate groundfish and halibut statistics to IPHC regulatory areas**

<table>
<tr><th>NMFS Areas</th><th>IPHC Area</th><th>Region</th></tr>
<tr><td>517, 518, 519</td><td>4A</td><td rowspan="4">BSAI</td></tr>
<tr><td>541, 542, 543</td><td>4B</td></tr>
<tr><td>513, 514, 521, 523, 524</td><td rowspan="2">4CDE and Closed area</td></tr>
<tr><td>508, 509, 512, 516</td></tr>
</table>

[4] The treatment of directed halibut fishery information for IPHC Area 4 as it regards the overlap of BSAI and GOA FMP areas is addressed in Section 4.4.1 of this DEIS.

1.6 Abundance indices

The Council selected two abundance indices that could be used to track halibut abundance and to guide setting PSC limits for the BSAI groundfish fisheries[5]. The selected indices are based on the NMFS Alaska Fisheries Science Center (AFSC) eastern Bering Sea (EBS) shelf bottom trawl survey and the IPHC setline survey covering IPHC Areas 4ABCDE. Both indices represent the best available scientific information. A short description of each index is provided below for context in understanding the alternatives that index halibut PSC to abundance.

1.6.1 AFSC EBS shelf bottom trawl surveys

The NMFS AFSC has conducted the EBS shelf bottom trawl survey (EBS shelf trawl survey) annually ***with the exception of 2020***[6] since 1982 using standardized protocols.

1.6.1.1 Survey Objectives

The AFSC designed the EBS shelf survey to describe the composition, distribution and abundance of demersal fish, shellfish and principle epibenthic invertebrate resources of the eastern Bering Sea. The continental shelf area of the eastern Bering Sea has proven to be one of the most productive fishing areas in the world in terms of both species' abundance and commercial value.

Results of the EBS shelf survey provide up-to-date estimates of biomass, abundance, and population structure of groundfish populations in support of stock assessment and ecosystem forecast models that form the basis for groundfish and crab harvest advice. Relative abundance (catch per unit effort) and size and/or age composition data are key results from this survey. The survey covers Pacific halibut in addition to target species such as walleye pollock, Pacific cod, yellowfin sole, northern rock sole, red king crab, and snow and tanner crabs. Additional data collected on the survey are used to improve understanding of life history of the fish and invertebrate species as well as the ecological and physical factors affecting their distribution and abundance. The EBS shelf survey is generally described in a NOAA Technical Memo (Stauffer, 2004).

The main objective of AFSC groundfish trawl surveys is to collect fishery-independent data for multiple species which describe the:

- temporal distribution and abundance of the commercially and ecologically important groundfish halibut and crab species,
- changes in the species composition and size and age compositions of species over time and space,
- reproductive biology and food habits of the groundfish community
- the physical environment of the groundfish habitat.

1.6.1.2 Technical Design

The stratified random design of the EBS shelf survey consists of a grid with stations placed at the center of each 20 × 20 nautical square miles (Figure 1-4). Beginning in 1982, the same 356 stations were

[5] Additional indices were considered and not carried forward as candidate indices see Table 1-2 for more information on those indices.

[6] See Section 2.6 for information on the cancellation of 2020 surveys due to COVID-19 outbreak and further discussion of future planning for PSC limit determination in the event that future surveys are not able to be conducted or conducted at a reduced effort.

sampled annually. The AFSC added 20 stations to the northwest sector in 1987, resulting in a total of 376 stations.

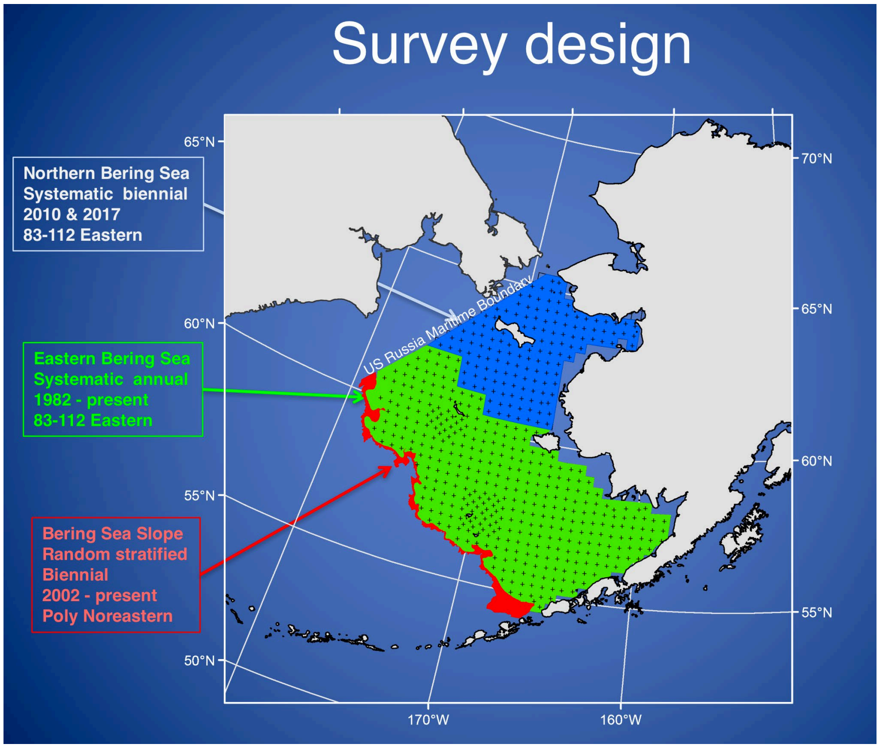


Figure 1-4 Layout of NMFS trawl survey designs (Source: Bob Lauth, AFSC).

The bottom trawl gear and trawling protocols used in AFSC surveys are described in Stauffer (2004). Samples obtained from the survey's standard 30-min tow range in weight from 30 to 17,800 kg (median = 1,167 kg). The time available to process this volume of catch is approximately equal to the time required for the vessel to traverse the 20 nautical miles to the next towing site (approx. 2 hours). Catches weighing 1,200 kg or less by visual estimate are lifted by crane from the trawl deck to a sorting table, where the catch is sorted and enumerated in its entirety. Catches from these tows are processed completely. However, roughly half of all EBS tows exceed the limits of the sorting table and must be subsampled. This is accomplished by lifting the whole catch off the deck, obtaining its weight with a load cell, and emptying it into a large bin containing a brailing net. The catch is subsampled by lifting the contents of the brailing net to a sorting table. The catch from the sorting table is weighed and enumerated by species, and weights and numbers are extrapolated to the total catch based on weight. The remaining catch on deck is sifted or "whole-hauled" for Pacific halibut (*Hippoglossus stenolepis*) and commercial crabs (*Lithodes* spp., *Paralithodes* spp., *Chionoecetes* spp.) and, in more recent years, other large-bodied species including Greenland turbot (*Reinhardtius hippoglossoides*), Pacific cod (*Gadus macrocephalus*), skates (*Raja* spp., *Bathyraja* spp.) and some species of sculpins (*Hemitripterus bolini*, *Hemilepidotus* spp., *Myoxocephalus* spp.).

Catches larger than the lifting capacity of the crane (approx. 5 metric tons) are emptied on deck and measured volumetrically using a density coefficient applied to calculate total catch weight. Once the weight of these very large catches (approx. 1.5% of all catches) is estimated, a sample is brought to the table for sorting and enumeration, and then extrapolated to the total catch. Whole-hauling occurs for the species mentioned above even on these large catches.

1.6.1.3 Effective Assessment of Halibut

The AFSC developed trawl efficiency and enumeration confidence matrices for both fishes and invertebrates collected during the EBS shelf survey from 1982 through 2014. The trawl efficiency index scores describe how accurate and consistent the survey is as an indicator of relative animal density and are provided for each taxon code appearing in the survey database. These efficiency index scoresare subjective but were influenced by the results from several catch efficiency field experiments using NMFS trawl gear (e.g., Weinberg and Munro 1999; Munro and Somerton, 2001; Somerton and Munro, 2001;, Weinberg et al. 2002; Kotwicki and Weinberg 2005; Somerton et al. 2007; Weinberg et al. 2016). The efficiency index for Pacific halibut received the highest score, indicating that the AFSC believes the Pacific halibut CPUE calculated from the EBS shelf survey is an accurate and consistent indicator of relative animal density. Pacific halibut also received the highest score for confidence in the enumeration of weight and counts from the EBS shelf survey. A detailed description of the efficiency and enumeration confidence indices is provided in a 2016 NOAA Technical Memo (Stevenson et al., 2016).

The IPHC has deployed a biologist on the EBS shelf survey every year since 1998 to collect halibut samples. The IPHC participates in the EBS shelf survey to augment information collected in its coastwide setline survey. The setline survey is the primary fishery-independent source of data for the halibut stock assessment (Henry et al. 2015). However, Pacific halibut occupy a vast area of the Bering Sea shelf for which the IPHC lacks the financial resources to sample in its entirety. Moreover, the fishing gear used in the coastwide setline survey data generally catches halibut that are over 26 inches in length (O26) and available for harvest in the directed commercial fishery. Therefore, in most years, the EBS shelf survey is the only measure of relative abundance for smaller sizes of halibut (under 26 inches in length or U26) for much of this area. The halibut data collection (including ages) and treatment of information collected by the IPHC during the EBS shelf survey is described and the results are reported in the IPHC Report of Assessment and Research Activities 2016 (IPHC-2016-RARA-26-R).

The EBS shelf survey has different size-selectivity than setline gear, making it necessary to apply a calibration to the EBS shelf survey based on relative selectivity in the two surveys to include these data directly in the IPHC halibut stock assessment. In 2006, the IPHC added shelf stations to its setline survey in the Bering Sea region in order to compare information from setline stations in that area with data collected on the EBS shelf survey. After the study, the IPHC concluded that the EBS shelf survey, along with periodic IPHC survey calibrations, provided an adequate accounting of Pacific halibut biomass on the EBS shelf (Clark and Hare 2007) and is a useful tool for constructing a population-density index for the IPHC stock assessment (Webster 2014). The 2006 study was repeated in 2015 and confirmed the earlier finding (IPHC-2016-RARA-26-R). Based on this information, the EBS shelf survey would be an appropriate index of halibut abundance in the Bering Sea.

1.6.1.4 Availability of halibut data

Annual survey data are available each year in the fall ***with the exception of 2020*** and are used to prepare groundfish stock assessments. Therefore, the most recent EBS shelf survey data would be available for use as an index for the annual BSAI groundfish harvest specifications process in which the halibut PSC limits are established.[7]

1.6.1.5 Halibut Abundance data from survey

The IPHC used the shelf survey to estimate total Pacific halibut abundance in the EBS at 66 million fish in 2016, slightly higher than in 2015. As shown in Figure 1-5 and Table 1-4, estimated abundance declined by 4% to 22% annually beginning in 2006 from a high of 133.4 million halibut down to around

[7] EBS surveys were cancelled in 2020 due to the Covid-19 pandemic crisis. See Section 2.6 for further discussion of future planning for PSC limit determination in the event that future surveys are not able to be conducted or conducted at a reduced effort.

70 million halibut in 2019. The biomass estimates have steadily declined since the 2010 peak of over 195 thousand t down to just under 114 thousand t in 2019.

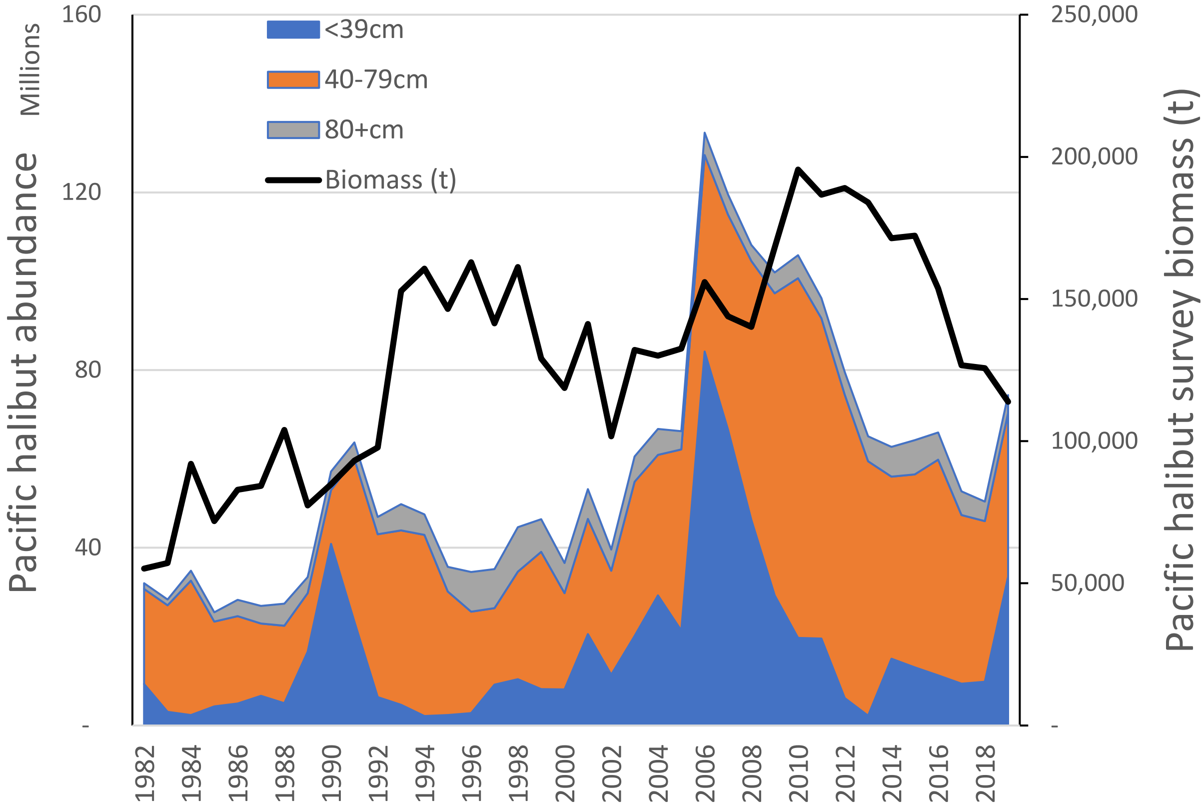


Figure 1-5 **Estimated abundance (numbers of Pacific halibut) by length category, total biomass (t) as estimated by the EBS bottom trawl survey data, 1982-2019. The trawl survey index was the area-swept biomass (catch-per-unit-effort multiplied by stratum area) estimated for the EBS by the annual NMFS EBS trawl survey during 1998–2019. These include all the standard core area strata (Table 1-4), but not the northwest area strata.**

Table 1-4 Estimated trawl survey index (metric tons t) for the year 1998–2019

Year	Trawl Index	Year	Trawl Index
1998	161,256	2009	168,102
1999	129,116	2010	195,535
2000	118,677	2011	186,666
2001	141,219	2012	189,000
2002	101,706	2013	183,989
2003	132,151	2014	171,427
2004	130,075	2015	172,237
2005	132,518	2016	153,704
2006	155,964	2017	126,684
2007	143,903	2018	125,957
2008	140,247	2019	113,855

1.6.2 IPHC Standardized Coastwide fishery independent setline survey (FISS)

The IPHC's annual fishery independent setline survey (FISS) survey, referred to as the setline survey in this document, is the most important and comprehensive data input to the annual Pacific halibut stock assessment.

1.6.2.1 Survey Objective

The primary objective of the IPHC setline survey (FISS) is to sample Pacific halibut for stock assessment and stock distribution estimation. Other objectives include tagging of halibut, collection of environmental data, collecting data from other species, and recording observations of seabirds.

1.6.2.2 Technical design

In the past, the survey typically chartered 12 to 14 fishing vessels during the summer months to survey more than 1300 stations on a 10nm by 10nm grid in nearshore and offshore waters of southern Oregon, Washington, British Columbia, southeast Alaska, the central and western Gulf of Alaska, Aleutian Islands, and northern Bering Sea (Henry et al 2017). Depths surveyed typically ranged from 20–275 fathoms (37–503 m) but shallower stations from 10–20 fathoms (18–37 meters) and deeper stations up to 400 fathoms (732 m) were surveyed in recent years as part of expansion studies. Now that those expansion studies are complete, the entire depth range from 10–400 fathoms (18–732 m) and IPHC convention area is part of the survey design and includes 1,890 stations on a 10-mile grid from California to the Bering Sea shelf edge. IPHC is currently considering sampling design options that include 1) a full sampling of the 1,890 station design, 2) complete randomized sampling of stations within each IPHC Regulatory Area, 3) randomized cluster sampling in which clusters of stations are selected to make an operationally efficient fishing day, and 4) subarea sampling in which IPHC Regulatory Areas are divided into non-overlapping subareas and all stations within a selection of the subareas are sampled. The latter two options are examples that will meet the primary sampling objectives while also considering logistics and cost. Webster (2020) provides further details of the IPHC setline survey.

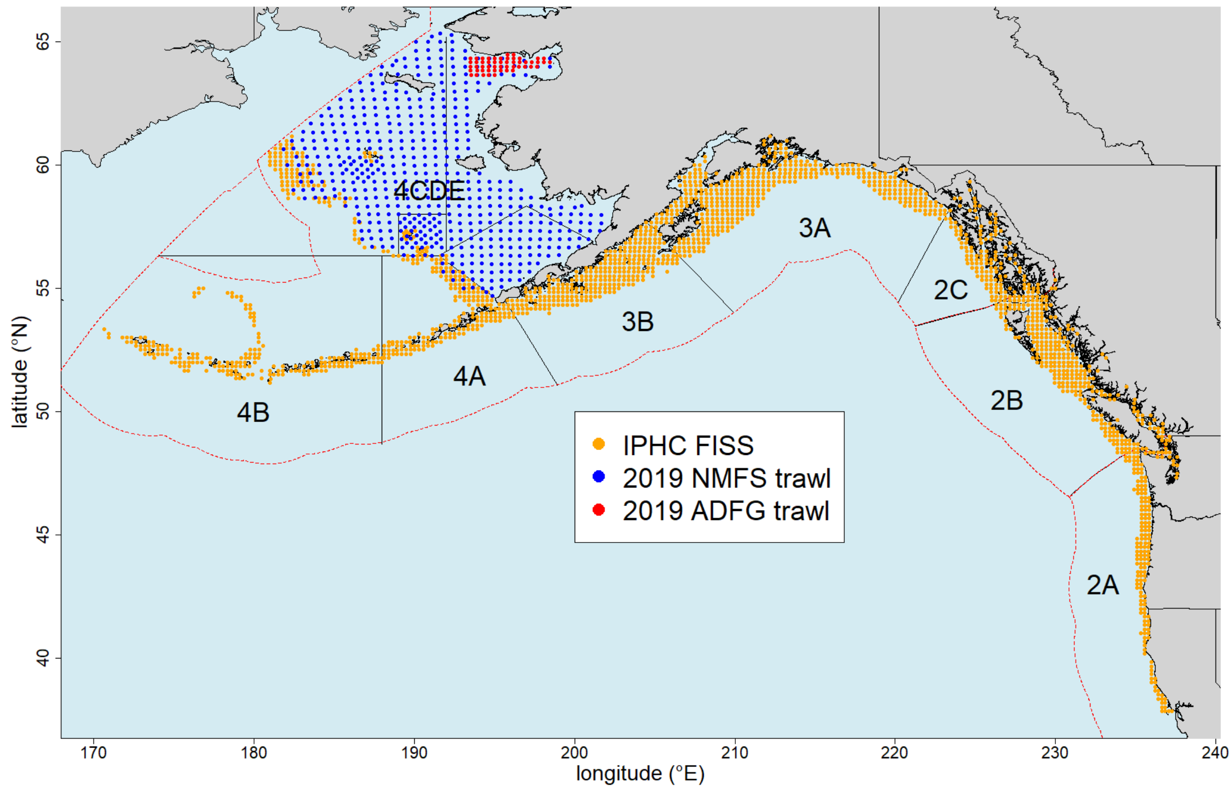


Figure 1-6 **Map of the full 1890 station FISS design, with orange circles representing stations available for inclusion in annual sampling designs, and other colors representing trawl stations from 2019 NMFS and ADFG surveys used to provide complementary data for Bering Sea modelling. From Webster (2020).**

The IPHC setline survey has evolved since 1993 with the addition of stations and the calibration with other surveys to utilize as much information as possible to estimate the abundance of Pacific halibut within the IPHC Convention Area. Prior to 1997, the survey had less coverage, but data are available for many Regulatory Areas (Stewart & Monahan 2016). The expansions from 2014–2019 added a considerable amount of information for the edges of the stock distribution, including calibrations with other surveys in the Bering Sea (e.g., the eastern Bering Sea trawl survey). In 2020, the IPHC setline survey sampled all stations in the core areas of the Pacific halibut stock (Regulatory Areas 3A and 2C as well as the northern portion of 2B). However, reduced survey effort was completed in the eastern half of 3B and other regulatory areas were omitted, including the EBS/AI areas (Figure 1-7).

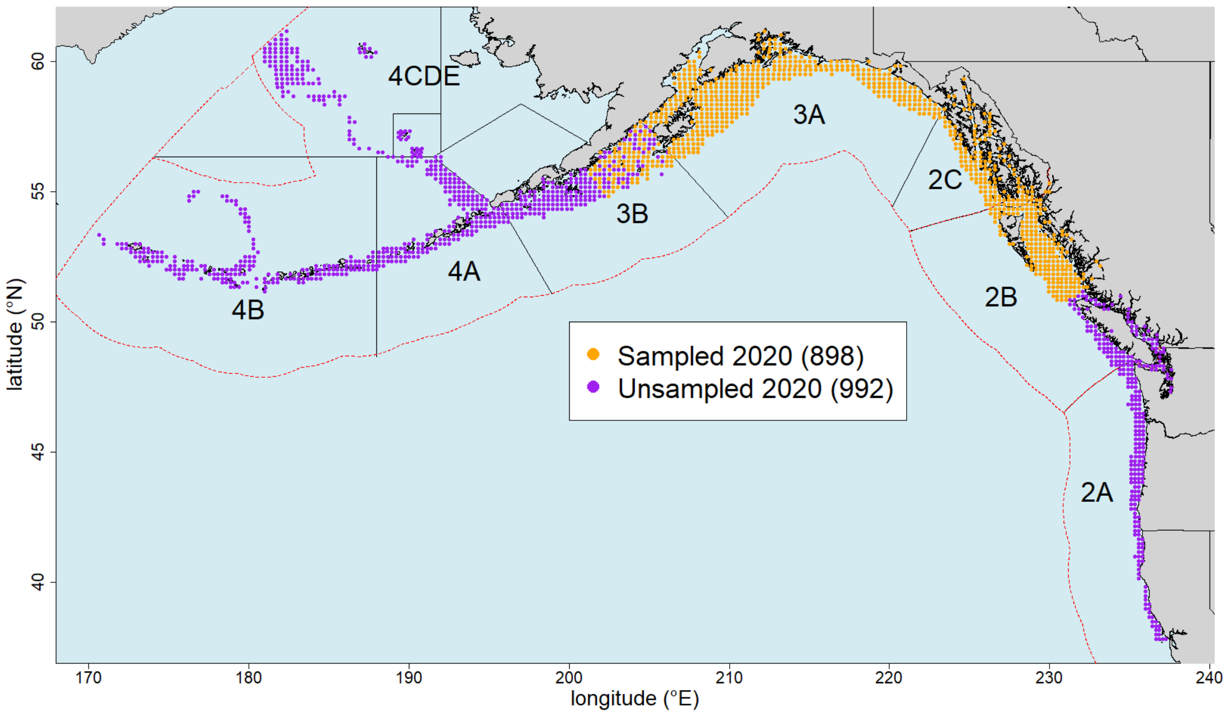


Figure 1-7 **Map of the implemented 2020 FISS design, with orange circles representing those stations to be fished in 2020, and purple circles representing stations from the survey design that were not fished in 2020. From Webster (2020).**

1.6.2.3 Sampling and analysis of IPHC setline survey (FISS) data

The fishing gear used in the setline survey generally catches halibut that are O26, similar to what is encountered in the directed fishery. Typically, five to seven skates of baited 16/0 hooks are fished where the number of skates may increase or decrease in each year depending on the expected encounter rate with Pacific halibut. The other specifications for gear, setting schedule, and soak time have remained consistent since 1998 (Henry et al 2017). A set is considered ineffective for stock assessment if predetermined limits for lost gear, depredation, or displacement from station coordinates are exceeded.

Pacific halibut observations are recorded by IPHC sea samplers on the vessel. The fork lengths of all Pacific halibut are recorded to the nearest centimeter. Each length is converted to an estimated weight using a standard formula (Clark 1992), and these weights were then used to generate the weight per unit effort (WPUE) data. However, starting in 2019, weights are directly observed during the sampling process. Average O32 WPUE, expressed as net pounds per skate, is calculated by dividing the estimated catch in pounds (net weight) of Pacific halibut equal to or over 32 inches (81.3 cm; O32 Pacific halibut) in length by the number of skates hauled for each station. The sex, state of maturity, prior hook injuries, and depredation are also recorded. Otoliths are collected from a subsample of O32 and U32 halibut.

The setline survey data are analyzed to estimate the coastwide numbers-per-unit-effort (NPUE) and weight-per-unit-effort (WPUE) of O32 halibut and all halibut caught (Total). In 2016, an improved approach (spatio-temporal modeling) was used to estimate density indices (Webster 2017). This space-time model improves estimation by fitting models to the data that account for spatial and temporal dependence, making use of the degree to which the halibut distribution is patchy (has regions of high and low density), and that those patches tend to persist with time. For example, if WPUE is high at a particular location it is more likely to be high at nearby locations, and at the same location in previous and subsequent years. Therefore, information about density at a location and time from a direct observation is also informed by information recorded nearby in space and time. Similarly, such an approach also allows estimation of a density index at a location with no data (e.g., a location between stations, a station with an ineffective set, or a region not surveyed annually). Additionally, auxiliary information collected on the survey (such as station depth) can provide further improvements.

The IPHC annual setline survey does not directly sample stations on the eastern Bering Sea flats (Figure 1-7), except for those around St. Matthew Island and the Pribilof Islands. Instead, data from annual NMFS trawl surveys, calibrated to the 2006 and 2015 IPHC setline surveys in the eastern Bering Sea (Webster et al. 2016), are integrated into the space-time analysis. The annual NMFS EBS trawl survey is used in conjunction with the NMFS/ADFG surveys of Norton Sound (Soong and Hamazaki 2012) to develop an estimate of the density of Pacific halibut in the Bering Sea (see Webster 2014 for details). Additionally, data from the NMFS sablefish longline survey have been used to index deep water (>275 fathoms, 503 meters) on the IPHC Regulatory Area 4D edge, but are no longer needed with the expanded survey design.

The WPUE and NPUE are standardized to account for hook competition (competition for baits among Pacific halibut and other species) and timing of the survey relative to the total harvest of Pacific halibut. The hook competition adjustment will increase the raw WPUE or NPUE at an individual station slightly with more competition (fewer baits returned) and is applied before the space-time model to account for variability in the standardization among stations. The standardization to account for the amount of harvest taken before the setline survey uses target harvest rates for each IPHC Regulatory Area and is done for each IPHC Regulatory Area instead of individual stations.

1.6.2.4 Availability of halibut data

The IPHC setline survey is typically completed in late summer and preliminary results are presented at the IPHC interim meeting in late November, although results may be available before then. It is possible that some minor changes due to data quality control and data checking may occur before the IPHC Annual Meeting in January, but these are not likely to be substantial. WPUE for all years 1993 to current are available for O32 and Total. Therefore, Total WPUE is used throughout this report since it is most congruent with the IPHC's concept of total constant exploitable yield (TCEY (O26 halibut)) and contains all of the information collected from the IPHC setline survey.

1.6.2.5 IPHC setline survey Pacific halibut abundance in the BSAI

The space-time model provides WPUE and NPUE for each IPHC Regulatory Area, with 4CDE combined into a single area. The IPHC Regulatory Areas can be summed together after weighting by bottom area of suitable habitat for Pacific halibut. Space-time model results of Total WPUE for IPHC Regulatory Areas 4A, 4B, and 4CDE are shown in Table 1-5 and Figure 1-8 along with an appropriately combined Total WPUE for all three areas (4ABCDE). The correlation between all of these index time-series is high.

The space-time model uses all years of data to inform the estimated WPUE in each year by estimating spatial and temporal correlations. This has two important outcomes. First, an additional year of observations will result in changes to the entire time-series, with the greatest change occurring to nearby years. For example, the addition of 2019 data slightly changed the index in 2018 as estimated from the previous year when 2019 data were not yet sampled (note this resulted in a 1.21% change from the previous calculated 2018 value). Second, the estimation of spatial and temporal correlation allows for the estimation of stations that were not sampled in a specific year (i.e., uses information from nearby stations that have observations in nearby years). This optimized use of the information from the sampled data reduces uncertainty and allows for the estimation of a consistent time-series over all years. Additionally, estimates of the WPUE can still be produced for areas that were not sampled in a particular year, with appropriate estimated uncertainty. This is particularly important for 2020 with the reduced survey in response to the COVID-19 pandemic crisis. The BSAI region was not surveyed by the IPHC or NMFS surveys (Figure 1-7), but the space-time approach is still able to produce an estimate for the area, with an increased uncertainty, using the observations from previous years and the stations outside of the BSAI that are sampled in 2020. Therefore, even though the BSAI was not sampled in 2020, an estimate from the setline survey for use as an ABM index is available, but additional years without data will further increase uncertainty and reduce precision in the predictions. The estimate of the 4ABCDE setline survey index for 2020 is 7,552 and the 2018 and 2019 indices are updated to 7,709 and 7,460, respectively. Therefore, the recent three-year average is 7,574.

Table 1-5 IPHC fishery independent setline survey Total WPUE for the entire coast (coastwide), specific areas in IPHC Regulatory Area 4, and the sum of all areas in IPHC Regulatory Area 4 (4ABCDE) appropriately weighted by bottom area. The indices are standardized to their means (1998-2019) for comparison, except for "Index 4ABCDE," which is the calculated weight-per-unit-effort index (WPUE) for all sizes of Pacific halibut. These estimates do not include 2020 data.

Year	Coastwide	4A	4B	4CDE	4ABCDE	Index 4ABCDE
1998	1.51	2.15	2.55	1.00	1.77	18,577
1999	1.40	1.88	2.04	0.97	1.55	16,155
2000	1.44	1.89	1.87	1.05	1.55	16,207
2001	1.30	1.58	1.38	1.03	1.32	13,681
2002	1.29	1.42	1.03	0.96	1.16	12,037
2003	1.17	1.22	0.84	0.97	1.04	10,862
2004	1.16	1.09	0.76	0.93	0.96	10,128
2005	1.05	0.99	0.71	0.94	0.91	9,856
2006	0.99	0.85	0.82	1.08	0.94	9,932
2007	0.98	0.80	1.01	1.01	0.93	9,922
2008	0.92	0.93	1.01	1.02	0.98	10,714
2009	0.85	0.90	0.84	1.03	0.94	9,989
2010	0.81	0.77	0.73	1.06	0.88	9,271
2011	0.81	0.69	0.75	1.02	0.83	8,896
2012	0.86	0.68	0.63	1.02	0.80	8,539
2013	0.74	0.53	0.75	1.01	0.76	8,133
2014	0.79	0.56	0.65	1.04	0.77	8,173
2015	0.80	0.56	0.67	1.05	0.78	8,385
2016	0.82	0.51	0.68	1.03	0.75	8,134
2017	0.68	0.52	0.62	0.91	0.69	7,583
2018	0.64	0.47	0.69	0.90	0.68	7,228
2019	0.60	0.56	0.60	0.85	0.68	7,104

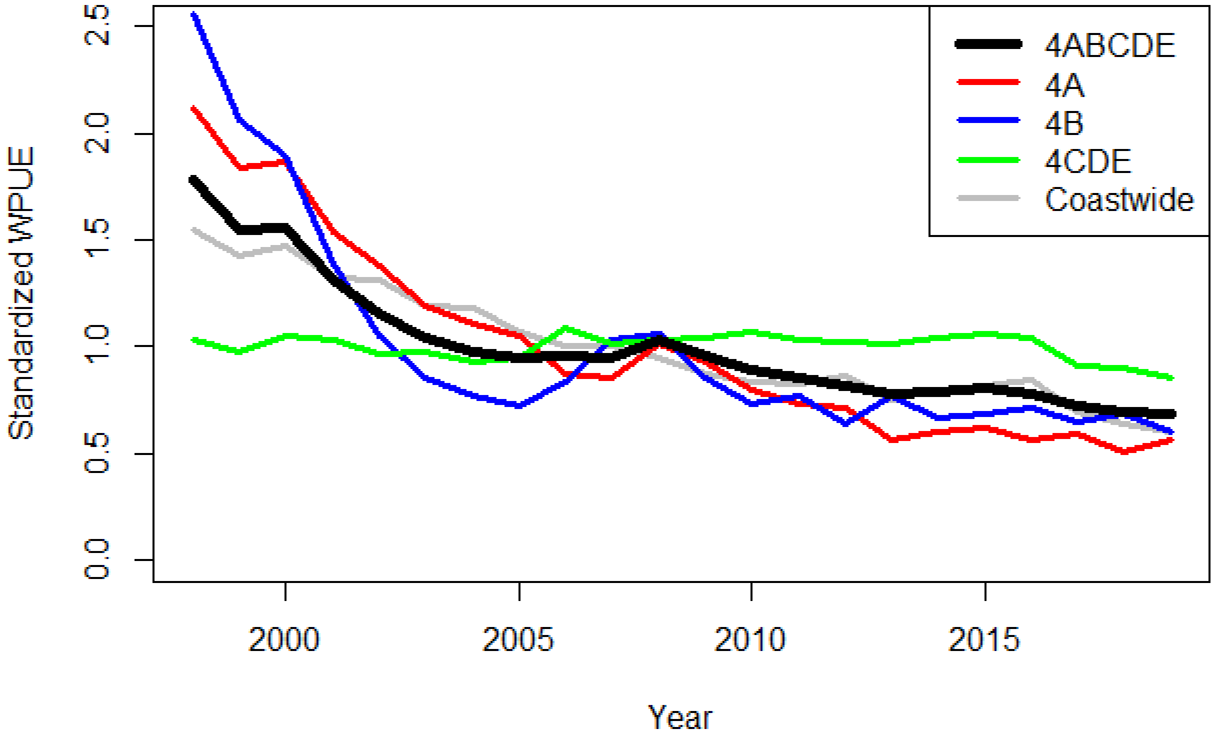


Figure 1-8 **WPUE all Pacific halibut (Total) for IPHC Regulatory Areas in Area 4 standardized to the mean of the time series (1998-2019) for each Area. Area 4ABCDE is the sum of Areas 4A, 4B, and 4CDE, and Coastwide is all IPHC Regulatory Areas summed. Summed indices are appropriately weighted by bottom area. These estimates do not include 2020 data.**

2 Description of Alternatives

NEPA requires that an EIS analyze a reasonable range of alternatives consistent with the purpose and need for the proposed action. The alternatives in this chapter were designed to accomplish the stated purpose and need for the action. All of the alternatives were designed to link PSC limits to halibut abundance for the Amendment 80 (A80) sector[8]; other PSC limits for BSAI halibut are unaffected. The current halibut PSC limit for the Amendment 80 sector is established in the BSAI Groundfish FMP. Changing the PSC limit for the Amendment 80 sector (under Alternatives 2, 3 and 4) requires amendments to both the FMP and federal regulations.

There are four alternatives under consideration by the Council. While the Council has considered a variety of options and approaches during the scoping and development of this issue (2016-2020; see further discussion in Section 2.7), in October 2020, the Council identified three action alternatives that variously index the halibut PSC limit for the Amendment 80 sector to BSAI halibut abundance using Look-up Tables of abundance values from both the EBS trawl survey and the IPHC setline survey (Table 2-1 through Table 2-3).

Alternative 1: No action. BSAI halibut Amendment 80 PSC limit is 1,745 t.

Alternative 2: PSC limit is determined annually based on EBS shelf trawl and IPHC setline survey values from the most recent year available, using a 3x2 look-up table with PSC limits that range from the current limit (1,745 t) to 20 percent below the current limit.

Alternative 3: PSC limit is determined annually based on EBS shelf trawl and IPHC setline survey values from the most recent year available, using a 4x2 look-up table with PSC limits that range from the 15 percent above the current limit to 30 percent below the current limit.

Alternative 4: PSC limit is determined annually based on EBS shelf trawl and IPHC setline survey values from the most recent year available, using a 4x2 look-up table with PSC limits that range from the current limit to 45 percent below the current limit.

The Council also adopted four options, applicable under any of Alternatives 2 through 4, which could affect how the PSC limits would be calculated. Option 1 would use the three-year rolling average of the survey estimate instead of the most recent year available for the look up table, while other options (2-4) may be applied following the determination of the PSC limits (note that Option 4 is mutually exclusive with the selection of either Options 2 or 3). The alternatives and options are discussed in more detail in the subsections that follow.

[8] See Section 3.3 for a description of the Amendment 80 sector.

Table 2-1 Alternative 2: 3x2 Look up table to determine PSC limits based on survey states, with PSC limits that range from current PSC limit to 20% below current limit.

		EBS shelf trawl survey index (t)	
		Low < 150,000	**High ≥ 150,000**
IPHC setline survey index in Area 4ABCDE (WPUE)	**High ≥ 11,000**	1,571 mt (10% below current)	1,745 mt (current limit)
	Medium 8,000 – 10,999	1,483 mt (15% below current)	1,571 mt (10% below current)
	Low < 8,000	1,396 mt (20% below current)	1,483 mt (15% below current)

Table 2-2 Alternative 3: 4x2 Look up table to determine PSC limits based on survey states, with PSC limits that range from 15% above current PSC limit to 30% below current limit.

		EBS shelf trawl survey index (t)	
		Low < 150,000	**High ≥ 150,000**
IPHC setline survey index in Area 4ABCDE (WPUE)	**High ≥ 11,000**	1,745 mt (current limit)	2,007 mt (15% above current)
	Medium 8,000 – 10,999	1,396 mt (20% below current)	1,745 mt (current limit)
	Low 6,000-7,999	1,309 mt (25% below current)	1,396 mt (20% below current)
	Very Low < 6,000	1,222 mt (30% below current)	1,309 mt (25% below current)

Table 2-3 Alternative 4: 4x2 Look up table to determine PSC limits based on survey states, with PSC limits that range from current PSC limit to 45% below current limit.

		EBS shelf trawl survey index (t)	
		Low < 150,000	**High ≥ 150,000**
IPHC setline survey index in Area 4ABCDE (WPUE)	**High ≥ 11,000**	1,396 mt (20% below current)	1,745 mt (current limit)
	Medium 8,000 – 10,999	1,222 mt (30% below current)	1,396 mt (20% below current)
	Low 6,000-7,999	1,047 mt (40% below current)	1,222 mt (30% below current)
	Very Low < 6,000	960 mt (45% below current)	1,047 mt (40% below current)

2.1 Alternative 1, No Action

This action is focused only on the Amendment 80 sector. Under the No Action alternative, or status quo, the BSAI PSC limits are set in the FMP and in regulation as an amount of halibut equivalent to 3,515 t of halibut mortality. Within that total, the BSAI PSC limit for the Amendment 80 sector are set in the FMP and in regulation as an amount of halibut mortality equivalent to 1,745 t (implemented at that level in 2016). The Amendment 80 trawl PSC limit is specifically allocated among the Amendment 80 cooperative(s) and the Amendment 80 limited access sector, however the Amendment 80 sector is currently comprised of a single cooperative (Alaska Seafood Cooperative) and there is currently no limited access participation. All vessels fishing in the sector must stop fishing for the remainder of the year when the annual PSC limit is reached. Table 2-4 provides data on halibut PSC mortality usage in the Amendment 80 sector from 2010 through 2020.

Table 2-4 Halibut PSC limit, encounters, and mortality by Amendment 80 sector, 2010 through 2020

A80 Sector	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
PSC limit	2,425	2,375	2,325	2,325	2,325	2,325	1,745	1,745	1,745	1,745	1,745
Halibut encounters	2,823	2,277	2,469	2,677	2,667	1,719	1,965	1,976	2,555	3,067	2,031
Halibut mortality	2,254	1,810	1,944	2,166	2,178	1,404	1,412	1,167	1,343	1,461	1,097

Note: Halibut PSC that occurs on an A80 vessel due to harvest in the CDQ fishery is not included in this table.

2.2 Alternatives 2 through 4: Set PSC Limit for Amendment 80 based on Abundance of BSAI halibut according to tables employing levels of both the EBS trawl and the IPHC Setline Survey

Under Alternatives 2 through 4, the Amendment 80 sector halibut PSC limits would be prescribed annually based on look up tables where the level of the PSC limit (metric tons of halibut mortality) is based on the independent values of two survey abundance indices: the EBS shelf trawl survey index (metric tons) and the IPHC setline survey index in Area 4ABCDE (weight per unit of effort, or WPUE).

The look up tables, which vary by alternative, determine the Amendment 80 sector PSC limit based upon where the two survey index values intercept. Each alternative defines the same two states for the EBS trawl survey ("low" or "high"), but differ by defining either three ("low/medium/high") or four (addition of a "very low") states for the IPHC survey. Figure 2-1 shows the historical EBS trawl survey biomass estimates with the delineation of low and high below or above the 150,000 mt mark as indicated in Alternatives 2-4[9]. Figure 2-2 shows the biomass estimates for the IPHC Setline Survey historically with delineations for the ranges of states as indicated in Alternatives 2-4 (Very Low: <6,000, Low: 6,000-7,999, Medium: 8,000-10,999 and High: ≥11,000, note the Very Low state does not apply to Alternative 2). Values for the surveys as well as the relative states are shown in Table 2-5.

Under all three of these Alternatives, the process for PSC setting is such that the survey data for determining the appropriate 'state' under any of the look up tables would occur in the Fall of the preceding year (see Figure 2-3 below) and that determination will be used to establish the appropriate PSC limit in the subsequent year.

Table 2-5 contains the historical survey values for both surveys (1998 through 2019), their resulting state in that year as defined under the alternatives, and what the Amendment 80 PSC limit would have been in each historical year, under each Alternative, had the PSC limits been calculated under those survey states.

[9] Note this and the following figure also illustrate survey values using the three-year rolling average as proposed under Option 1.

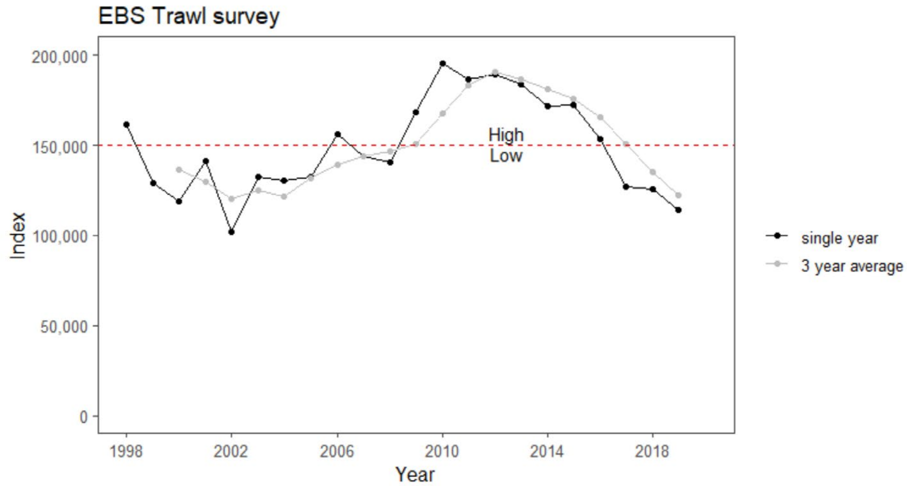


Figure 2-1 Historical values of the EBS trawl survey (mt) 1998 – 2019 for single point value in that year (black line and points) or Option 1's rolling three year average (grey).

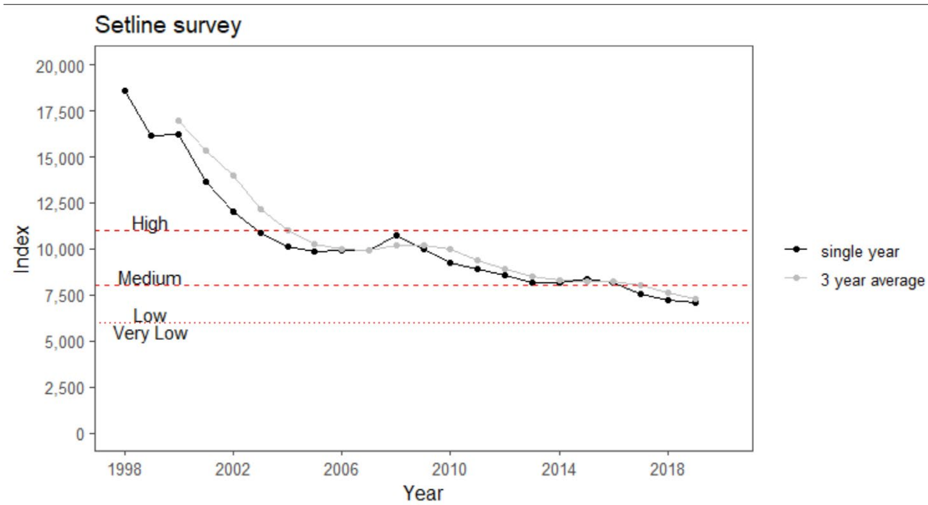


Figure 2-2 Historical values of the IPHC setline survey (WPUE) 1998 – 2019 for single point value in that year (black line and points) or Option 1's rolling three year average (grey).

Year of survey | Year PSC limit set

Year of survey	Setline Index	Setline State	Trawl Index	Trawl State	Year PSC limit set	Lookup tables		
Alternative		2,3,4		2, 3, 4	Alternative	2	3	4
2015	8,385	Medium	172,237	High	2016	1571	1745	1396
2016	8,134	Medium	153,704	High	2017	1571	1745	1396
2017	7,583	Low	126,684	Low	2018	1396	1309	1047
2018	7,228	Low	125,957	Low	2019	1396	1309	1047
2019	7,104	Low	113,855	Low	2020	1396	1309	1047

Figure 2-3 Schematic for understanding the timing of survey availability and resulting PSC limit setting as shown in Table 2-5

Table 2-5 Historical survey values for IPHC Setline index (WPUE), EBS Trawl (mt) and resulting PSC limit 'States" for each based on Alternatives 2 – 4 (left panel) (High/Medium/Low/Very Low). Note that current survey values for setline have not reached the established 'very low' level as specified under Alternatives 3 and 4. Back-calculated PSC limits based on Alternatives 2-4 are shown (right panel). Note that the year of PSC limit is lagged one year from the survey year as the determination of survey value is made in the year prior to implementation of the PSC limit.

	Setline		Trawl			PSC Limits from Lookup tables		
Survey year	Index	State	Index	State	PSC Limit year	Alt 2	Alt 3	Alt 4
1998	18,577	High	161,256	High	1999	1745	2007	1745
1999	16,155	High	129,116	Low	2000	1571	1745	1396
2000	16,207	High	118,677	Low	2001	1571	1745	1396
2001	13,681	High	141,219	Low	2002	1571	1745	1396
2002	12,037	High	101,706	Low	2003	1571	1745	1396
2003	10,862	Medium	132,151	Low	2004	1483	1396	1222
2004	10,128	Medium	130,075	Low	2005	1483	1396	1222
2005	9,856	Medium	132,518	Low	2006	1483	1396	1222
2006	9,932	Medium	155,964	High	2007	1571	1745	1396
2007	9,922	Medium	143,903	Low	2008	1483	1396	1222
2008	10,714	Medium	140,247	Low	2009	1483	1396	1222
2009	9,989	Medium	168,102	High	2010	1571	1745	1396
2010	9,271	Medium	195,535	High	2011	1571	1745	1396
2011	8,896	Medium	186,666	High	2012	1571	1745	1396
2012	8,539	Medium	189,000	High	2013	1571	1745	1396
2013	8,133	Medium	183,989	High	2014	1571	1745	1396
2014	8,173	Medium	171,427	High	2015	1571	1745	1396
2015	8,385	Medium	172,237	High	2016	1571	1745	1396
2016	8,134	Medium	153,704	High	2017	1571	1745	1396
2017	7,583	Low	126,684	Low	2018	1396	1309	1047
2018	7,228	Low	125,957	Low	2019	1396	1309	1047
2019	7,104	Low	113,855	Low	2020	1396	1309	1047

2.3 Options that could apply to Alternatives 2, 3 and 4

Selection of options is not mandatory. Option 1 may be selected with any other option. Option 2 and Option 3 may also be selected in tandem but the selection of Option 4 is mutually exclusive with the selection of either Options 2 or 3. In order to facilitate tabular presentation of multiple Alternatives and options, the analysts have developed the nomenclature shown in Figure 2-4 that is used in all subsequent tables throughout this analysis.

Understanding the nomenclature of the Alternatives and Options: e.g. Alternative 3.2.1

	Lookup tables			Option 2 Suboption 1: varies ≤10% per year			Suboption 2: varies ≤ 15% pe year		
Alternative	2	3	4	2.2.1	3.2.1	4.2.1	2.2.2	3.2.2	4.2.
2015	1,571	1,745	1,396	1,571	1,745	1,396	1,571	1,745	1,39
2016	1,571	1,745	1,396	1,571	1,745	1,396	1,571	1,745	1,39
2017	1,571	1,745	1,396	1,571	1,745	1,396	1,571	1,745	1,39
2018	1,396	1,309	1,047	1,414	1,571	1,256	1,396	1,483	1,18

Figure 2-4 Nomenclature to understand the numbering of Alternatives and Options throughout this analysis

2.3.1 Option 1: Rolling survey average to determine PSC limits

PSC limit is determined using a 3-year rolling average of survey index values instead of the most recent survey value.

This option would be used to smooth inter-annual variability in the PSC limit based on changes in the survey states from one year to the next. Absent this option being selected the most recent survey year value would determine the survey state for PSC setting in the subsequent year. Table 2-6 shows the resulting difference in PSC limits when employing option one as opposed to the most recent value using the historical time series of both surveys as with Table 2-5.

Table 2-6 Back-calculated PSC limits based on Alternatives 2-4 with Option 1 are shown (right panel), along with historical survey values for IPHC Setline index (WPUE), EBS Trawl (mt) and resulting PSC limit 'States" for each based on Alternatives 2 – 4 with Option 1 (left panel). Changes (in grey shading) are highlighted where the historical use of a 3-year rolling average to determine the survey value under Option 1, as opposed to the most recent survey year. Survey values associated with these PSC limit determinations are shown in Table 2-5

Option 1: 3-yr rolling average

	Setline average		Trawl average			PSC Limits from Lookup tables		
Survey years	Index	State	Index	State	PSC limit year	Alt 2.1	Alt 3.1	Alt 4.1
1998-2000	16,980	High	136,350	Low	2001	1571	1745	1396
1999-2001	15,348	High	129,671	Low	2002	1571	1745	1396
2000-2002	13,975	High	120,534	Low	2003	1571	1745	1396
2001-2003	12,193	High	125,025	Low	2004	1571	1745	1396
2002-2004	11,009	High	121,311	Low	2005	1571	1745	1396
2003-2005	10,282	Medium	131,581	Low	2006	1483	1396	1222
2004-2006	9,972	Medium	139,519	Low	2007	1483	1396	1222
2005-2007	9,903	Medium	144,128	Low	2008	1483	1396	1222
2006-2008	10,189	Medium	146,705	Low	2009	1483	1396	1222
2007-2009	10,208	Medium	150,751	High	2010	1571	1745	1396
2008-2010	9,991	Medium	167,961	High	2011	1571	1745	1396
2009-2011	9,385	Medium	183,434	High	2012	1571	1745	1396
2010-2012	8,902	Medium	190,400	High	2013	1571	1745	1396
2011-2013	8,523	Medium	186,552	High	2014	1571	1745	1396
2012-2014	8,282	Medium	181,472	High	2015	1571	1745	1396
2013-2015	8,230	Medium	175,884	High	2016	1571	1745	1396
2014-2016	8,231	Medium	165,789	High	2017	1571	1745	1396
2015-2017	8,034	Medium	150,875	High	2018	1571	1745	1396
2016-2018	7,648	Low	135,448	Low	2019	1396	1309	1047
2017-2019	7,305	Low	122,165	Low	2020	1396	1309	1047

2.3.2 Option 2: PSC variability

The PSC limit varies no more than a selected percentage per year.

The suboptions are:

10%

15%

Under Option 2, the percentage selected constrains the annual determination of the new PSC limit after it is calculated using the Alternative's lookup table. The purpose of this option, as with Option 1, is to reduce inter-annual variability in the PSC limit. This option would be particularly important when the specified abundance indices are near the thresholds that delineate the different PSC limits in the look-up tables (Table 2-7). The nomenclature for the suboptions is described above in Figure 2-4.

Table 2-7 Back-calculated PSC limits under Option 2, with the two suboptions, as compared to those directly from the PSC lookup tables for Alternatives 2-4; differences (higher or lower) marked with shading. Note that these limits are calculated based on the table limits (using the most recent survey year available, and not based on the Option 1, 3-year rolling average survey indices.

	Lookup tables			Option 2 Suboption 1: varies ≤10% per year			Suboption 2: varies ≤ 15% per year		
Alternative	2	3	4	2.2.1	3.2.1	4.2.1	2.2.2	3.2.2	4.2.2
2010	1,571	1,745	1,396	1,571	1,536	1,344	1,571	1,605	1,396
2011	1,571	1,745	1,396	1,571	1,689	1,396	1,571	1,745	1,396
2012	1,571	1,745	1,396	1,571	1,745	1,396	1,571	1,745	1,396
2013	1,571	1,745	1,396	1,571	1,745	1,396	1,571	1,745	1,396
2014	1,571	1,745	1,396	1,571	1,745	1,396	1,571	1,745	1,396
2015	1,571	1,745	1,396	1,571	1,745	1,396	1,571	1,745	1,396
2016	1,571	1,745	1,396	1,571	1,745	1,396	1,571	1,745	1,396
2017	1,571	1,745	1,396	1,571	1,745	1,396	1,571	1,745	1,396
2018	1,396	1,309	1,047	1,414	1,571	1,256	1,396	1,483	1,187
2019	1,396	1,309	1,047	1,396	1,413	1,131	1,396	1,309	1,047
2020	1,396	1,309	1,047	1,396	1,309	1,047	1,396	1,309	1,047

2.3.3 Option 3: Annual limit

Establish an "annual limit" based on the PSC limit generated by the look-up table. The annual limit will be defined as either (Suboption 1) 80% or (Suboption 2) 90% of the PSC limit. In 3 of 7 years, the A80 sector may exceed the annual limit up to the PSC limit generated by the look up table. If the A80 sector has exceeded the annual limit in 3 of the past 7 years, then either 80% or 90% of the PSC limit (as determined by the selected suboption) is a hard cap for that year.

The purpose of the annual limit (80-90% of the PSC limit generated from the action Alternatives look up tables) is to incentivize the A80 sector to achieve halibut bycatch mortality levels that are lower than the look-up table levels at all times. As such, the A80 sector would be permitted to incur an amount of halibut PSC that is above the annual limit but below the PSC limit generated by the look-up table in 3 of any 7 consecutive years, as assessed on a rolling 7-year timeline. If the A80 sector exceeds the annual limit in 3 of 7 years then the annual limit proportion (as defined under Suboptions 1 or 2) of the PSC limit generated by the look-up table is a hard cap 'for that year'. The analysts assume that, per the specifications cycle, if the annual limit is exceeded for a 3rd time in 7 years *during* a season then the "hard cap" annual limit provision apply for the following year; it would not close the fishery during the year when the third exceedance of the annual limit occurs. ***The Council should clarify if this option should be interpreted differently.***

In any given year, the A80 sector's PSC is assessed against the annual limit, depending on the suboption selected, which it will be determined to have either exceeded or not exceeded. Next, the result from that year plus the results for the six preceding years will be assessed in total to determine whether the annual limit was exceeded in 3 of 7 years, on a rolling basis.

For Option 3 as applied to Alternatives 2-4, the back-calculated PSC limits by Alternative (2010-2020) as well as the 'annual limit' as indicated by Option 3 suboptions are shown (Table 2-8).

Table 2-8 Option 3 back-calculated Annual limits (2010-2020) as compared to the PSC limits from the lookup tables for Alternatives 2-4, with shading indicating whether the actual mortality by A80 in that year would have exceeded the value in the table (PSC limit or annual limit options). Amendment 80 PSC mortality is shown in Table 2-4. Note that these limits are calculated based on the table limits (using the most recent survey year available, and not based on the Option 1, 3-year rolling average survey indices.

	Lookup tables			Option 3 80% of lookup table			90% of lookup table		
Alternative	2	3	4	2.3.1	3.3.1	4.3.1	2.3.2	3.3.2	4.3.2
2010	1,571	1,745	1,396	1,257	1,396	1,117	1,414	1,571	1,256
2011	1,571	1,745	1,396	1,257	1,396	1,117	1,414	1,571	1,256
2012	1,571	1,745	1,396	1,257	1,396	1,117	1,414	1,571	1,256
2013	1,571	1,745	1,396	1,257	1,396	1,117	1,414	1,571	1,256
2014	1,571	1,745	1,396	1,257	1,396	1,117	1,414	1,571	1,256
2015	1,571	1,745	1,396	1,257	1,396	1,117	1,414	1,571	1,256
2016	1,571	1,745	1,396	1,257	1,396	1,117	1,414	1,571	1,256
2017	1,571	1,745	1,396	1,257	1,396	1,117	1,414	1,571	1,256
2018	1,396	1,309	1,047	1,117	1,047	838	1,256	1,178	942
2019	1,396	1,309	1,047	1,117	1,047	838	1,256	1,178	942
2020	1,396	1,309	1,047	1,117	1,047	838	1,256	1,178	942

Table 2-9 Historical PSC limits, Encounters and Mortality (mt) by Amendment 80 from 2010-2020

Year	Amendment 80 PSC (mt) Limit	Encounter	Mortality
2010	2,425	2,823	2,254
2011	2,375	2,277	1,810
2012	2,325	2,469	1,944
2013	2,325	2,677	2,166
2014	2,325	2,667	2,178
2015	2,325	1,719	1,404
2016	1,745	1,965	1,412
2017	1,745	1,976	1,167
2018	1,745	2,555	1,343
2019	1,745	3,067	1,461
2020	1,745	2,031	1,097

As Shown in Table 2-8, historically annual limits as shown under Option 3 were exceeded. Table 2-9 uses one of the historically calculated alternatives (3.3.2 indicating Alternative 3, option 3, suboption 2 for 90% annual limit of the PSC limit) to indicate when and for how long the annual limit would become a hard cap. Here each year of realized PSC mortality is assessed against its specified annual limit with shading to indicate whether or not a determination would have been made whether it was exceeded and thus is counted toward one of the three assessed years. Once the 3rd year in a rolling 7 has been reached the annual limit becomes a hard limit in the following year (as noted in red text). In this example the first year that the annual limit becomes a hard cap is 2013. Due to the rolling 3 in 7-year nature of the assessment, it remains a hard cap in this example in 2015-2017 regardless of mortality being below the annual limit in those years. The annual limit is again exceeded (even though practically speaking in this example it would have been a hard cap that was reached) through 2019 and then remains a hard cap in 2020 despite not being reached in that year. In this example, because mortality was below the annual limit in 2020 then the year 2014 would drop out of the '3 in 7' consideration and it would return to being an annual limit and not a hard cap in 2021. However, another annual limit could not be exceeded until after 2025 in order to drop 2018 and 2019 from the 3-year rolling time frame. If mortality exceeded the annual limit in any year from 2021-2024 then the annual limit would return to being a hard cap as those years would remain within the 3 in 7 calculation including 2018-2019.

Table 2-10 Amendment 80 historical mortality (2010-2020) and calculated annual limit for 3.3.2 (Alternative 3, option 3 suboption 2) for an annual limit at 90% of the look up table limit for Alternative 3. Red shading for Alt 3.3.2 indicates when the annual limit was exceeded while red text indicates years in which the annual limit is now assessed as a hard limit. Note that these limits are calculated based on the table limits (using the most recent survey year available, and not based on the Option 1, 3-year rolling average survey indices.

Year	Mortality	Alt 3.3.2
2010	2,254	1571
2011	1,810	1571
2012	1,944	1571
2013	2,166	**1571**
2014	2,178	**1571**
2015	1,404	**1571**
2016	1,412	**1571**
2017	1,167	**1571**
2018	1,343	**1178**
2019	1,461	**1178**
2020	1,097	**1178**
2021	TBD	TBD
2022	TBD	TBD

2.3.4 Option 4: Rollover of unused PSC (mutually exclusive with Options 2 and 3)

PSC unused in one year may roll to the following year to increase the PSC limit generated by the lookup table up to 20%. Any PSC savings in excess of 20% would stay in the water.

This option would allow for additional PSC in a subsequent year, when PSC from a given year is not realized. The amount of PSC allowed to 'rollover' to a subsequent year would be capped at 20% of the in-year PSC limit. An example is shown in Table 2-11 for Alternative 3 using the back-calculated halibut PSC limits derived from a look up table that includes survey states based on 2015-2020 data. In this example the term "table limit" refers to the PSC limit calculated by the lookup table, and "effective limit" to refer to the PSC limit including the available rollover from the previous year. Here the EBS survey state is in the "High" while the Setline survey state is at "Medium". Between 2017 and 2018 while the PSC limit dropped, with the use and rollover from 2017 the 'effective limit' increased. Here under this option, 2017 shows the first example where the rollover is capped by the 20% provisions rather than the full amount (in this example 578 mt) being able to be rolled over. Thus 229 mt 'stays in the water' as intended by the wording of the option. From 2017-2020 both surveys are in a "Low" state and the Look up Table limit would drop. For hypothetical purposes we assume both surveys return to "High" (EBS) and "Medium" (Setline) to show how moving from 2020 to 2021 impacts the increase in the PSC Table Limit as well as the effective limit due to the rollover. Note that the effective limit can exist in a given year up to the highest value in the lookup table plus 20% assuming there was sufficient PSC savings in the previous year to allow for that rollover. However, hypothetically if the survey had increased slightly in 2019 resulting in a higher cap of 1745 in 2020, there would have been a paradoxical effective cap and no rollover under a lower cap in 2019 followed by much higher PSC available for use in 2020 regardless of the usage in the previous year. This is something that is hypothetically possible under this option albeit not easily shown using straight historical data for this example. It is not clear to the analysts and should clarified by Council what objective this option is intended to achieve and how the efficacy of that could be evaluated.

Table 2-11 Example of Option 4 as applied to Alternative 3 through 2020, with hypothetical 2021-2022 values. 2015-2020 based upon observed historical survey states and resulting Look up table limit for Alternative 3 as shown in Table 2-8, with actual use 2015-2020. Note when actual use exceeded the Alternative 3 limit it was simply assumed that there was no possible rollover, greyed values indicate where the actual > limit). For 2021-2022 it was assumed that the setline survey value moved back into the "High" range after three years in the 'Low' state to show hypothetical possibility (in italics) of an increase in survey states after a decrease. Note that these limits are calculated based on the table limits (using the most recent survey year available, and not based on the Option 1, 3-year rolling average survey indices.

Year	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	***2021***	***2022***
PSC from lookup table	1745	1745	1745	1309	1309	1309	*1745*	*1745*
PSC use by A80	1404	1412	1167	1343	1461	1097	*1097*	
Remainder (Potential amount to rollover)	341	333	578	-34	-152	212	*648*	...
Maximum rollover possible	349	349	349	262	262	262	*349*	...
Effective PSC limit (lookup table PSC + rollover)	1745	2086	2078	1571	1309	1309	*1957*	*2094*
Difference in PSC limits	0	341	333	262	0	0	*212*	*349*

2.4 Historical Comparison of Alternatives

Figures and tables in this section are designed to provide an overall comparison of the limits and options across all of the alternatives when applied historically. A historical comparison of the PSC limits as a result of status quo with the proposed bands to indicate PSC limits across the action alternatives (Figure 2-5) shows that PSC limits historically have fallen within the upper limits of the proposed alternatives but not the lower bands included in the look up tables.

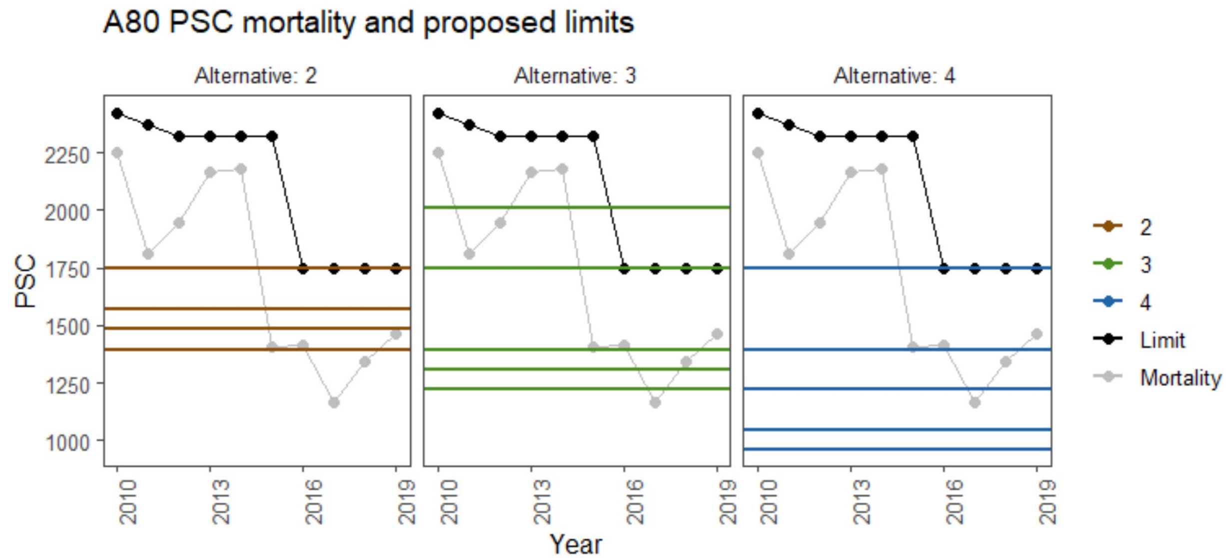


Figure 2-5 **Historical comparison of the status quo PSC limits compared with the solid bands (brown Alt2; green Alt 3; blue Alt 4) which indicate proposed PSC limit range across the look up table for each action alternative. Black line is the historical limit while grey indicates the actual PSC mortality. The status quo limit from 2016-present is 1,750 mt.**

Two options for constraining the inter-annual variability in the PSC limits are shown applied historically in Figure 2-6. Here there is more variability in the resulting PSC limit due to suboptions under Option 2 (constraining to less than 10% and 15% inter-annually) than the PSC limit resulting from a three-year survey average instead of the single year value.

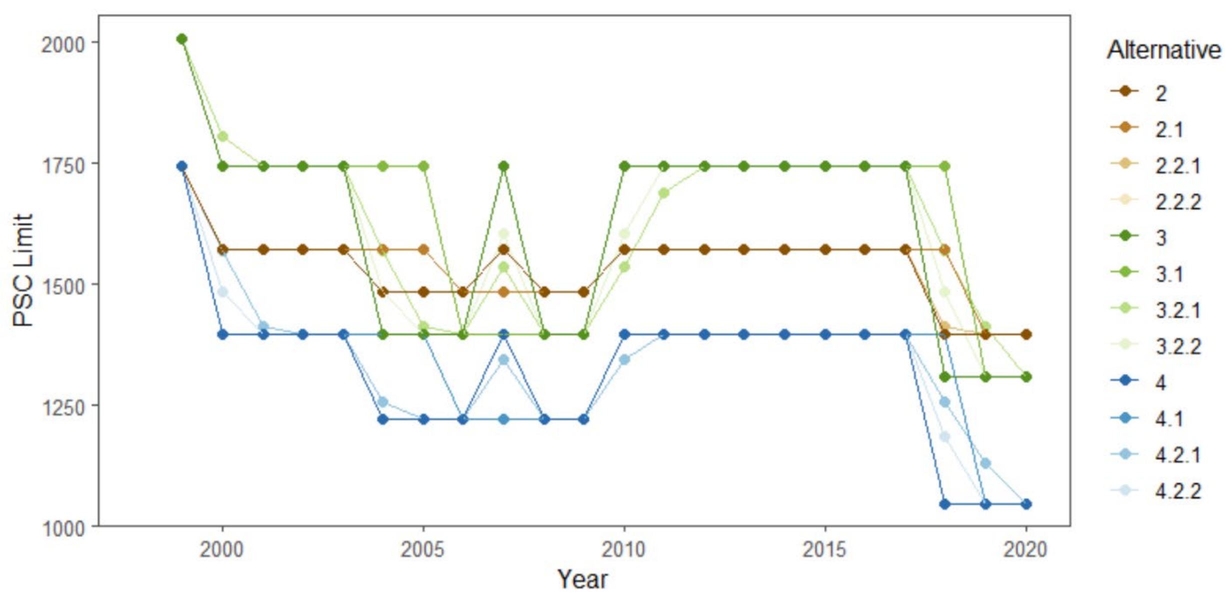


Figure 2-6 **Comparison of the PSC limits as a result of the historical application (1998-2020) of the three action alternatives and options 1 and 2. Here option 1 (denoted X.1; e.g. 2.1, 3.1) indicates the PSC limit when a 3-year rolling average is used instead of the single year survey value. Option 2 (denoted X.2.1 and A.2.2; e.g. 2.2.1, 2.2.2) indicates the PSC limit value resulting from constraining the inter-annual variability in the PSC limit to ≤10% (option 2, suboption 1) or ≤15% (option 2 suboption 2) .**

Table 2-12 shows a way to compare across the alternatives and survey states to provide a snapshot of what PSC limits will result from various combinations of states of each of the two surveys. Figures 2-1, 2-2 and 2-4 provide the historical context of what the observed values of these surveys have been and where that falls under the identified states (1998-2019). Additional information is provided in Table 2-13 as to the probability (based on simulation modeling) of the values of the individual survey falling into each of these designated states over a range of years.

Table 2-12 Comparison of PSC limits across all three action alternatives with the survey states necessary to achieve that limit.

	Alt 2				Alt 3				Alt 4			
	EBS		Setline		EBS		Setline		EBS		Setline	
PSC limit	State	Index	State	Index	State	Index	State	Index	State	Index	State	Index
960									low	<150,000	very low	<6,000
1047									low	<150,000	low	6,000-7,999
									high	>150,000	very low	<6,000
1222					low	<150,000	very low	<6,000	low	<150,000	medium	8,000-10,999
									high	>150,000	low	6,000-7,999
1309					low	<150,000	low	6,000-7,999				
					high	>150,000	very low	<6,000				
1396	low	<150,000	low	<8,000	low	<150,000	medium	8,000-10,999	low	<150,000	high	>=11,000
					high	>150,000	low	6,000-7,999	high	>150,000	medium	8,000-10,999
1483	low	<150,000	medium	8,000-10,999								
	high	>150,000	low	<8,000								
1571	low	<150,000	high	>=11,000								
	high	>150,000	medium	8,000-10,999								
1745	high	>150,000	high	>=11,000	low	<150,000	high	>=11,000	high	>150,000	high	>=11,000
					high	>150,000	medium	8,000-10,999				
2007					high	>150,000	high	>=11,000				

The simulation model results for Pacific halibut in the BSAI (as described in Chapter 5) were used to illustrate the probabilities of the different cells resulting from the look-up tables (Table 2-13, Figure 2-7). These cells represent different combinations of categorized IPHC setline survey and the EBS bottom trawl survey values. The simulations shown are for future PSC values set to the current status quo limit of 1,745 t. Near term (2021-2030), mid-term (2031-2060) and near-end period (2061-2100) were presented and compared to results over the entire simulation time frame (2021-2100). For the short-term simulation, 20% of the simulations were in the low BTS and very low setline survey state combination. The highest index categories for both surveys occurred in only in only 6% of the simulations for this period. However, evaluation over the whole period indicated a much higher proportion for the highest categories for both surveys.

Two of the three alternatives have the maximum PSC limit equal to the status quo limit (1,745 t). The maximum PSC limit in Alternative 3 is 2,007 t. In Chapter 6 we showed that simulation results are insensitive to the range of PSC removals considered in this suite of alternatives. For contrast we use the near-term and full-term scenarios under both status quo removals and no PSC to show the relatively small differences. This showed that the estimated probability of future values occurring in different cells of the PSC look-up table (Figure 2-7).

Table 2-13 Survey states, percentage of time model simulations over a range of time frames resulted in that combination of survey states and the PSC limits that result from those across alternatives

EBS		Setline		Proportion of simulations in each combination of survey states under status quo PSC				PSC limits		
State	Index	State	Index	2021-2030	2031-2060	2061-2100	2021-2100	Alt 2	Alt 3	Alt 4
low	<150,000	very low	<6,000	25%	14%	20%	18%	1396	1222	960
low	<150,000	low	6,000-7,999	17%	10%	11%	11%	1396	1309	1047
low	<150,000	medium	8,000-10,999	2%	7%	6%	6%	1483	1396	1222
low	<150,000	high	≥11,000	0%	2%	1%	1%	1571	1745	1396
high	>150,000	very low	<6,000	16%	4%	7%	7%	1483	1309	1047
high	>150,000	low	6,000-7,999	22%	11%	15%	14%	1483	1396	1222
high	>150,000	medium	8,000-10,999	12%	24%	22%	21%	1571	1745	1396
high	>150,000	high	≥11,000	6%	28%	19%	21%	1745	2007	1745

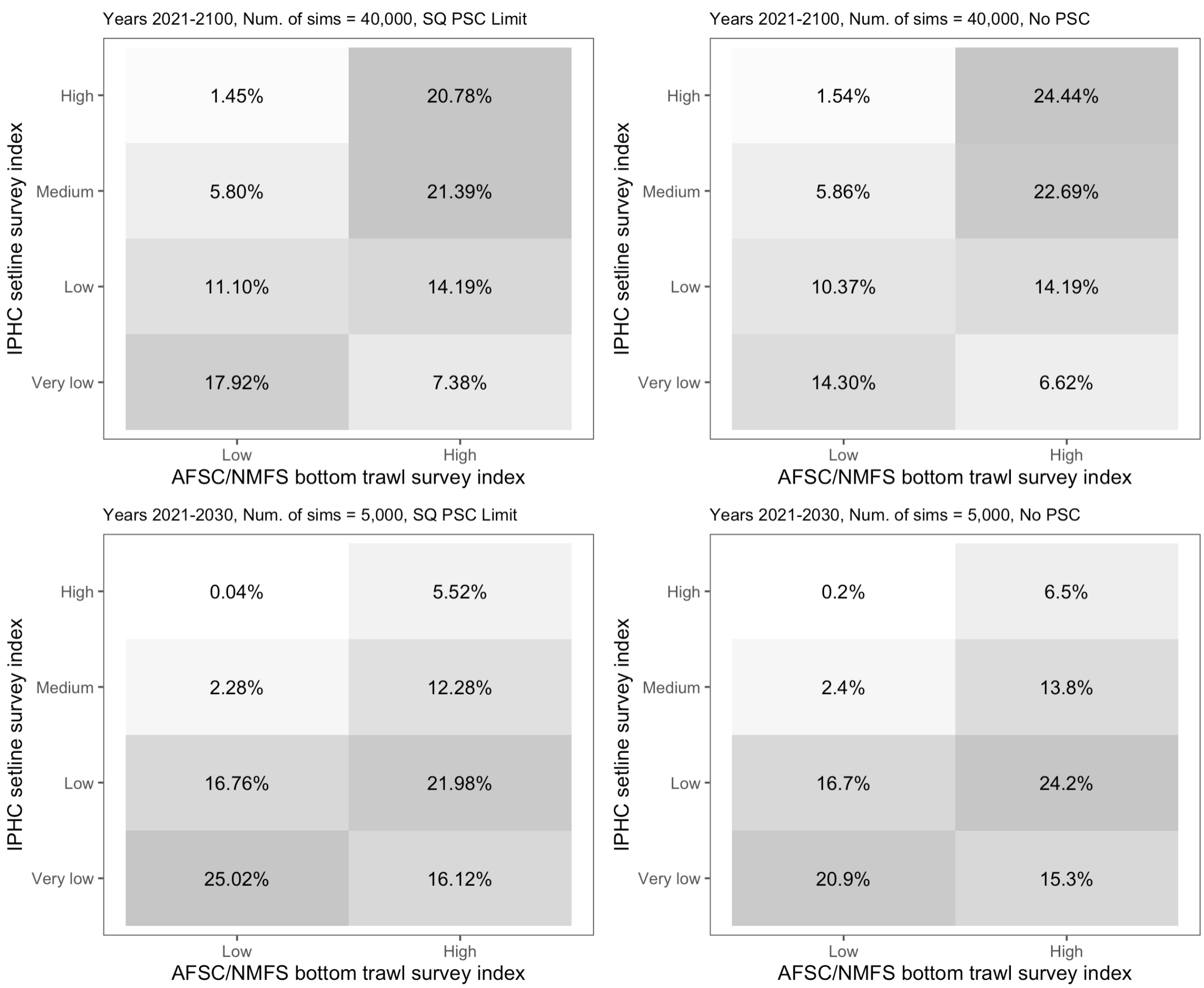


Figure 2-7 Proportion of short-term and long-term simulations (2021-2100 top row; 2021-2030 bottom row) in each of the combined alternative "states" of indices used to specify PSC Limits assuming the status quo PSC limit (left panels) and no PSC (right panels).

Table 2-14 shows the suite of PSC limits calculated historically (1999-2020) with the resulting PSC limits and annual limits under options 1 and 2 for comparative purposes across all alternatives. Also shown in shading and within the table is the mortality associated with the A80 sector from 2010-2020 and where the values in the tables for the alternatives historically would have been exceeded. The comparison of back calculated PSC limits and actual A80 PSC mortality in previous years are *for comparison purposes only*. *The analysts are not implying that the A80 sector would* *necessarily* *have been shut down during parts of those years* because fishery participants have the opportunity to make operational choices that might allow the sector as a whole to function under a lower limit. This is discussed further in Chapter 5. This table is shown here merely to compare calculated levels historically across all of the alternatives.

Table 2-14 Back-calculated PSC limits for Alternatives 2-4 and limits resulting from application of Options 1-3, , and A80 PSC use (highlighted cells = A80 sector would/could have reached the limit). Note that the limits for options 2 and 3 are calculated based on the table limits using the most recent survey year available, and not based on the Option 1, 3-year rolling average survey indices. Notations for options are as follows: Option 1 X.1 (e.g Alt 2 = 2.1); Option 2, suboptions 1 and 2 as X.2.1 (e.g. Alt 2.2.1); similarly, for options 3 suboptions 1 and 2 X.3.1 (e.g. Alt 2.3.1)

	Lookup tables			Option 1 3-yr rolling average			Option 2 varies ≤ 10% per year			varies ≤ 15% per year			Option 3 80% of lookup table			90% of lookup table				Amendmen
Alternative	2	3	4	2.1	3.1	4.1	2.2.1	3.2.1	4.2.1	2.2.2	3.2.2	4.2.2	2.3.1	3.3.1	4.3.1	2.3.2	3.3.2	4.3.2	**Limit**	**Encounter**
1999	1745	2007	1745	NA	NA	NA	1745	2007	1745	1745	2007	1745	1396	1606	1396	1571	1806	1571		
2000	1571	1745	1396	NA	NA	NA	1571	1806	1571	1571	1745	1483	1257	1396	1117	1414	1571	1256		
2001	1571	1745	1396	1571	1745	1396	1571	1745	1413	1571	1745	1396	1257	1396	1117	1414	1571	1256		
2002	1571	1745	1396	1571	1745	1396	1571	1745	1396	1571	1745	1396	1257	1396	1117	1414	1571	1256		
2003	1571	1745	1396	1571	1745	1396	1571	1745	1396	1571	1745	1396	1257	1396	1117	1414	1571	1256		
2004	1483	1396	1222	1571	1745	1396	1483	1571	1256	1483	1483	1222	1186	1117	978	1335	1256	1100		
2005	1483	1396	1222	1571	1745	1396	1483	1413	1222	1483	1396	1222	1186	1117	978	1335	1256	1100		
2006	1483	1396	1222	1483	1396	1222	1483	1396	1222	1483	1396	1222	1186	1117	978	1335	1256	1100		
2007	1571	1745	1396	1483	1396	1222	1571	1536	1344	1571	1605	1396	1257	1396	1117	1414	1571	1256		
2008	1483	1396	1222	1483	1396	1222	1483	1396	1222	1483	1396	1222	1186	1117	978	1335	1256	1100		
2009	1483	1396	1222	1483	1396	1222	1483	1396	1222	1483	1396	1222	1186	1117	978	1335	1256	1100		
2010	1571	1745	1396	1571	1745	1396	1571	1536	1344	1571	1605	1396	1257	1396	1117	1414	1571	1256	2,425	2,823
2011	1571	1745	1396	1571	1745	1396	1571	1689	1396	1571	1745	1396	1257	1396	1117	1414	1571	1256	2,375	2,277
2012	1571	1745	1396	1571	1745	1396	1571	1745	1396	1571	1745	1396	1257	1396	1117	1414	1571	1256	2,325	2,469
2013	1571	1745	1396	1571	1745	1396	1571	1745	1396	1571	1745	1396	1257	1396	1117	1414	1571	1256	2,325	2,677
2014	1571	1745	1396	1571	1745	1396	1571	1745	1396	1571	1745	1396	1257	1396	1117	1414	1571	1256	2,325	2,667
2015	1571	1745	1396	1571	1745	1396	1571	1745	1396	1571	1745	1396	1257	1396	1117	1414	1571	1256	2,325	1,719
2016	1571	1745	1396	1571	1745	1396	1571	1745	1396	1571	1745	1396	1257	1396	1117	1414	1571	1256	1,745	1,965
2017	1571	1745	1396	1571	1745	1396	1571	1745	1396	1571	1745	1396	1257	1396	1117	1414	1571	1256	1,745	1,976
2018	1396	1309	1047	1571	1745	1396	1413.9	1571	1256	1396	1483	1187	1117	1047	838	1256	1178	942	1,745	2,555
2019	1396	1309	1047	1396	1309	1047	1396	1413	1131	1396	1309	1047	1117	1047	838	1256	1178	942	1,745	3,067
2020	1396	1309	1047	1396	1309	1047	1396	1309	1047	1396	1309	1047	1117	1047	838	1256	1178	942		

* Option 2 and option 3 percentages calculated from lookup table limits based on survey values from the most recent year available (not option 1 limits based on 3-yr rolling average)

Shaded cells indicate back-calculated limit was less than A80 PSC mortality in that year

2.5 Annual process for specifying PSC limits under Alternative 2 - 4

Alternatives 2 through 4 would necessitate annually specified PSC limits for the Amendment 80 sector. This would occur during the annual groundfish harvest specifications process that begins with proposed specifications in October of each year and finalized specifications in December.

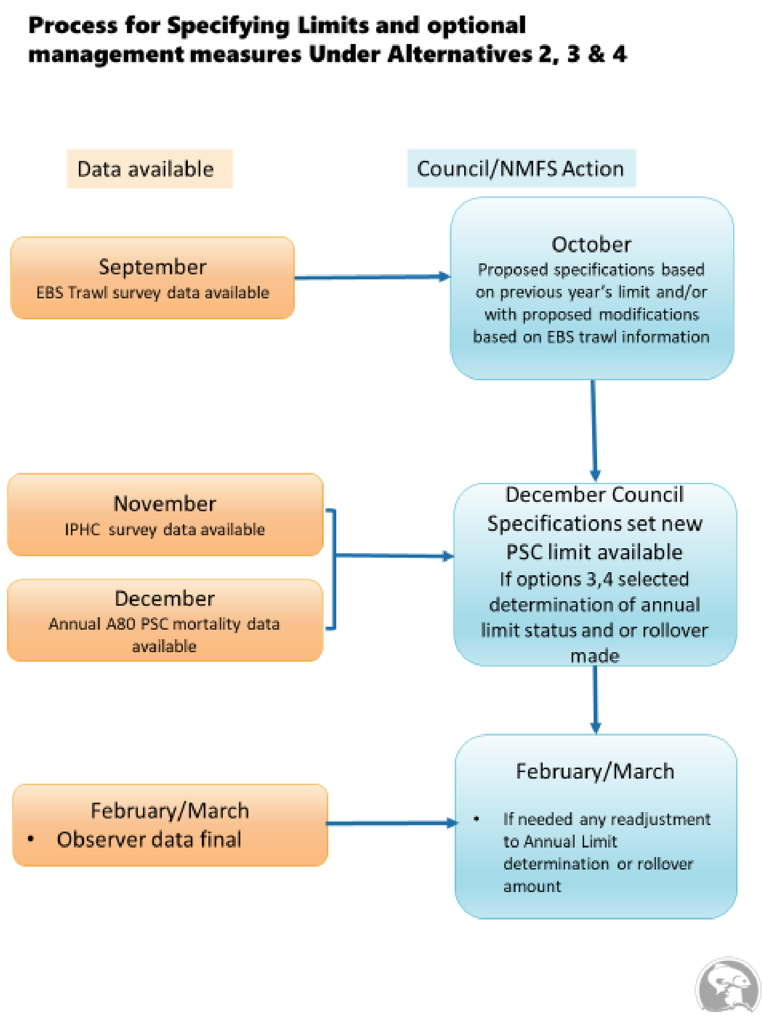


Figure 2-8 Annual process for specifying halibut PSC limits under Alternatives 2 and 3

As discussed in Section 1.6.1, **with the exception of 2020,** EBS trawl survey biomass estimates are available for the September Groundfish Plan Team meetings thus the trawl survey number for purposes of the look up table would be available at that time[10] and could be used for proposed specifications in the determination of a 'high' or 'low' EBS survey (above and below 150,000). However, IPHC setline survey estimates may not be available until late October or possibly late November because the survey is typically not completed until early September and time is needed to verify and model the data. Due to this, PSC limits set for proposed specifications at the October meeting would either be informed by the previous year's limits (as is standard practice for the other BSAI biomass-based PSC limits during

[10] See section 2.4 for considerations of no new survey data

proposed specifications when information to update the calculations is not yet available) or by the previous year's IPHC setline survey estimate combined with updated information on the EBS trawl survey estimate. This would be of particular importance if the trawl survey was nearing the threshold below or above 150,000 mt. Final specifications would be adopted at the December Council meeting for the subsequent fishing year. The specifications process under the action alternatives would be modified to incorporate an annually specified PSC limit for Amendment 80 but this can be accommodated within the process that is already in place as with other annually specified PSC limits in the BSAI groundfish specifications process. PSC limits would be annually determined. If either Options 1 or 2 are adopted, an additional calculation would need to be made prior to establishing the limit from the look up table to either average over the most recent three survey estimates (Option 1) or constrain any resulting PSC limit to less and either 10 or 15 percent of the previous year's limit (Option 2).

If the revised PSC limit in December is considerably lower than the one approved for opening the fishery in January these may be adjusted in-season as needed by NMFS. See Section 3.2.1 on NMFS authority for in season adjustments to start the fishing year prior to final specifications being approved in March. This is of particular importance in the event of lower limits from one year to the next.

For either Option 3 or 4, a determination of A80 PSC usage would be necessary prior to establishing if an annual limit was exceeded (Option 3) or what, if any, amount of PSC is available for a rollover (Option 4). This information is generally available immediately following the close of the fishery and should be available in time for final specifications in December. However, while the A80 data is unlikely to be modified substantially after the fishing season concludes, observer data may not be fully debriefed until February or March of the following year. The management consequences of any A80 PSC mortality revisions depend on the direction and the magnitude of the change.

Under Option 4, if the magnitude of a PSC change is small (e.g. 50 tons) and would not affect a rollover under Option 4 then a straightforward data update would occur and would have no consequences. Year-to-year PSC rollovers amounts – i.e., the increase in the effective limit relative to the limit defined in the look-up table – can be thought of as appending onto the end of the fishing year in terms of when PSC is used. History indicates that the final rollover amount would not need to be settled in order for NMFS to manage the first one or two months of the A80 fishery.

Post-season adjustments to A80 PSC mortality based on observer debriefing could complicate the application of Option 3, *but only in a narrow set of circumstances*. In most cases, the status of the 3-years-out-of-7 rule for Option 3 will be known in advance – the A80 sector will either be at the look-up table limit or capped at the 'annual limit' in the following year based on past performance relative to the annual limit in the six preceding years. However, *if* the status of the 3-out-of-7 rule is in question *and if* the inseason estimate of A80 PSC (prior to debriefing and reconciliation) is near the 'annual limit', then it could be unclear whether A80 will be fishing under the look-up table limit or the 'annual limit' in the upcoming season when the Council is considering final harvest specifications in December.

2.6 Considerations in the circumstance of no new survey data

In 2020 the annual EBS trawl survey and the IPHC EBS survey component were cancelled due to the COVID-19 pandemic crisis and a reduced survey effort was completed in the GOA and other regions. As of this writing, it is unknown if surveys will occur as regularly planned in 2021. In the absence of new data in any given year under any of the alternatives, the Council may wish to set the limits at the PSC limit from the previous year. Should there be multiple years without additional survey data the Council could consider an adjustment to the limit (higher or lower) depending upon the trend in survey data from previous years. **The Council should clarify how it would set annual PSC limits in the absence of one or more years of survey data.**

2.7 Alternatives considered but not carried forward for analysis

An initial review DEIS was presented to the Council in October 2020. At that time a more complex formulation of 2 and 3-dimensional control rules were considered for a range of starting points and slopes for establishing halibut PSC limits. At that time a discussion paper was also presented which provided, among other considerations, a more simplified approach to setting PSC limits indexed to abundance using look up tables. Following Council review of both the discussion paper and DEIS in October 2020, the Council chose to provide a more simplified approach to setting PSC limits. Therefore the previous complicated set of Alternatives, Elements and Options which had been under development for several Council meetings (see Table 1-2) was replaced by the current alternative set and the Council's Purpose and Need for this action was revised. As a result of that revision the previous 5 inferred objectives derived from the Purpose and Need for were superseded by the focus upon adhering to balancing the National Standards as noted in the Council review.

Previously the Council had considered a broader alternative set which considered linking PSC limits to abundance for all sectors including the fixed gear sector, TLAS and the CDQ. Due to the fact that the Amendment 80 sector comprises the majority of the halibut PSC mortality, in February 2020 the Council narrowed the focus of the analysis to be an action only for the Amendment 80 sector. This was in contrast to the broader suite of alternatives and application to all four sectors considered in the preliminary review DEIS presented to the Council in October 2019[11]. These Alternatives had ranged from status quo with fixed halibut PSC limits by sector to a range of complex gear-specific PSC limits linked to BSAI halibut abundance for all sectors. Under the previous alternative set PSC limits would be established for all sectors by gear type (aggregate trawl PSC limit and an aggregate non-trawl PSC limit) using a control rule applied to one or two biomass indices (EBS trawl and IPHC setline). Sixteen sub-alternatives were analyzed to demonstrate a range of stakeholder proposals as well as additional scenarios to show the behavior of different combinations of Elements and Options.

Additional alternatives and concepts that have been considered in previous iterations of this ABM action are listed below:

Indices of abundance: A wide range of different indices were considered for linking halibut abundance to halibut PSC in the development of alternatives prior to selecting the EBS Trawl survey and the IPHC setline survey for the alternatives. Additional indices considered include the EBS slope survey, the GOA bottom trawl survey, the AFSC longline survey and the IPHC coastwise assessment results. Different size categories of halibut from these surveys were also considered to develop a 'juvenile index' of abundance. In addition, a number of fishery catch-per-unit-effort indices were also considered. The Council also considered indices in numbers instead of biomass. Additional information and correlation amongst these various indices are contained in Appendix 2 of the October 2019 DEIS. The SSC determined that the most appropriate indices for indexing PSC limits to abundance are the EBS trawl survey and the IPHC Setline survey.

Simplified bycatch control rules: In April 2016, an appendix to a discussion paper proposed some simplified bycatch control rules (referred to as BCRs). These proposed BCRs included a ratio of historical bycatch to indices of abundance from the IPHC setline survey and the EBS trawl survey as well as consideration of target spawning biomass and weighted based upon the previous year's PSC limit. These concepts were not carried forward by the Council at that time.

Extension to the GOA: The Council briefly considered extending the ABM analysis to include the Gulf of Alaska but deferred further consideration of this to after the Bering Sea ABM PSC action was completed.

[11] October 2019 Halibut ABM analysis

2.8 Policy tradeoff and decision points

In constructing a preferred alternative (PA) or preliminary preferred alternative (PPA), there are a number of Alternatives and options to select from as well as policy tradeoffs to be considered. This section describes the decision-tree for the construction of a PPA as well as policy-level considerations with respect to the MSA National Standards in doing so. Up to three steps are necessary to create a PPA as shown in Figure 2-9. As described previously, there are three action alternatives in this analysis, in addition to the Status quo (Alternative 1). These action alternatives, if selected, would modify the Amendment 80 PSC limit to establish an annual process for PSC limit-setting based on a look up tables framed by survey states. Next, the Council may choose to select additional options in addition to the specific action alternative to either smooth the inter-annual variability in the PSC limit (options 1 and 2) or add additional incentives or flexibility regarding PSC usage (Options 3 or 4). Of these Option 4 is mutually exclusive with the selection of either Options 2 or 3. Finally, Options 2 and 3, if selected, require the Council to select a specific suboption.

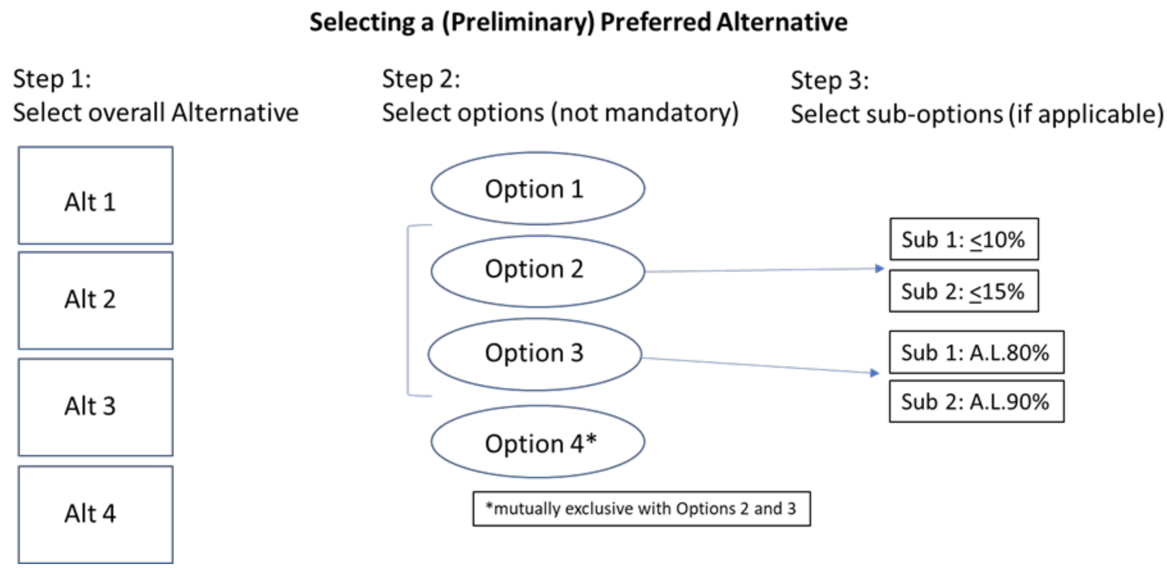


Figure 2-9 Iterative steps in selecting amongst Alternatives and Options for creating a preferred alternative. Note that neither Option 1 nor 4 have additional sub-options associated with them and that the selection of Option 4 is mutually exclusive with the selection of Options 2 and 3.

One of the policy tradeoffs of this management action is the relative trade-off between National Standard 1 (achieve Optimum Yield, in this case for groundfish harvest) and National Standard 9 (minimize bycatch to the extent practicable, in this case for halibut). Based on evaluations in Chapter 5.5, and as a very gross approximation, under the assumption of random or average usage from 2016-2019, the Amendment 80 sector is most likely to be limited by PSC usage below cap levels of 1,396 t and more likely to be limited by TAC constraints at levels of 1,396 t and above. None of the possible PSC limit outcomes under Alternative 2 fall below 1,396 t, while under Alternative 3 those outcomes occur only at the two lowest tiers of the IPHC setline survey index. Therefore, Alternatives 2 and 3 provide the most flexibility for fishing operations to achieve optimum yield both at lower halibut biomass levels and particularly at higher biomass survey states. Alternative 4 is more likely to result in a PSC limit below 1,396 t except at the higher levels of both surveys. Options 3 and 4 provide incentives for the A80 fleet to reduce halibut bycatch beyond what is provided by the PSC limit to avoid forgone harvest opportunities throughout the sector's multispecies fishing year. Additional information on the practicability of fishing operations at lower PSC limits is provided in Chapters 3 and 5. Policy decisions balancing NS1 and NS9 must address the ability of the fleet to catch their quota while minimizing bycatch to the extent practicable.

To provide some additional insight into the likelihood of the state of halibut biomass into the future, survey states and their probability of occurrence were simulated for short-term and long-term time frames (Table 2-13). In the short-term (2021-2030), the most likely survey states will remain at the lower end of the IPHC setline survey and vary between low and high levels of the EBS trawl survey. This means that the lowest levels of PSC limits under all alternatives are likely in the near-term. Figure 2-10 illustrates the cross section of the most likely long- and near-term survey outcomes from the simulation, as well as which levels of PSC limit under the various alternatives are likely to cause the primary constraint on groundfish harvest.

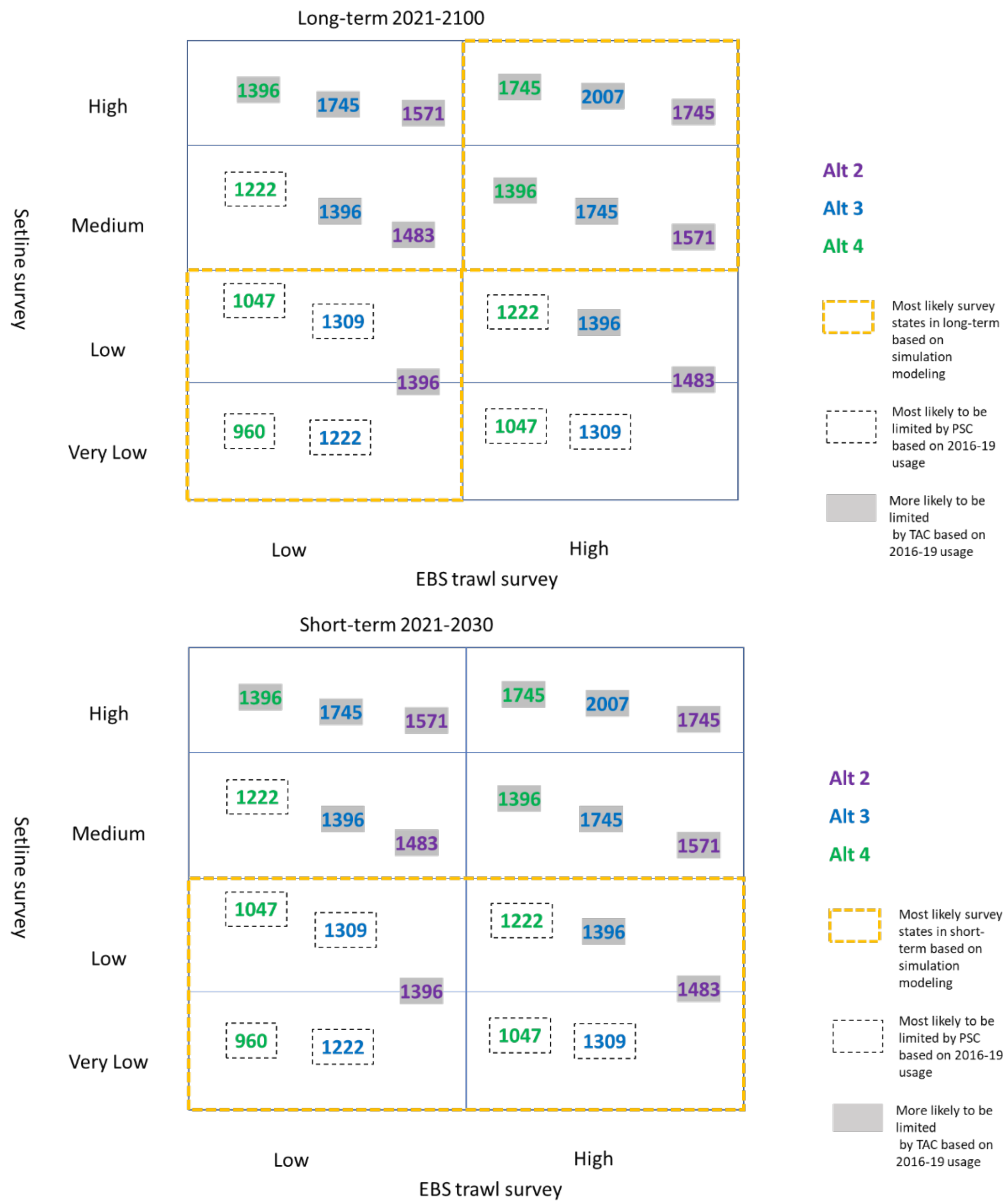


Figure 2-10 Simulated survey states and long-term (upper panel) and short-term (lower panel) PSC limits by Alternative. Here the dotted yellow lone indicates the most likely survey state for that time frame based on the simulation. Based on the groundfish revenue examination in Chapter 5.5, PSC limits (assuming usage from 2016-2019) are more likely to be constraining below 1396 t while TAC is more limiting at PSC limits above 1396 t.

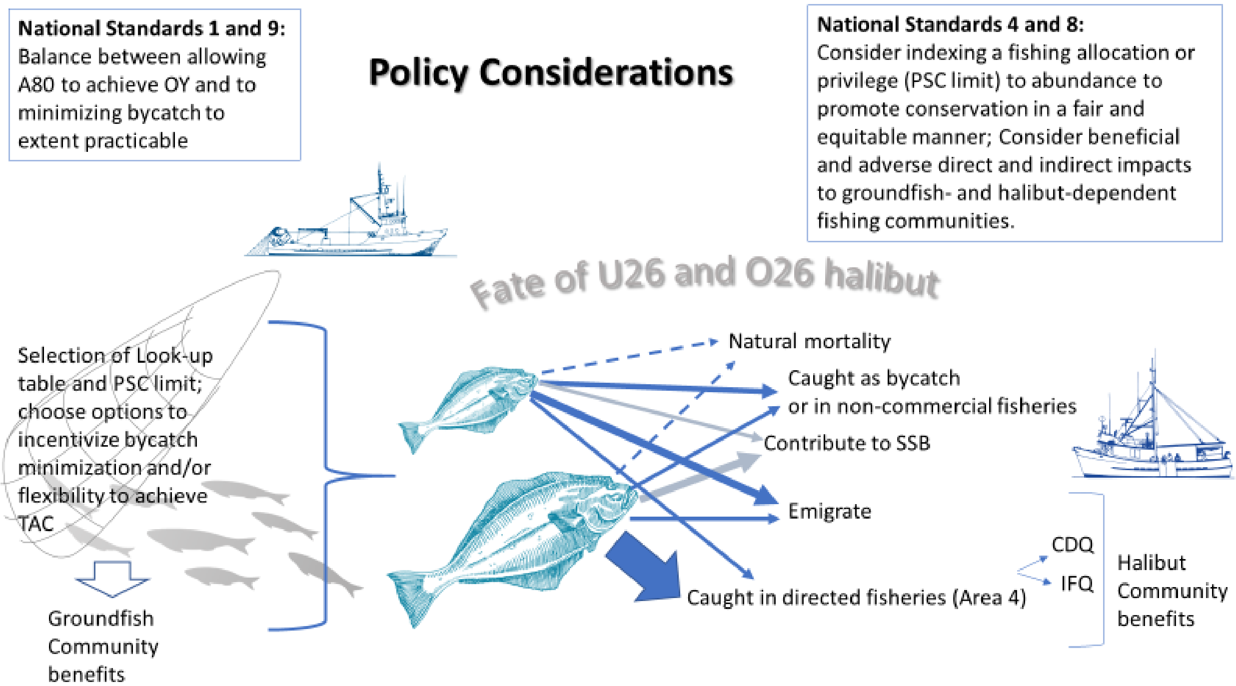


Figure 2-11 Schematic of trade-offs in considerations of some key National Standards based on the relative fate of O26 and U26 halibut. Here the width of the blue arrows represents relative magnitude of removals between O26 and U26 fish. Grey arrows show that contribution to SSB is from both sources but unknown magnitude while dotted lines for natural mortality indicate that it is considered equivalent between older and younger fish but is in fact an unknown quantity.

Other policy tradeoffs stemming from the National Standards include consideration of National Standards 4 (allocate fishing privileges (in this case, a halibut PSC limit that varies with abundance) in a manner that is fair and equitable to all U.S. fishermen) and 8 (take into account the importance of fishery resources to fishing communities, in this case both groundfish- and halibut-dependent communities, and minimize adverse economic impacts on such communities) (Figure 2-11). Options are provided to further incentivize bycatch reduction beyond what is provided by the PSC limit itself in order for the A80 fleet to mitigate their halibut PSC such that they may avoid forgone harvest opportunities throughout the sector's multispecies fishing year. Additional information on how all of the alternatives under consideration address each of the ten National Standards is contained in Section 7.1.

3 Groundfish Stock Status and Amendment 80 Fishery Description

3.1 Description of Groundfish resources

The Council recommends annual catch limits, allocations, and PSC limits for the federally managed commercial groundfish fisheries in the BSAI. Target species managed in the BSAI FMP include: walleye pollock, Pacific cod, sablefish, various flatfishes (yellowfin sole, Greenland turbot, arrowtooth and Kamchatka flounders, northern rock sole, flathead sole, Alaska plaice, and others), various rockfish species (Pacific ocean perch, northern rockfish, rougheye and blackspotted rockfish, shortraker rockfish, and others), Atka mackerel, skates, sculpins, sharks, squids, and octopuses. Among the BSAI groundfish fisheries managed under the FMP is the sector that would be directly regulated by the action alternatives under consideration: the BSAI non-pollock trawl CP sector, commonly referred to as Amendment 80 (A80). This section of the DEIS describes how BSAI groundfish are assessed and managed, as well as the manner in which the A80 sector has operated since its implementation in 2008.

This document focuses on the A80 sector from among the several BSAI groundfish fisheries due to the narrowed scope of the proposed action alternatives. The preliminary analysis that was reviewed by the Council in October 2019 provided background on the other BSAI groundfish fisheries for which halibut PSC limits are established (NPFMC 2019a; Section 3). That information is incorporated here by reference. Those fisheries include the trawl limited access sector (TLAS), the hook-and-line CP sector (HALCP; often referred to as the Freezer Longline Coalition cooperative or FLC), the hook-and-line CV sector (HALCV), and the groundfish and PSC allocations made to Community Development Quota (CDQ) groups which are fished using a variety of gear types (trawl, HAL, pot) on vessels owned by the groups or in partnership with other groundfish harvest companies.

Annual Stock Assessment Fishery Evaluation (SAFE) report and Ecosystem Status Report (ESR) for 2020

The annual BSAI Groundfish SAFE Report (NPFMC 2020b), which is considered by the Council during its annual December meeting when determining the biennial final harvest specifications, provides a detailed discussion of the status of individual groundfish stocks, and is incorporated here by reference. The Council also receives an Ecosystem Status Report (ESR) on an annual basis in conjunction with setting harvest specifications. Given the lack or surveys in 2020, a brief summary of environmental conditions in 2019 is summarized below (excerpted from the ESR portion of the 2019 SAFE Report Introduction; NPFMC 2019b).

2019 represented the warmest bottom temperatures on record for the EBS, including unpreceded warm conditions in the inner domain, it is also a second winter in a row of low sea ice in NBS, with “physics to fisheries” impacts on the cold pool through fish distributions (juveniles and adults). Sea ice extent was anomalously low in the winter of 2018/2019 (despite an early near-normal ice extent through Jan. that rapidly retreated in Feb. 2019). As a result, there was a small cold pool in the NBS (only slightly larger than 2018). The zooplankton prey base in 2019 was dominated by small, lipid poor copepods and there was a low abundance of lipid rich large copepods and euphausiids. This shift in prey base has potential impacts on the carrying capacity of the system, especially for newly recruited juvenile fish. In contrast to previous years, there were below average coccolithophore blooms in 2019. The spring bloom was ~9 d earlier than normal, and jellyfish abundance continued to increase.

Upper trophic level responses were mixed. There was declaration by NOAA of an Unusual Mortality Event (UME) due to 200+ emaciation-caused deaths of gray whales migrating back to the EBS. This reflects the poor 2018 foraging conditions; in the EBS gray whales feed on amphipods, mysids, crab larvae, and are in potential competition with groundfish in the NBS. Similarly, short-tailed shearwater die-offs were observed in 2019, reflective of 2018 foraging conditions (e.g., euphausiids) in the EBS before making migrations. Like previous years, ice seals continued to be impacted by lack of sea ice. A

NOAA UME was also declared for Ice Seals in 2019. Like gray whales, many carcasses were young animals that were in poor condition or emaciated, and pups exhibited a decline in condition (blubber thickness), possibly reflecting competition with fish in the NBS and lack of ice.

In contrast, conditions likely improved in 2019 for other upper-trophic consumers like seabirds (except short-tailed shearwaters). Seabirds may have been successful at finding lipid rich copepods and euphausiids, even though abundances were low, competition for available prey may have been reduced as a result of shearwater mortality and/or poor recruitment events for fish species. Colonies at the Pribilof Islands may have benefited from northward shifts in fish populations. There remains a high level of concern regarding food security for local communities in Alaska that rely on subsistence resources including seabirds.

Similarly, fish condition in the SEBS survey in 2019 was above average. Multiple groundfish stocks like pollock appear to be persisting through warm conditions and/or are utilizing cold water refugia in the Northern Bering Sea. For example, the pollock 2018-year class appears strong, Pacific cod biomass continue to increase in the NBS, and groundfish condition across multiple species increased from 2018. Groundfish biomass in the NBS continued to increase (30% since 2017) as did abundance (52% increase relative to the 2017 survey). Abundance in the SEBS increase 112% from 2018 while biomass increased slightly (2% relative to 2018). There was indication of recruitment of some key fish species in both areas (e.g., Pacific cod). Juvenile Walleye pollock (age 0) pollock were captured in the NBS, and the SEBS saw a 75% increase in juvenile pollock biomass. Other species show mixed responses. Bristol Bay sockeye had the 4^{th} largest return since 1963; crab biomass is down, likely reflecting multiple years of benthic productivity, difference in larval recruitment, and changes (increase) in predation. The OSCURS model based index of on-shore transport (key for flatfish recruitment) showed high on-shore transport, which is in contrast to previous years of offshore or little-onshore transport. For pollock, below average recruitment is projected from age 0 energy density, diet energy density, and surface silicic acid, while the temperature change index indicates increased recruitment. Combination of reduced predation and increased productivity may have led to increased survival (based on CEATTLE).

Overall, despite anomalous environmental conditions, the present status of the BSAI stocks continues to appear mostly favorable. Nearly all stocks are above their target levels (Figure 3-1). The abundances of EBS pollock, EBS Pacific cod, all rockfishes managed under Tier 3, and all flatfishes managed under Tiers 1 or 3 are projected to be above their target biomass levels in 2020 (B_{MSY} or the B_{MSY} proxy of $B_{35\%}$) in 2020 while sablefish and blackspotted/rougheye rockfish remain below this target level.

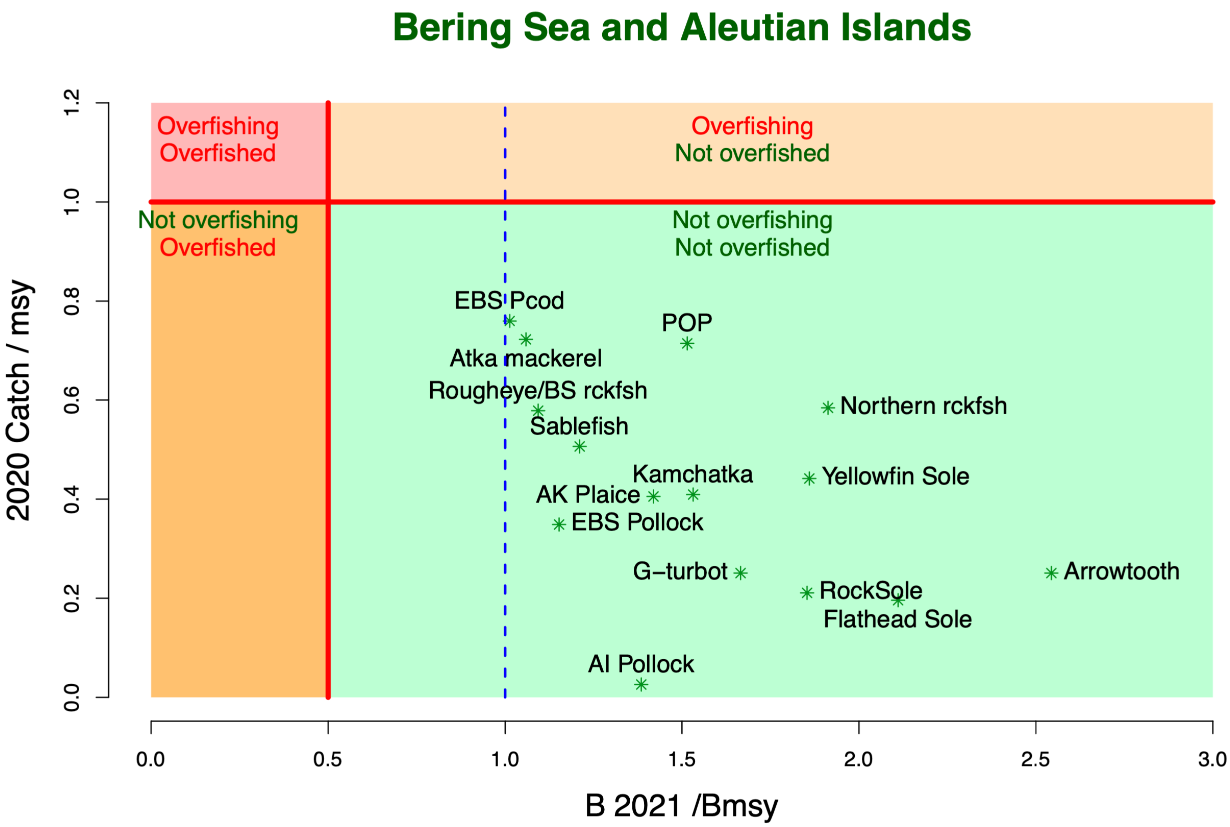


Figure 3-1 Summary of Bering Sea stock status 2021 (spawning biomass relative to Bmsy; horizontal axis) and 2020 year catch relative to fishing at Fmsy (vertical axis) where F_{OFL} is taken to equal F_{MSY}.

Across all gear types and sectors, total commercial groundfish catch levels (TACs) in the BSAI are capped at 2 million metric tons each year; the cap corresponds to the upper limit on the optimum yield in the BSAI FMP. The 2 million metric ton constraint is well below the sum of ABCs for the FMP groundfish species. For example, the sum of 2020 groundfish FMP species' ABCs is 3,272,581 t. In 2019 the sum of ABCs was 3,367,578 t; the TAC was set at 2,000,000 t and total catch was 1,957,943 t. Figure 3-2 and Table 3-1 show total BSAI groundfish harvest (t) by species or species group from 2004 through 2019.[12] Figure 3-3 shows the relative percentage of harvest for each species or species group. Total catch has consistently approached the 2 million ton cap, excepting the period from 2008 through 2010 when TACs were set lower and may have been suppressed by the demand impact of a broad economic recession in addition to lower pollock TAC.[13] Pollock has always accounted for the largest share of groundfish catch (roughly 70% since 2015, up from 60% to 65% from 2008 through 2012). The figures break out yellowfin sole from other flatfish. Yellowfin sole has accounted for roughly 7% to 10% of total groundfish catch during the analyzed period, while all other flatfish combine to account for roughly 4% to 7%. Within the BSAI flatfish category, yellowfin sole accounted for an average of 55% of catch from 2004 through 2019, and that proportion has been above 60% since 2016.[14] Other notable trends in the most recent years include an increase in the harvest of rockfish species and sablefish. Rockfish catch reached 54,657 t in 2019 while the period's annual average prior to that year was 28,000 t. Sablefish catch

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[12] "Other species" include sculpins, skates, sharks, squid, and octopus.

[13] Total TAC was 1.84 million t in 2008, 1.68 million t in 2009, and 1.68 million t in in 2010 before increasing to 2.0 million t in 2011.

[14] Other flatfish include arrowtooth flounder, Bering flounder, Alaska plaice, Kamchatka flounder, starry flounder, rock sole, rex sole, flathead sole, petrale sole, dover sole, English sole, butter sole, and Greenland turbot,

volume remains small compared to the entire BSAI cap but increased from 85 t in 2015 to 3,070 t in 2019.

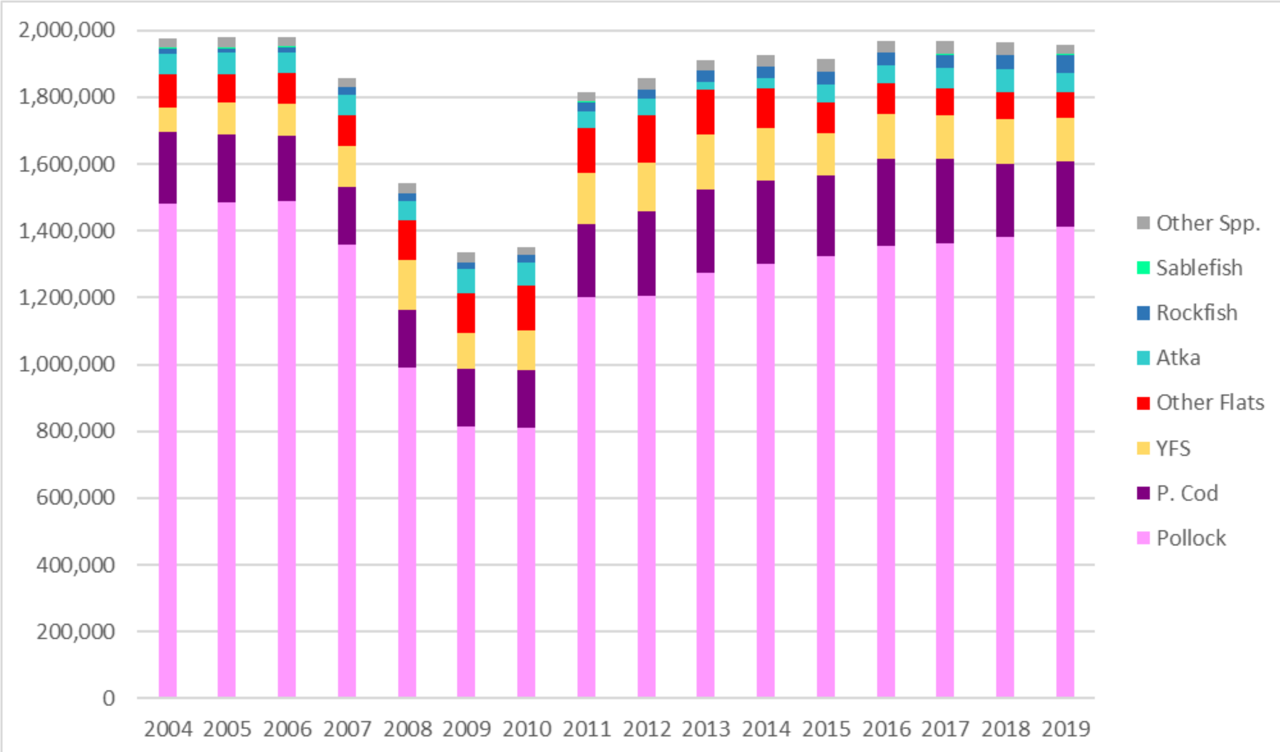


Figure 3-2 BSAI catch (metric tons) by species or species group across all gear types and sectors, 2004 through 2019

Table 3-1 BSAI catch (1,000 metric tons) by species or species group across all gear types and sectors, 2004 through 2019

Year	Pollock	P. Cod	YFS	Other Flats	Atka	Rockfish	Sablefish	Other Spp.	Total
2004	1,482	213	76	99	61	18	0.9	30	1,977
2005	1,485	205	94	85	62	15	1.3	30	1,979
2006	1,490	193	99	89	62	17	1.0	28	1,979
2007	1,357	174	121	94	59	23	1.0	28	1,857
2008	992	171	149	121	58	22	0.7	30	1,542
2009	813	176	108	118	73	19	0.6	28	1,334
2010	812	172	119	134	69	23	0.7	23	1,352
2011	1,200	220	151	134	52	28	0.5	29	1,815
2012	1,206	251	147	143	48	28	0.6	31	1,855
2013	1,274	250	165	132	23	35	0.6	33	1,912
2014	1,300	249	157	119	31	36	0.4	34	1,927
2015	1,323	242	127	92	53	40	0.1	36	1,913
2016	1,355	261	135	90	54	37	0.4	36	1,968
2017	1,361	253	132	79	64	38	1.1	39	1,968
2018	1,381	220	132	81	70	42	1.7	38	1,965
2019	1,411	198	128	79	57	55	3.1	26	1,956
Average	1,265	215	127	105	56	30	1	31	1,831

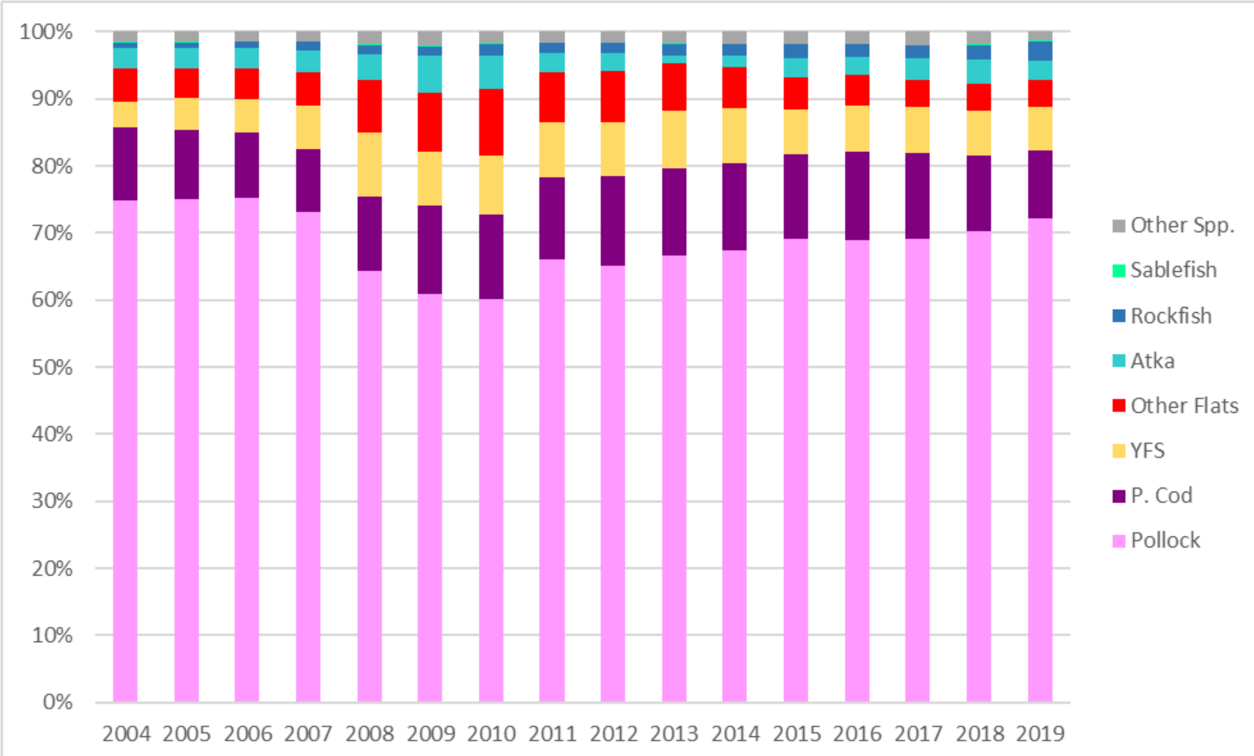


Figure 3-3 Percentage share of total BSAI groundfish catch by species or species group (all gear types and sectors), 2004 through 2019.

Additional information on Pacific cod and flatfish stocks is provided below to augment the information available in SAFE reports for consideration in the impacts of alternatives based upon the combination of stock trends, TAC-setting, and alternative halibut PSC limits for the A80 sector, which is sometimes operationally constrained by its allocation of the BSAI Pacific cod TAC.

3.1.1.1 Pacific cod

Pacific cod is distributed widely over the eastern Bering Sea (EBS) as well as in the Aleutian Islands (AI) area. Tagging studies (e.g., Shimada and Kimura 1994) have demonstrated significant migration both within and between the EBS, AI, and Gulf of Alaska (GOA). However, recent research indicates the existence of discrete stocks in the EBS and AI (Canino et al. 2005, Cunningham et al. 2009, Canino et al. 2010, Spies 2012). Research conducted in 2018 indicates that the genetic samples from the NBS survey in 2017 are very similar to those from the EBS survey area, and quite distinct from samples collected in the Aleutian Islands and the Gulf of Alaska (Spies et al. 2019).

Although the resource in the combined EBS and AI (BSAI) region had been managed as a single unit from 1977 through 2013, separate harvest specifications have been set for the two areas since the 2014 season.

Cod was managed as a single BSAI stock through 2013 with an increasing population trend through 2012. Beginning in 2014 separate catch specifications have been set for the Aleutian Islands (AI) cod population and the Bering Sea (BS) cod population. Catch specifications and population estimates for AI cod are based on survey biomass trends in the AI which have increased slightly in recent years. Nevertheless, the OFL and ABC have remained constant since 2019 at 27,400 and 20,600 respectively (Thompson et al. 2019b).

Catch specifications for EBS Pacific cod – OFL, ABC, and TAC – have declined for the last several years due to overall estimated population declines (Table 3-2). In setting TACs for both the AI and BS, the

Council takes into consideration the State GHL fishery (See Section 3.2.1.2 for additional information on cod allocations and reductions for State GHL fisheries).

Table 3-2 Catch specifications for BS cod 2017-2020

Year	Age 0+ biomass	OFL	ABC	TAC
2017	1,260,000	284,000	239,000	223,704
2018	918,000	238,000	201,000	188,136
2019	824,000	216,000	181,000	166,475
2020	751,708	185,650	155,873	141,799

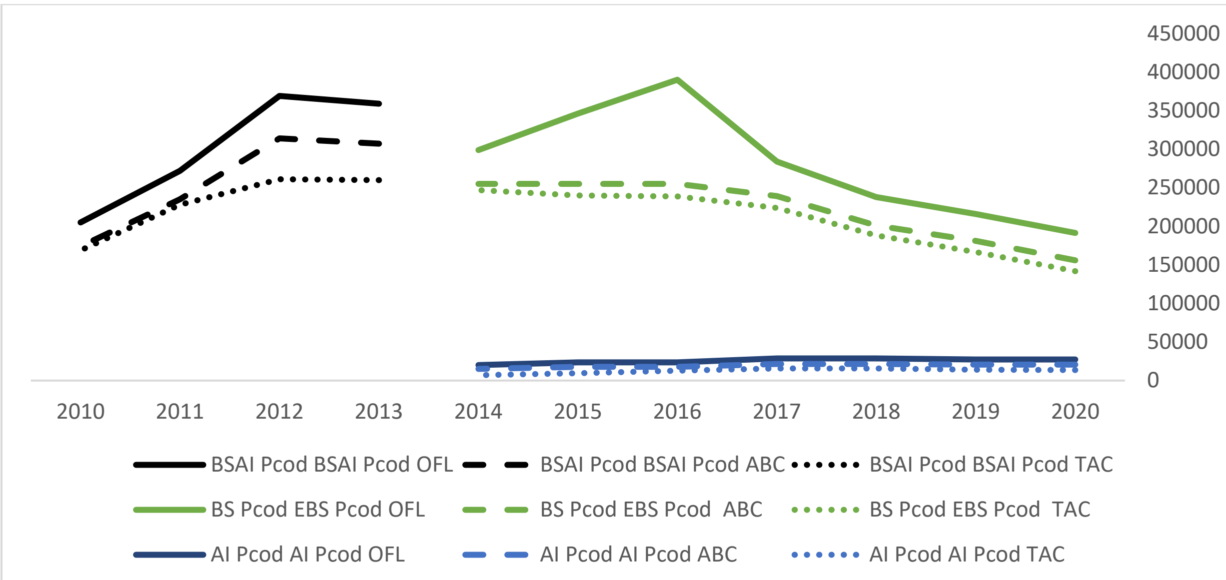


Figure 3-4 BSAI, Eastern Bering Sea (EBS) and Aleutian Island (AI) Pacific cod OFL, ABC and TAC 2010-2020 (break between 2013 and 2014 reflects the switch to specifying harvest by BS and AI separately).

3.1.1.2 Flatfish stocks

Key harvested flatfish species in the BSAI include yellowfin sole, northern rock sole, flathead sole and Alaska Plaice. All of these stocks are currently well above their target Bmsy stock size (Figure 3-1). TACs for flatfish stocks have been set well below their ABC levels due to a variety of harvesting constraints including both market and halibut bycatch considerations. Yellowfin sole continues to comprise the majority of flatfish harvested in the BSAI; northern rock sole the second is the second most harvested BSAI flatfish.

OFL, ABC and TACs in recent years for yellowfin sole and northern rock sole are shown in Figure 3-5 and listed in Table 3-3 and Table 3-4. Biomass for each year corresponds to the projection given in the SAFE report issued in the preceding year. With the exception of Greenland turbot, all flatfish stocks have specifications managed at the BSAI-wide level (Table 3-5).

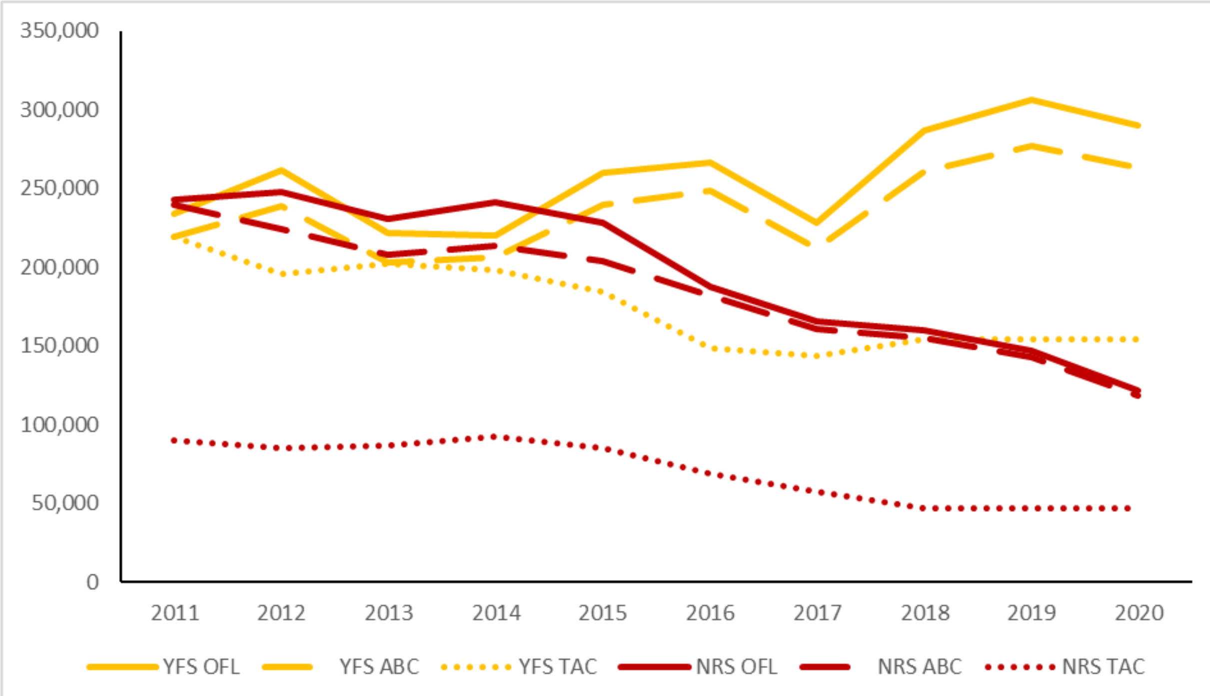


Figure 3-5 **OFL, ABC and TAC levels for yellowfin sole and northern rock sole**

Table 3-3 **Catch specifications for yellowfin sole 2017-2020**

Year	Age 6+ Biomass	OFL	ABC	TAC
2017	2,290,000	287,000	260,800	154,000
2018	2,553,100	306,700	277,500	154,000
2019	2,462,400	290,000	263,200	154,000
2020	2,461,850	287,943	260,918	150,700

Table 3-4 **Catch specifications for northern rock sole 2017-2020**

Year	Age 6+ Biomass	OFL	ABC	TAC
2017	1,000,600	159,700	155,100	47,100
2018	923,200	147,300	143,100	47,100
2019	828,000	122,000	118,900	47,100
2020	1,068,000	157,300	153,300	47,100

3.2 Management of the NMFS groundfish fisheries

3.2.1 Groundfish harvest specification process

This section provides an overview of the BSAI groundfish specifications and management process for all managed stocks as they are set in a single Council consideration during the December Council specifications process. This considers all groundfish sectors including pollock. Details on the Amendment 80 sector allocations and management are contained in a follow up section (Section 3.3).

The groundfish fisheries in Federal waters off Alaska are managed under the Fishery Management Plan for Groundfish of the Bering Sea and Aleutian Islands Management Area (BSAI FMP) and the Fishery Management Plan for Groundfish of the Gulf of Alaska (GOA FMP). In the Bering Sea and Aleutian

Islands (BSAI) and Gulf of Alaska (GOA), groundfish harvests are managed subject to annual limits on the amounts of each groundfish species or species group that may be taken. The annual harvest specifications also set or apportion the PSC limits. The annual limits are referred to as "harvest specifications," and the process of establishing them is referred to as the "harvest specifications process." The intended effect of these actions is to conserve and manage the groundfish resources in the BSAI in accordance with the MSA. The U.S. Secretary of Commerce approves the harvest specifications based on the recommendations of the Council. The goals of the harvest specifications process are to (1) manage fisheries based on the best scientific information available, (2) provide for adequate prior public review and comment on Council recommendations, (3) provide for additional opportunity for Secretarial review, (4) minimize unnecessary disruption to fisheries and public confusion, and (5) promote administrative efficiency.

At their October meeting, the Council recommends the proposed groundfish and PSC limits for the groundfish fisheries of the BSAI, and NMFS publishes them in the Federal Register. If only the EBS trawl survey data is used to translate into index values, then the final PSC limits would be known at the October Council meeting and published in the proposed harvest specifications.

Regulations at § 679.20(c)(3) further require NMFS to consider public comment on the proposed annual groundfish limits and the proposed PSC allowances, and to publish final harvest specifications in the Federal Register. At their December meeting, the Council recommends the final groundfish and PSC limits for the groundfish fisheries. The final harvest specification amounts are not expected to vary greatly from the proposed harvest specification amounts. NMFS will publish the final harvest specifications after 1) considering comments received within the comment period, 2) consulting with the Council at its December meeting, 3) considering information presented in the Supplemental Information Report to the EIS that assesses the need to prepare a Supplemental EIS, and 4) considering information presented in the final SAFE reports prepared for the groundfish fisheries. If the IPHC survey data is used to translate into index values, then the final PSC limits will only be known at the December Council meeting and published in the final harvest specifications.

The final harvest specifications are usually effective with publication in the Federal Register in late February to early March. The groundfish fisheries open on January 1 for non-trawl gear and January 20 for trawl gear. The PSC limits from the previous two year harvest specifications are used to open the fisheries until superseded by the final harvest specifications PSC limits. If the PSC limits increase from the previous second year harvest specification fisheries that might otherwise remain open under these PSC limits may prematurely close based on the lower PSC limits in place until the final harvest specifications are published. Also, if the PSC limits decrease from the previous second year harvest specification fisheries that might closed directed fishing under these PSC limits may be exceeded based on the higher PSC limits in place until the final harvest specifications are published.

To cover the time between the opening of the groundfish fisheries and the publication of the final harvest specifications, the Regional Administrator may use the Inseason Adjustment authority under § 679.25 to adjust a PSC limit based on a determination that such adjustment is necessary to prevent the taking of a prohibited species that, on the basis of the best available scientific information, is found by NMFS to be incorrectly specified.

The use of the Inseason Adjustment authority may be warranted if the Council elects to use the IPHC survey data to inform index values given that these data are not available until after the initial harvest specifications are presented to the Council at their October meeting.

Groundfish harvest specifications establish an over-fishing level (OFL), acceptable biological catch (ABC), and TAC by species and area in the BSAI. As shown in Table 3-5 some species are allocated TAC for the entire BSAI when the population structure indicates a single stock. Others, such as Pacific cod and sablefish have separate allocations by the BS subarea of the BSAI, and the AI subarea of the BSAI. Additionally, for some rockfish as well as Atka mackerel, allocations are further specified within regions for localized depletion concerns.

Table 3-5 2020-2021 OFLs, ABCs and TACs for BSAI Groundfish

Species	Area	2020 OFL	2020 ABC	2020 TAC	Catch as of 11/7/2020	Final 2021 OFL	Final 2021 ABC	Final 2021 TAC
Pollock	EBS	4,085,000	2,043,000	1,425,000	1,364,949	2,594,000	1,626,000	1,375,000
	AI	66,973	55,120	19,000	2,971	61,856	51,241	19,000
	Bogoslof	183,080	137,310	75	8	113,479	85,109	250
Pacific cod	BS	191,386	155,873	141,799	136,185	147,949	123,805	111,380
	AI	27,400	20,600	13,796	5,321	27,400	20,600	13,796
Sablefish	AK	50,481				60,426	29,588	
	BSAI		n/a	n/a	n/a	n/a	n/a	8,113
	BS	n/a	2,174	1,861	5,184	n/a	3,396	3,396
	AI	n/a	2,952	2,039	1,123	n/a	4,717	4,717
Yellowfin sole	BSAI	287,307	260,918	150,700	128,320	341,571	313,477	200,000
Greenland turbot	BSAI	11,319	9,625	5,300	2,312	8,568	7,326	6,025
	BS	n/a	8,403	5,125	1,639		6,176	5,125
	AI	n/a	1,222	175	673		1,150	900
Arrowtooth flounder	BSAI	84,057	71,618	10,000	10,265	90,873	77,349	15,000
Kamchatka flounder	BSAI	11,495	9,708	6,800	7,279	10,630	8,982	8,982
Northern rock sole	BSAI	157,300	153,300	47,100	25,762	145,180	140,306	54,500
Flathead sole	BSAI	82,810	68,134	19,500	9,001	75,863	62,567	25,000
Alaska plaice	BSAI	37,600	31,600	17,000	19,954	37,924	31,657	24,500
Other flatfish	BSAI	21,824	16,368	4,000	4,113	22,919	17,189	6,500
Pacific ocean perch	BSAI	58,956	48,846	42,875	36,303	44,376	37,173	35,899
	BS	n/a	14,168	14,168	8,895		10,782	10,782
	EAI	n/a	11,063	10,613	9,557		8,419	8,419
	CAI	n/a	8,144	8,094	7,966		6,198	6,198
	WAI	n/a	15,471	10,000	9,885		11,774	10,500
Northern rockfish	BSAI	19,751	16,243	10,000	8,362	18,917	15,557	13,000
Blackspotted/Rougheye Rockfish	BSAI	861	708	349	458	576	482	482
	EBS/EAI	n/a	444	85	125	n/a	313	313
	CAI/WAI	n/a	264	264	333	n/a	169	169
Shortraker rockfish	BSAI	722	541	375	214	722	541	500
Other rockfish	BSAI	1,793	1,344	1,088	996	1,751	1,313	916
	BS	n/a	956	700	293		919	522
	AI	n/a	388	388	703		394	394
Atka mackerel	BSAI	81,200	70,100	59,305	57,506	85,580	73,590	62,257
	EAI/BS	n/a	24,535	24,535	22,926		25,760	25,760
	CAI	n/a	14,721	14,721	14,588		15,450	15,450
	WAI	n/a	30,844	20,049	19,992		32,380	21,047
Skates	BSAI	49,792	41,543	16,313	17,221	49,297	41,257	18,000
Sculpins	BSAI	67,817	50,863	5,300	4,805	N/A	N/A	
Sharks	BSAI	689	517	150	179	689	517	200
Octopuses	BSAI	4,769	3,576	275	682	4,769	3,576	700
Total	BSAI	5,584,382	3,272,581	2,000,000	1,849,473	3,945,315	2,747,727	2,008,113

BSAI TAC setting is generally driven by tradeoffs between the availability of pollock, BS Pacific cod, key flatfish species and the constraint of the 2 million metric ton optimum yield cap. High value, low volume species such as sablefish and rockfish have TACs set equal to ABC while lower value flatfish stocks such as arrowtooth flounder have TACs set well below ABC for both market reasons and expected halibut bycatch rates. Trends in ABCs and TACs between three key stocks (EBS pollock, BS Pacific cod and yellowfin sole) are shown in Figure 3-6. At lower levels of pollock ABC (e.g., 2010-2012) the pollock TAC is set equal to the ABC. Since 2012, as the pollock ABC increased, the pollock TAC remained relatively stable thus allowing for higher TACs to be set for other BSAI groundfish species. BS Pacific cod ABC is reduced by the state guideline harvest level (GHL) prior to TAC being established (see Section 3.2.1.2 for more information on TAC setting and allocation for cod). As noted previously the Pacific cod ABC has been declining in recent years thus BS cod TAC levels have also been declining (Figure 3-6). TAC levels for yellowfin sole have been stable since 2015 following a declining during the 2010 to 2015 period.

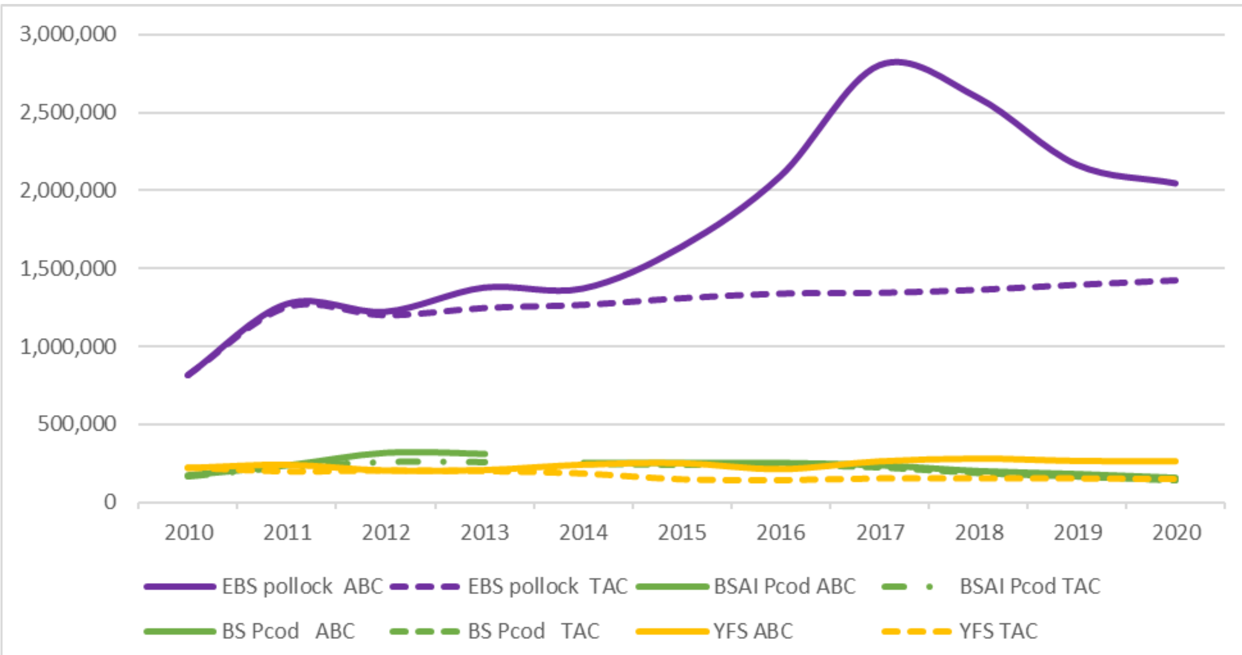


Figure 3-6 ABC and TAC for EBS pollock, BS cod and yellowfin sole (metric tons)

POP TACs have generally been set close to or equal to the ABC (Figure 3-7). Atka mackerel TACs have fluctuated due to a range of regulations limiting total catch in areas because the species is a Steller sea lion prey item.[15]

[15] NMFS Final Rule implementing Steller sea lion mitigation measures (79 CFR 70285, November 2014)

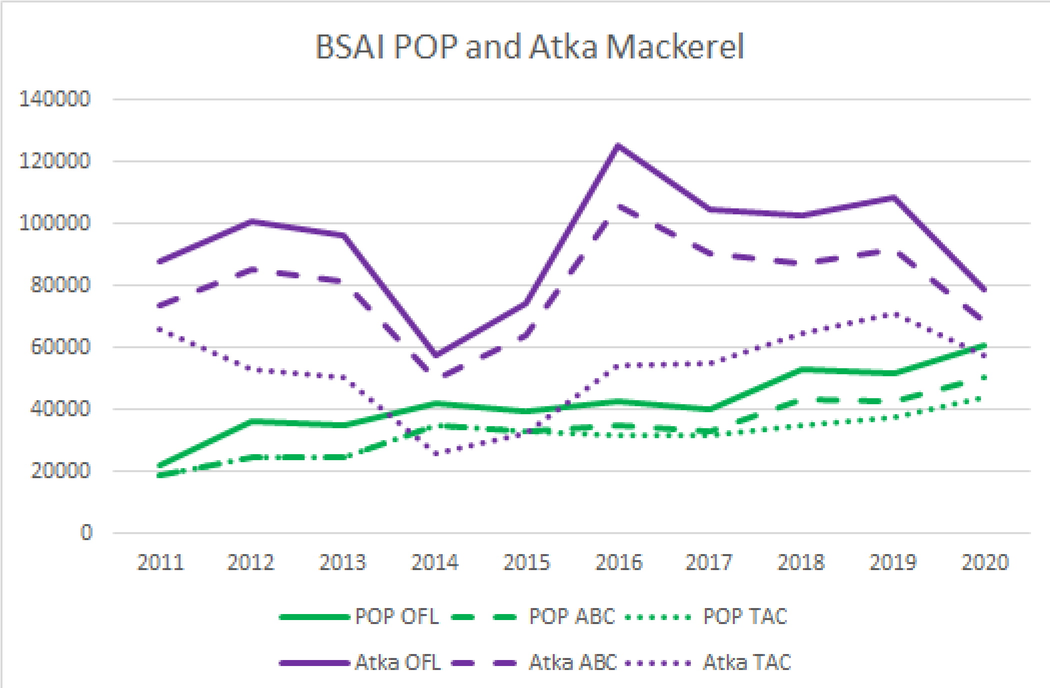


Figure 3-7 OFL, ABC and TAC levels for BSAI Pacific ocean perch (POP) and Atka mackerel

3.2.1.1 Flatfish flexibility exchange program

Beginning in the 2015 fishing year, an ABC reserve is annually specified for the flatfish species that are allocated to CDQ groups and A80 cooperatives – flathead sole, rock sole, and yellowfin sole. The ABC reserve is divided by CDQ groups and A80 cooperatives using the same formulas as in the annual harvest specifications process, ensuring that an entity exchanging one flatfish quota for another cannot result in exceeding an ABC or the 2 million ton OY cap. The reserve for each species is specified by the Council's evaluation of the ABC surplus for each species (i.e., the difference between the ABC and TAC). The Council considers whether the reserve needs to be reduced by a discretionary buffer amount based on social, economic, or ecological considerations. The Council then designates some, all, or none of the ABC surplus as the ABC reserve. Figure 3-8 shows the ABC and TAC for the three stocks subject to the Flatfish Flexibility Exchange Program.

The purpose of the Flatfish Flexibility Exchange Program is to allow cooperatives or CDQ groups to increase their harvest opportunity and/or reduce halibut PSC through flexibility in their choice to target a certain flatfish species. Decisions to utilize the flexibility program might reflect halibut PSC rates in a certain target fishery or catchability and market conditions. Within the species subject to the program, a vessel is only required to hold quota for any of the three species.

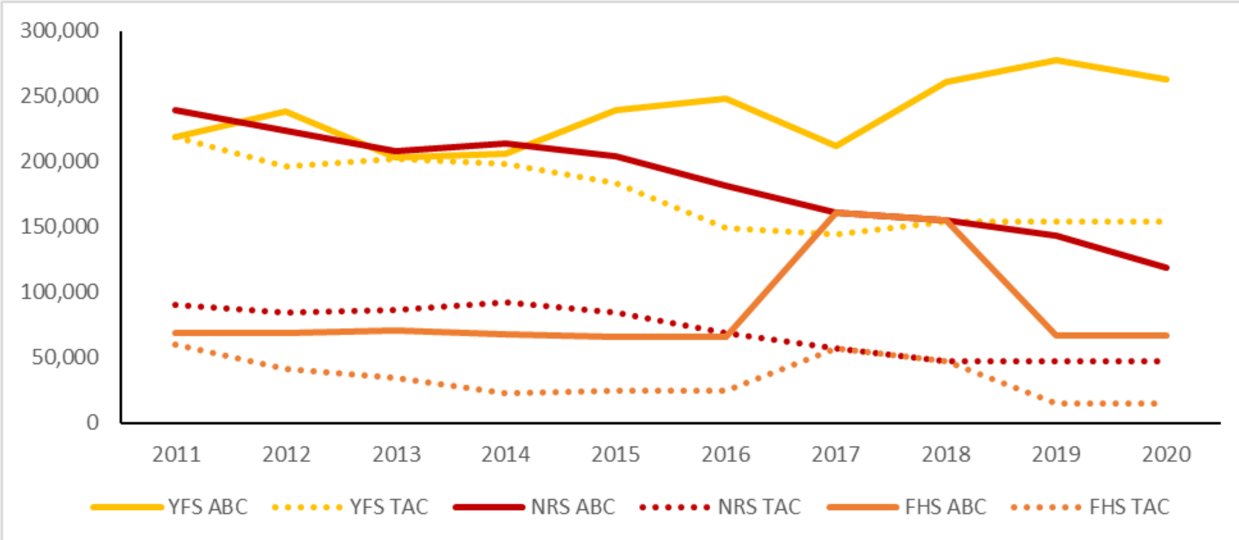


Figure 3-8 ABC and TAC levels for the three flatfish species managed under flatfish specifications: yellowfin sole (YFS), northern rock sole (NRS) and flathead sole (FHS).

NMFS annually provides the Council with a report on the flatfish exchanges made by the Amendment 80 cooperatives and CDQ groups. That report is made during the NMFS SF Inseason Management Annual Report at each December Council meeting, and an annually updated PDF of all flatfish exchanges is available on the NMFS Alaska Groundfish Harvest Specifications page.[16] These reports provide the Council with information to consider when deciding whether to establish a buffer by reducing the amount of the ABC reserve available to be exchanged by eligible entities in a future year.

In 2015 and 2016, net exchanges of flathead sole and rock sole for yellowfin sole. These exchanges resulted in roughly 11,000 t and 9,500 t of additional yellowfin sole TAC in each respective year. In 2017, net exchanges resulted in roughly 2,700 t of TAC shifting from rock sole to yellowfin sole, with a negligible net change to the initial flathead sole TAC. Net exchanges in 2018 flowed from rock sole to both yellowfin sole and flathead sole, resulting in roughly 2,600 additional tons of flathead sole TAC and 1,950 additional tons of yellowfin sole TAC. The same pattern occurred in 2019, with rock sole being exchanged for the other species, resulting in 5,650 additional tons of flathead sole and 2,450 additional tons of yellowfin sole.

As one would expect, the bulk of exchanges are executed in September and October when TACs are more likely to be constraining or as entities adjust targets to meet business targets or to keep bycatch rates down to meet internal cooperative performance standards. As of August, there have been no flatfish exchanges in 2020. Fewer exchanges may be expected in 2020 due to lower overall flatfish harvest, and thus less need to exchange one eligible species to afford an opportunity to target another.

3.2.1.2 Pacific cod allocation

Pacific cod is allocated across state and federal fisheries and to various gear and operational type sectors within each management realm. Stock assessment and harvest specifications are made separately for the BS and AI areas due to population distinctions. Figure 3-9 provides a schematic of how BS and AI ABCs are first apportioned to the state-managed GHL fisheries in each area's state waters. After that, the TAC recommended by the Council is allocated to CDQ groups and finally the remainder is allocated to the federal non-CDQ groundfish sectors. The TAC that the Council recommends accounts for the BS and AI

[16] See, for example, "Further Allocations" at https://www.fisheries.noaa.gov/alaska/commercial-fishing/2020-2021-alaska-groundfish-harvest-specifications.

GHL allocations such that ABC is not exceeded, but the Council's TAC is not necessarily set at a level where TAC plus the GHL is equal to the ABC. TAC may be set lower based on policy decisions accounting for the state of all the BSAI groundfish stocks and the need to remain within the 2 million metric ton optimum yield cap. The allocation to the non-CDQ sectors is based on the summed BS and AI TACs. Those federal groundfish sectors include – in order of allocation percentage – the combined hook-and-line and pot sector, trawl CVs, A80, AFA trawl CPs, and jig gear. The allocation to the hook-and-line and pot sectors is subdivided between HAL CPs, HAL CVs ≥ 60' LOA, HAL and pot CVs less than 60' LOA, pot CPs, and pot CVs ≥ 60' LOA.

The following subsections provide additional detail on the management of federal and state Pacific cod fisheries in the BSAI.

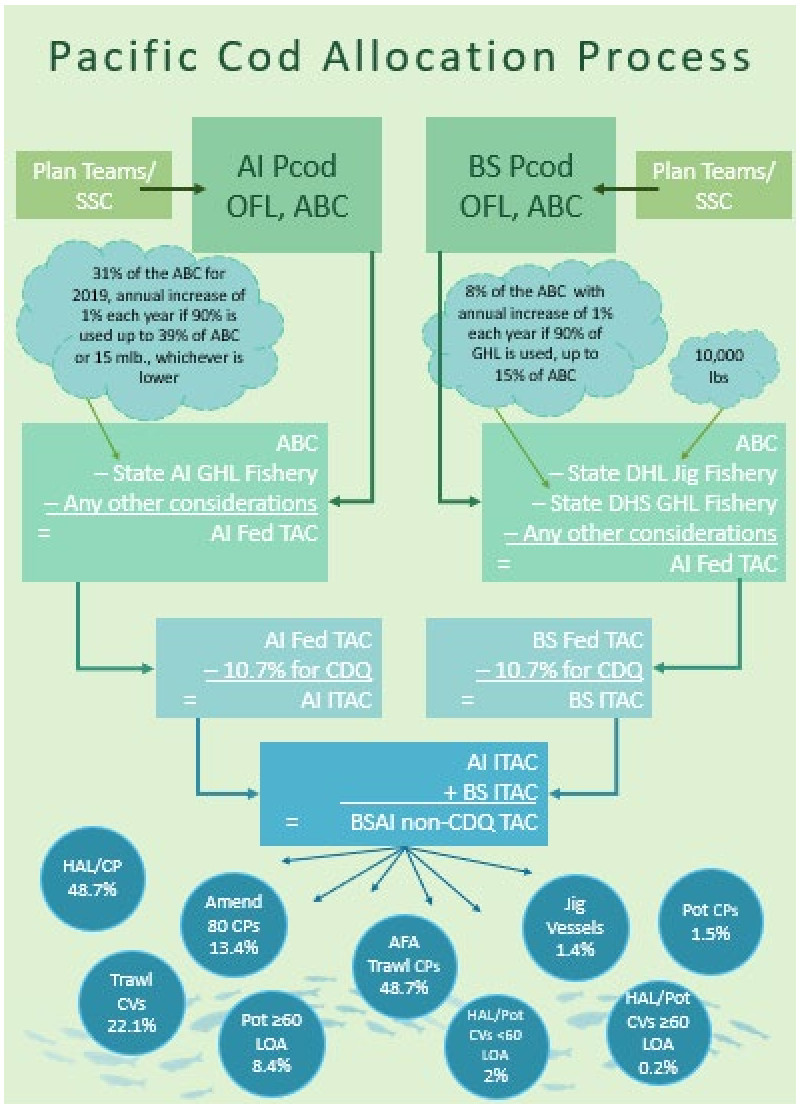


Figure 3-9 BSAI cod allocation beginning with area-specific ABCs in BS and AI, deduction of the state GHL, CDQ allocations and recombined BSAI TAC for sector and seasonal allocations. Total of 34 separate allocations to sectors and seasons (seasons not depicted).

3.2.1.2.1 State fisheries (guideline harvest level)

The State manages three GHL fisheries for Pacific cod. Two occur within state waters in the BS (pot and jig gear) and one occurs within state waters in the AI (pot and trawl gear).

In October 2018, the Alaska Board of Fisheries (BOF) made changes to the BS and AI GHLs that determine the available harvest in the state waters Pacific cod fisheries under its jurisdiction. Because the GHL is deducted from the BSAI Pacific cod ABC before any allocation to federal fisheries, increasing the GHL *may* reduce available harvest for groundfish harvesters, including the A80 sector and CDQ groundfish allocations. A higher GHL directly affects the TAC available to all federal sectors when TAC is set equal to the ABC minus the GHL; that has been the case in recent years, as Pacific cod ABCs are low. In some instances, the Council could recommend Pacific cod TACs that are less than "ABC minus GHL" to preserve room within the 2 million t OY cap for the harvest of other groundfish species. This occurred in 2015.[17] In years when the difference (gap) between TAC and "ABC minus GHL" is greater than zero, the effect of an increased GHL percentage depends on the amount of that percentage and the size of the gap.

After deducting the GHL from ABC, the Council recommends TAC levels such that ABC is not exceeded; 10.7% of that TAC is allocated to CDQ groups before the remainder is allocated to gear and operational type harvest sectors. From that remainder, 13.4% is allocated to the A80 sector. Under current regulations, and making the presumption that TAC is being set equal to "ABC minus GHL," shifting an additional pound of Pacific cod from the federal TAC to the GHL fisheries reduces the allocation to the A80 sector by 0.12 pounds. The same shift of one pound would reduce the CDQ allocation by 0.107 pounds.

The Dutch Harbor subarea (DHS) of the Bering Sea GHL fishery for Pacific cod was first opened in 2014. State regulations provided for a GHL of 3% of the BSAI Pacific cod ABC, which was subtracted from the BS ABC and accounted for when the Council recommended the federal BS TAC. Starting in 2016, the BOF changed the DHS GHL calculation to align with the split of the federal BSAI Pacific cod stock into separate BS and AI stocks. As part of those modifications, the DHS GHL was changed to 6.4% of the BS ABC. The DHS GHL was changed again at the October 2018 BOF meeting. The DHS GHL was increased to 8.0% of the BS ABC starting in 2019 and increased to 9.0% in 2020. If the GHL is fully harvested (90% considered fully harvested) then the limit is increased by 1% of the BS ABC each year until it reaches 15%.[18] The 15% GHL would continue unless changed by the BOF. Until 2019, the DHS fishery occurred in state waters between 164 degrees and 167 degrees west longitude. At its October 2018 meeting the BOF expanded the area to include waters between 162.30 degrees and 167.00 degrees west longitude.

The DHS fishery is open to vessels 58' or less using pot gear with a limit of 60 pots per vessel. The season opens seven days after the federal BSAI <60' pot/longline sector's season closure and may close and re-open as needed to coordinate with federal fishery openings. The 2020 season opened on January 26 and was closed on March 12 (47 days) because the GHL was projected to be taken. Since 2014, the season has opened between January 19 and February 12. Season length has ranged from 31 days in 2018 to 71 days in 2016 – setting aside the exceptional year of 2014 when the fishery remained open until September 1. The DHS pot gear fleet reached 40 vessels in 2020, which was the largest fleet size during the 2014 through 2020 period. Participation has increased steadily from 16 vessels in 2014 and 14 vessels in 2015. All of the catch is delivered to shoreside plants since it is harvested by pot vessels that are 58' or less.

When the DHS GHL for pot gear reaches 15% of the BS ABC, it will equate to a 134% increase from the 2018 GHL allocation. In poundage terms, the 2018 GHL (6.4%) was 28.36 million lbs. (12,864 t); however, the pounds associated with a 15% DHS GHL – or any percentage in any future year – will depend on the level of the BS ABC.

[17] BS ABC = 255,000 t; BS GHL = 8,178 t; BS TAC = 240,000 t. In this case, the Council set the TAC 6,822 t lower than it conceivably could have without exceeding the ABC after accounting for the GHL.

[18] From 2014 through 2020, the DHS GHL fishery was harvested at 97% of the GHL or greater.

The BOF also created a 100,000 lbs. (~45 t) GHL jig gear fishery for Pacific cod in the DHS. That fishery began in May 2019.

The State of Alaska has managed a GHL fishery for Pacific cod in state waters in the AI subarea since 2006. The AI GHL was 3% of the federal BSAI Pacific cod ABC from 2006 through 2015. Beginning in 2016, the AI GHL changed to 27% of the AI ABC, with an annual 4% step-up provision that could bring the GHL to 39% of the AI ABC if the AI GHL is fully harvested on a continuing basis. The GHL is considered fully harvested if 90% is taken by November 15. The BOF capped the AI GHL at a maximum of 15 million lbs. (6,804 t). At the BOF October 2018 meeting, the BOF included a four percent step-down provision if the AI GHL is not fully harvested (90% harvest) during two consecutive calendar years. The GHL may not be reduced below 15% of the AI Pacific cod ABC. The majority of the AI GHL state waters fishery has been harvested by vessels using trawl and pot gear (harvest information for this fishery is confidential during recent years due to the number of processor participants). In 2019, the AI GHL stepped up to 31% of the AI ABC and in 2020 the AI GHL capped out at 15 million lbs. or 6,804 t, which was 33% of the AI ABC. The BOF had established the 2020 AI GHL at 35% of the AI ABC, which would have equaled 7,210 t had the cap not been in place. In 2021 the AI GHL will be established at 39% of the AI ABC unless that amount is constrained by the 15 million lbs. GHL limit, which depends on where the ABC is set.

3.2.1.2.2 Federal fisheries (TAC)

Once the BS and AI TACs are established, regulations at § 679.20(a)(7)(i) allocate 10.7% of the Bering Sea Pacific cod TAC and 10.7% of the Aleutian Islands Pacific cod TAC to the CDQ Program for the exclusive harvest by Western Alaska CDQ groups. The remaining portion of TAC is the ITAC. An incidental catch allowance (ICA) is set for the HAL and pot gear sectors to cover catch while targeting non-cod species. The ICA is set based on NMFS's estimate of need and that amount is deducted from the aggregate allocation to HAL and pot sectors before suballocations are made to gear and size-based sectors. For the 2020 BSAI Pacific cod fishery, the ICA was 400 t.

After subtracting the CDQ allocation from the BS and AI TACs, NMFS combines the remaining BS and AI TACs into one BSAI non-CDQ TAC, which is available for harvest by nine non-CDQ fishery sectors. Regulations at § 679.20(a)(7)(ii)(A) define the nine Pacific cod non-CDQ fishery sectors in the BSAI and specify the percentage allocated to each. Allocations for 2020 can be seen in Table 9 of the annual harvest specifications published in the Federal Register.[19] The non-CDQ fishery sectors are defined by a combination of gear type (trawl, HAL, pot), operation type (CV or CP), and vessel size categories (i.e., vessels greater than or equal to 60 ft in length overall, or less than 60 ft in length overall).

NMFS manages each of the non-CDQ fishery sectors to ensure that harvest of Pacific cod does not exceed their overall annual allocations. NMFS monitors harvests that occur while vessels are directed fishing for Pacific cod (specifically targeting and retaining Pacific cod above specific threshold levels) and harvests that occur while vessels are directed fishing in other fisheries and incidentally catching Pacific cod (e.g., the incidental catch of Pacific cod while directed fishing for pollock in the AFA fishery). For the non-AFA trawl CP sector (A80), NMFS allocates exclusive harvest privileges to vessels participating in an A80 cooperative and prohibits them from exceeding their cooperative allocation. For other non-CDQ fishery sectors, NMFS carefully tracks both directed and incidental catch of Pacific cod. NMFS takes appropriate management measures, such as closing directed fishing for a non-CDQ fishery sector, to ensure that total directed fishing and incidental catch do not exceed that sector's allocation.

An allocation to a non-CDQ fishery sector may be harvested in either the BS or the AI, subject to the non-CDQ Pacific cod TAC specified for the BS or the AI. If the non-CDQ Pacific cod TAC is reached in

[19] https://www.federalregister.gov/documents/2019/03/13/2019-04539/fisheries-of-the-exclusive-economic-zone-off-alaska-bering-sea-and-aleutian-islands-final-2019-and#p-45

either the BS or AI, NMFS will prohibit directed fishing for Pacific cod in that subarea for all non-CDQ fishery sectors, even if there is a positive remaining amount in the overall BSAI area.

Allocations of Pacific cod to the CDQ Program and to the non-CDQ fishery sectors are also apportioned by seasons. In general, regulations apportion CDQ and non-CDQ fishery sector allocations among three seasons that correspond to the early (A-season), middle (B-season), and late (C-season) portions of the year. Depending on the specific CDQ or non-CDQ fishery sector allocation, between 40 percent and 70 percent of the Pacific cod allocation is apportioned to the A-season, which is historically the most lucrative fishing season due to the presence of valuable roe in the fish and the good quality of the flesh during that time of year. The allocation of Pacific cod among the CDQ Program and the nine non-CDQ fishery sectors, as well as the seasonal apportionment of those allocations, create a large number of separate sectoral-seasonal allocations. To help ensure the efficient management of these allocations, regulations allow NMFS to reallocate (rollover) any unused portion of a seasonal apportionment from a non-CDQ fishery sector to that sector's next season during the current fishing year unless the Regional Administrator determines a non-CDQ fishery sector will not be able to harvest its allocation. The one exception where seasonal rollovers are not allowed is the jig gear sector

3.2.2 Halibut PSC limit and discard mortality

The halibut PSC limits for BSAI groundfish sectors are described in Section 2.4. Under status quo regulations, the A80 sector is managed under a halibut PSC hard cap of 1,745 t of mortality. NMFS has the ability to make a within-year reallocation of halibut PSC from the TLAS sector to the A80 sector as the Regional Administrator deems appropriate (50 CFR 679.91(f)(4)(i)). Any amount of halibut PSC that would be reallocated under this rule is first reduced by 5% to ensure some amount of PSC savings if the reallocated PSC is maximally used. This regulatory flexibility tool has been used only three times, in the late-year portions of 2010, 2013, and 2014 when the TLAS sector was largely winding down and the A80 sector was still prosecuting yellowfin sole. The historical use cases for this tool align with the highest A80 PSC use rates since 2010; however, the use of this inseason management tool was primarily an artifact of the two-cooperative A80 environment that existed at that time. Reallocated PSC is issued at the A80 cooperative level. In the cases when one of the cooperatives could benefit from a buffer to ensure their late-season fishing opportunity, it was more expedient to reallocate from a sector that was not utilizing its limit than to negotiate an intra-sector transfer of PSC. None of the years when this rule was utilized resulted in total A80 PSC mortality exceeding the limit at the time. The rule has not been utilized in recent years because the sector has reduced its PSC use relative to the limit and because the sector has consolidated into a single cooperative, thus eliminating operational barriers to intra-sector PSC transfers. The analysts note that the Council is not contemplating a change to this existing regulation under the ABM action.

The two subsections that follow describe how the estimated catch of Pacific halibut is translated to a mortality estimate that is then debited against a fishery or sector's PSC limit. The first subsection notes recent modifications to the discard mortality rate (DMR) estimation methodology and lists the resulting DMRs that have been applied to the A80 sector (BSAI non-pelagic trawl CPs, in this context) and other fisheries. The second subsection describes the methodology for estimating discard mortality when deck sorting is occurring. A80 deck sorting was developed under a series of EFPs that were intermittent beginning in 2009 but ramped up to more robust sampling and greater vessel participation from 2015 to the present. As of 2020, deck sorting of halibut is implemented in regulation[20] and integrated into the Observer Program; data from deck sorted hauls is used in the Catch Accounting System (CAS). Section 3.4.4 provides additional information on the development of halibut deck sorting under the EFP and ties

[20] 50 CFR 679.120

that into the broader context of the active halibut mortality mitigation measures that A80 has enacted since 2015.

3.2.2.1 Discard mortality rate estimation process

To monitor halibut bycatch mortality allowances and apportionments, NMFS uses observed halibut incidental catch rates, halibut DMRs, and estimates of groundfish catch to project when a fishery's halibut bycatch mortality allowance or seasonal apportionment is reached. Halibut incidental catch rates are based on observers' estimates of halibut incidental catch in the groundfish fishery. DMRs are estimates of the proportion of incidentally caught halibut that do not survive after being returned to the sea. The cumulative halibut mortality that accrues to a particular halibut PSC limit is the product of a DMR multiplied by the estimated halibut PSC. DMRs are estimated using the best scientific information available in conjunction with the annual BSAI stock assessment process. The DMR methodology and findings are included as an appendix to the annual groundfish SAFE reports.

The approach to establishing DMRs has changed in recent years. At the Council's request, a new methodology was presented to and approved by the Plan Teams, SSC and Council in December 2016. The most recent revisions to DMR estimation were presented to the Groundfish Plan Teams in September 2019.[21] Beginning in 2016, the fishery definitions for DMR estimates and application transitioned from species composition to vessel/gear operational characteristics causatively linked to halibut mortality. While the previous approach used a 10-year reference period for DMR estimates, the current process uses a reduced reference period (2-3 years) to better incentivize improvement in halibut handling practices. The shorter reference period provides fishery participants an opportunity to see a lower DMR estimate result from their efforts, which may come at a financial or operational cost (see Section 3.4.4).

The estimation process uses weighted averages of sampled halibut bycatch viability and mortality ("condition data" – sampled halibut are rated excellent, poor, or dead) to expand estimated DMRs from a sample to the haul, trip, and fishery following the sampling hierarchy. All computations are completed within each sampling stratum (full coverage, gear-specific partial coverage, and EM) before estimates are combined across the strata to produce final DMR estimates. Annual DMRs are presented to the Plan Teams, SSC and Council in conjunction with the annual specifications process.

Table 3-6 shows the halibut DMRs for all gear and operational type sectors that are specified across the BSAI and GOA for 2018 through 2020. The A80 sector falls under the "BSAI non-pelagic trawl (NPT)" CP sector. DMRs are specified for a two-year period (with the 2020 DMRs applying to 2021) however, as with the harvest specifications, DMRs are annually updated and published in the Federal Register.[22] Note that for some sectors where the number of viabilities collected (N_viabilities) or the number of vessels observed (not shown) was small the applied DMR is a proxy taken from a more robustly sampled sector. The A80 sector is subject to a DMR estimated based on viabilities sampled on A80 vessels. The A80 DMR has decreased from 84% to 75% from 2018 to 2020. Halibut catch and mortality rate estimates are discussed in greater detail in Section 3.4.

[21] See Halibut DMR Working Group Recommendations for 2020 (presented at September 2019 Groundfish Plan Team Meeting), provided by the inter-agency Halibut DMR Working Group.

[22] For 2020/2021 BSAI groundfish harvest specifications, see BSAI Table 18 at https://www.fisheries.noaa.gov/alaska/commercial-fishing/2020-2021-alaska-groundfish-harvest-specifications.

Table 3-6 Halibut DMRs in harvest specifications for groundfish fisheries by gear and sector, and the number of animal viabilities assessed in order to estimate DMR, 2018 through 2020

			2018		2019		2020	
Area	**Gear**	**Sector**	**DMR**	**N_viabilities**	**DMR**	**N_viabilities**	**DMR**	**N_viabilities**
BSAI	**NPT**	CP	84%	2,025	78%	2,844	75%	1,100
		CV	60%	2,456	59%	2,736	58%	2,353
	HAL	CP	8%	9,459	8%	6,756	9%	4,990
		CV	17%	14	4%	2	9%[a]	43
	POT	All	9%	548	19%	380	27%	266
GOA	**NPT**	CP	84%	132	79%	1,300	75%[b]	1,524
		CV	67%	755	67%	1,106	68%	710
		CV (RP)	62%	176	49%	388	52%	323
	HAL	CP	10%	1,608	11%	1,637	11%	1,010
		CV	17%	456	21%	416	13%	362
	POT	All	7%	602	4%	450	0%	119
All	**PTR**	All	*Specified at 100% (not estimated)*					

a Based on BSAI HAL CP; b Based on BSAI NPT CP
Note: NPT = non-pelagic trawl; PTR = pelagic trawl; CV (RP) = Central GOA Rockfish Program Catcher Vessels

Table 3-7 shows the actual DMRs that have been applied to the A80 sector dating back to 2010, illustrating the shift from species composition to operational type.

Table 3-7 Halibut DMRs that have been applied to the A80 sector, 2010 through 2020

Gear	Fishery/Sector	2010-13	2013-16	2016-17	2017-18	2018-19	2019-20	2020-21
Non-CDQ trawl	Alaska plaice		71	66				
	Arrowtooth flounder [1]	76	76	84				
	Atka mackerel	76	77	82				
	Flathead sole	74	73	72				
	Greenland turbot	67	64	82				
	Kamchatka flounder			84				
	Non-pelagic pollock	73	77	81				
	Pelagic pollock	89	88	88				
	Other flatfish [2]	72	71	63				
	Other species [3]	71	71	66				
	Pacific cod	71	71	66				
	Rockfish	81	79	83				
	Rock sole	82	85	86				
	Sablefish	75	75	66				
	Yellowfin sole	81	83	84				
Non-pelagic trawl	Mothership and catcher/processor				85	84	78	75

[1] Arrowtooth flounder includes Kamchatka flounder 2010-14
[2] "Other flatfish" includes all flatfish species, except for halibut, Alaska plaice, flathead sole, Greenland turbot, rock sole, yellowfin sole, Kamchatka flounder, and arrowtooth flounder.
[3] "Other species" includes skates, sculpins, sharks, squids, and octopuses.
Source: Alaska Groundfish Harvest Specifications https://www.fisheries.noaa.gov/alaska/sustainable-fisheries/alaska-groundfish-harvest-specifications

3.2.2.2 NMFS Catch Accounting System methodology for halibut PSC estimation when deck sorting is occurring on an A80 vessel

When halibut deck sorting occurs on a non-pollock trawl CP or mothership, there are two components of the total halibut PSC in the CAS: (1) the weight and mortality of halibut sorted on deck; and (2) the weight and mortality of halibut in the factory.

Halibut sorted on deck: The current sampling protocols have been in place since 2019. When deck sorting occurs, the observer will determine which sampling design to implement based on the abundance of halibut. When halibut numbers are relatively low, observers employ a 1-in-5 (20%) simple random design to collect length and viability data. For hauls with high halibut numbers, the observer uses a 1 in 10 (10%) simple random design to collect length and viability data. If the observer feels that minimal halibut will be encountered, the observer collects length data for every halibut up to the first randomly selected assessment fish to ensure haul specific weight data is available. If they reach their randomly selected halibut, the extra lengths are deleted and are be factored in the halibut weight calculation. Occasionally, an observer is not be able to recognize a high halibut bycatch event. In these situations, the observer may switch from a 1 in 5 design to a 1 in 10 design after halibut deck sort data collection has begun. When this occurs, data collected using the 1 in 5 design is corrected during debriefing to match the 1 in 10 rate. The lengths of all the sampled halibut are converted to a weight using the IPHC's length weight table. The average weight of the sampled halibut is calculated and multiplied by the number of unsampled halibut to estimate the total weight of unsampled halibut. The weight of the sampled and unsampled halibut comprise the total weight of deck sorted halibut. The total weight of deck sorted halibut reported by the observer is posted in CAS as discarded halibut.

Next a halibut DMR is applied to the halibut PSC. The observer identifies the viability, or health, of the halibut in the simple random sample. The qualitative viabilities assessed by the observer correspond to a quantitative post-capture mortality rate. For each deck sorted haul, a weighted average DMR based on the weight of halibut at each viability level is calculated. That average DMR is applied to the total weight of deck sorted halibut in the haul, calculating a halibut PSC weight, which is posted in CAS. In the rare event there are no viabilities collected for a deck sorted haul, an annual average DMR from the vessel's other deck sorted hauls is used. If it is the vessel's first deck sorted haul for the year, and there are no other hauls from which to generate an average, then an annual average DMR from the deck sorted hauls of all vessels in the year is used. As other deck sorted hauls are sampled throughout the year and additional viability data become available, the annual average DMRs will be recalculated and reapplied to the vessel's deck sorted haul that is missing viability data.

The conditional mortality probabilities for halibut sorted on deck are 20% for "Excellent," 55% for "Poor," and 90% for "Dead".

Halibut recovered in the factory: The second component follows the CAS PSC estimation process described in Cahalan et al (2014), and the weight of halibut in an observer's species composition samples in the factory are extrapolated to the entire haul. In 2015 through 2017, a standard DMR of 90% was applied to the halibut recovered in the factory. Beginning in 2018, a DMR is applied to the halibut recovered in the factory based on DMRs published in harvest specification tables in the Federal Register (see Table 3-6). The appropriate DMR is applied based on gear, sector, and year to calculate a halibut PSC mortality weight.

The sum of the two estimates – halibut mortality from the deck sorted fish plus the halibut mortality of fish from the factory – is posted in CAS.

3.2.3 Groundfish fishery closures for crab in Bristol Bay

Several closure areas for trawl gear are in place and may afford protection to halibut spawning and nursery grounds (Figure 3-10). Many of these overlap the IPHC Closed Area. The nearshore Bristol Bay

Trawl Closure Area (Federal reporting areas 508 and 512) prohibits trawl fishing at all times, except seasonally in the Northern Bristol Bay Trawl Area. The Red King Crab Savings Area, which straddles reporting areas 509 and 516, is closed to non-pelagic trawling year-round (except for the subarea in certain years). There are also seasonal closures in the area. Federal reporting area 516 is closed to fishing with trawl gear from March 15 through June 15, and the subarea of the Red King Crab Savings Area is closed to non-pelagic trawling under certain conditions.

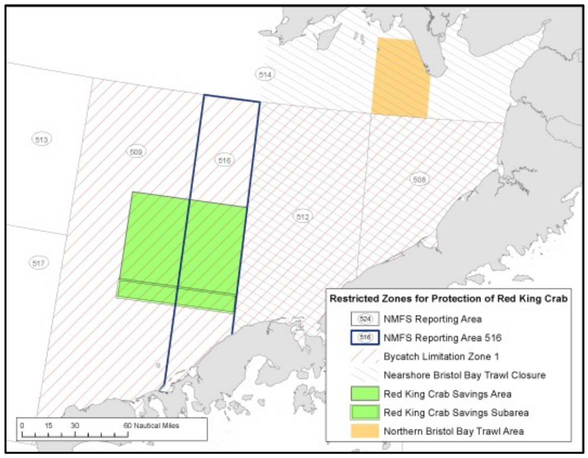


Figure 3-10 Bering Sea fishery closures for the protection of red king crab

3.2.4 Crab PSC limits and area closures

There are additional triggered time and area closures for Bristol Bay red king crab (BBRKC), Snow crab and Tanner crab in the Bering Sea. These measures are summarized below and affect trawl fisheries only.

Zones 1 and 2 are closed to directed fishing when the crab PSC limits (red king crab and EBS Tanner crab) are attained in specified trawl fisheries (Figure 3-11). Zones 1 and 2 were established by Amendment 10 to the BSAI groundfish FMP, after being implemented by emergency rule by NMFS in 1986 (NPFMC 1986). These areas were initially based upon the trawl survey distribution of red king crab and Tanner crab stocks at that time. The stair step procedure for determining PSC limits for red king crab taken in Zone 1 trawl fisheries is based on modeled abundance of mature female BBRKC and effective spawning biomass (ESB) from the stock assessment (Table 3-8).

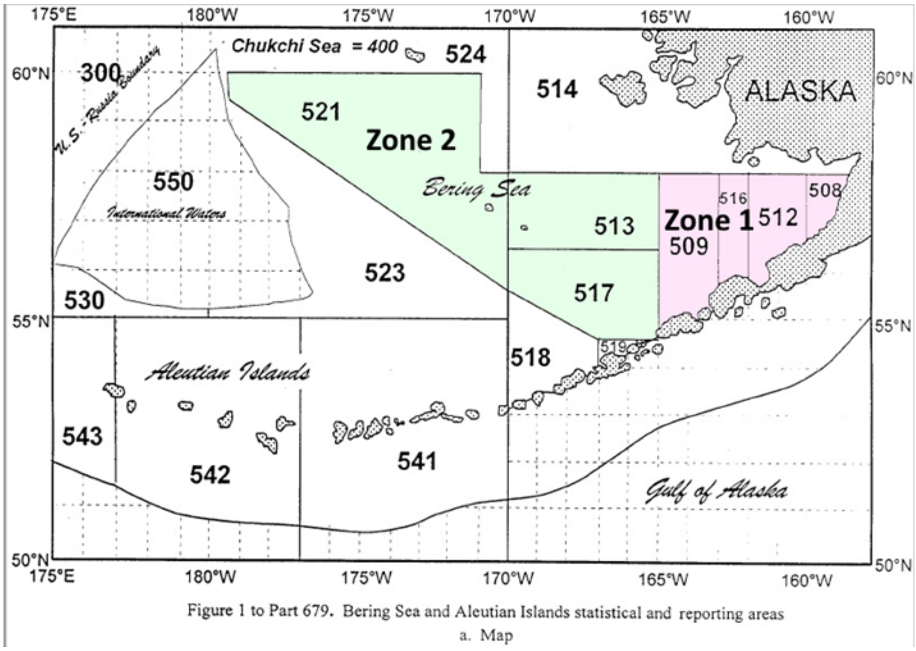


Figure 3-11 Zones 1 and 2 area for closures (Bristol Bay red king crab and EBS Tanner crab)

Table 3-8 PSC limits for Zone 1 red king crab (no Zone 2 red king crab)

When the number of mature female red king crab is …	The zone 1 PSC limit will be …
(A) At or below the threshold of 8.4 million mature crab or the effective spawning biomass is less than or equal to 14.5 million lb (6,577 mt)	32,000 red king crab
(B) Above the threshold of 8.4 million mature crab and the effective spawning biomass is greater than 14.5 but less than 55 million lb (24,948 mt)	97,000 red king crab
(C) Above the threshold of 8.4 million mature crab and the effective spawning biomass is equal to or greater than 55 million lb	197,000 red king crab

Source: 50 CFR 679.21(e)(1)(i)

A summary of all red king crab trawl closure measures in shown in Table 3-9.

Table 3-9 Red king crab trawl closures by NMFS reporting area

Area	Effective date	Closure
508	1997	• Closed to all trawl as part of Nearshore Bristol Bay Trawl Closure • Longline and pot vessels required to carry 100% observer coverage
509	--	• Open to trawling, except RKCSA (see below) • Closes, as part of Zone 1, to select target trawl fisheries when applicable red king crab PSC limits are reached by those fisheries
512	March 1987	• Closed to all trawl, first as the Crab and Halibut Protection Zone, and subsequently as part of Nearshore Bristol Bay Trawl Closure • Domestic Pacific cod trawl fishery allowed out to 25 fathoms, with 100% observer coverage, from 1987 to 1997
Eastern part of 514 *(east of 162° W)*	1997	• Closed to all trawl as part of Nearshore Bristol Bay Trawl Closure • Seasonal exemption for the Northern Bristol Bay Trawl Area, which is open to trawling from April 1 to June 15, annually[1]
516	1989	• Closes to all trawl from March 15 to June 15, annually, originally as a seasonal extension of the Crab and Halibut Protection Zone • Closes, as part of Zone 1, to select target trawl fisheries when applicable red king crab PSC limits are reached by those fisheries
Red King Crab Savings Area (RKCSA) *(straddles 509 & 516)*	1995	• Closed by emergency rule from Jan 20-April 19, 1995, to non-pelagic trawl (note, 516 portion of RKCSA also closed March 15-June 15) • Closed by inseason action to all trawl from Jan 20-June 15, 1996 • Closed by amendment to non-pelagic trawl beginning 1997 • Exemption for trawling allowed in the Red King Crab Savings Subarea, when a commercial fishery for Bristol Bay red king crab was allowed the previous year • 100% observer coverage required for all pot and longline vessels fishing in the RKCSA, and all trawl vessels fishing in the subarea

[1] Under a voluntary agreement between industry and members of the Togiak community, in place since 2009, the trawl fleet has agreed to cease fishing in the exempted Northern Bristol Bay Trawl Area by June 1, to avoid potential interactions with halibut.

There are two triggered closures in the trawl fishery to address trawl bycatch of Tanner crab. These are triggered time/area closures to trawl gear as shown in Figure 3-11. Trawl PSC trigger limits for EBS Tanner crab in Zones 1 and 2 are based on a percentage of the total abundance minus an additional reduction implemented in 1999 of Tanner crab as indicated by the NMFS trawl survey (Table 3-10).

Table 3-10 PSC limits for EBS Tanner crab

PSC limits for bairdi Tanner crab: Zone 1 and 2

Zone	Abundance	PSC Limit
Zone 1	0-150 million crabs	0.5% of the total abundance minus 20,000 animals
	150-270 million crabs	730,000
	270-400 million crabs	830,000
	over 400 million crabs	980,000
Zone 2	0-175 million crabs	1.2% of the total abundance minus 30,000 animals
	175-290 million crabs	2,070,000
	290-400 million crabs	2,520,000
	over 400 million crabs	2,970,000

Source: 50 CFR 679.21(e)(1)(ii)(A)

There is an additional separate triggered time/area closure for trawl fisheries to protect snow crab stocks and their habitat. This closure is triggered if the PSC limit is reached in specified fisheries. The limit accrues for bycatch taken within the *C. opilio* Bycatch Limitation Zone (COBLZ). That area then closes for the fishery that reaches its specified limit. (Figure 3-12). The COBLZ area was specified under amendment 40 the FMP and was established in 1997.

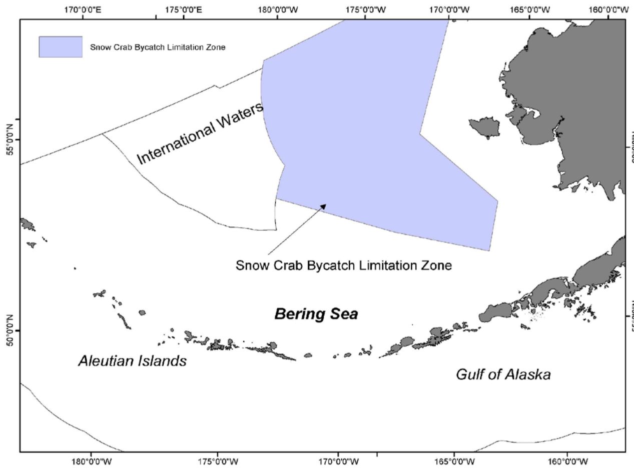


Figure 3-12 C. opilio Bycatch Limitation Zone (COBLZ)

EBS snow crab trawl PSC limits are based on total abundance of snow crab as indicated by the NMFS standard trawl survey. The cap is set at 0.1133% of the snow crab abundance index minus 150,000 crab, unless a minimum or maximum abundance threshold is reached. If 0.1133% multiplied by the total abundance is less than 4.5 million then the minimum PSC limit will be 4.350 million animals. If 0.1133% multiplied by the total abundance is greater than 13 million then the maximum PSC limit will be 12.850 million animals.[23] Snow crab bycatch that occurs outside of COBLZ does not accrue to the COBLZ limit.

A summary of all trawl closures, 2020 PSC limits, as well as other fixed closures to groundfish sectors and gears in the BSAI for crab bycatch management are shown in Table 3-11.

[23] 50 CFR 679.21(e)(1)(iii)

Table 3-11 Summary of groundfish fishery closures for crab PSC and habitat

Stock	Area	Gear type	Timing	For trigger closures		
				Allocation by sector or target fishery in 2020	How catch accrues	2020 PSC limit
Bristol Bay red king crab	Red King Crab Savings Area	nonpelagic trawl	closed year-round, except subarea	Up to 25% of Zone 1 PSC limit		
	Nearshore Bristol Bay Trawl Closure	nonpelagic trawl	closed year-round, except Togiak subarea open 4/15-6/15			
	Zone 1	all trawl	when limit is reached, area closes to target fishery	Amd. 80 sector yellowfin sole Pacific cod pollock/mackerel/ other species	RKC bycatch in Zone 1, by fishery	97,000 allocated among target fisheries
EBS Tanner crab	Zone 1	all trawl	when limit is reached, area closes to target fishery	Amd. 80 sector yellowfin sole rockfish Pacific cod pollock/mackerel/ other species	Tanner crab bycatch in Zone 1, by fishery	980,000 allocated among target fisheries
	Zone 2	all trawl	when limit is reached, area closes to target fishery	Amd. 80 sector yellowfin sole rockfish Pacific cod pollock/mackerel/ other species	Tanner crab bycatch in Zone 2, by fishery	2,970,000 allocated among target fisheries
Pribilof Islands blue king crab	Pribilof Islands Habitat Conservation Area	all trawl Pot fishing for Pacific cod	year-round			
EBS snow crab	*C. opilio* Bycatch Limitation Zone (COBLZ)	all trawl	when limit is reached, area closes to target fishery	Amd. 80 sector yellowfin sole rockfish Pacific cod pollock/mackerel/ other species	Snow crab bycatch in the COBLZ, by fishery	8,580,898 allocated among target fisheries
	Northern Bering Sea Research Area	nonpelagic trawl	currently year-round; fishing may resume in future under a research plan			
St Matthew blue king crab	St Matthew Island Habitat Conservation Area	nonpelagic trawl	year-round			

3.3 Amendment 80 fishery description

Note to the reader: CFEC/ADF&G Fish Ticket information and COAR data are not yet available for 2020 at the time of preparation. As a result, tables and figures that report revenue terminate in 2019.

Amendment 80 to the BSAI Groundfish FMP, implemented in 2008, facilitated the formation of fishery cooperatives for trawl CPs that are not eligible under the American Fisheries Act (AFA) to participate in directed pollock fisheries. A80 originally allocated five BSAI non-pollock trawl groundfish species to permit holders that formed a cooperative within the non-AFA trawl CP sector. The A80 sector is allocated a portion of the TAC for Pacific ocean perch in the AI, Atka mackerel, yellowfin sole, rock sole, and flathead sole in the BSAI, as well as an allowance of PSC quota for halibut and crab. Allocations were derived from the catch history of 28 original qualifying CPs from 1998 through 2004. Later, Amendment

85 allocated the A80 sector 13.4% of BSAI Pacific cod. Other eligible permit holders initially participated in a limited access fishery for the balance of the catch allocated to the sector.

The Council adopted Amendment 80 to meet the following objectives: (1) improving retention and utilization of fishery resources by the non-AFA trawl catcher/processor fleet by extending the groundfish retention standard (GRS) to non-AFA trawl catcher/processor vessels of all lengths; (2) allocating fishery resources among BSAI trawl harvesters in consideration of historic and present harvest patterns and future harvest needs; (3) authorizing the allocation of groundfish species to harvesting cooperatives and establishing a limited access privilege program (LAPP) for the non-AFA trawl catcher/processors to reduce potential GRS compliance costs, encourage fishing practices with lower discard rates, and improve the opportunity for increasing the value of harvested species; and (4) limiting the ability of non-AFA trawl CPs to expand their harvesting capacity into other fisheries not managed under a LAPP.

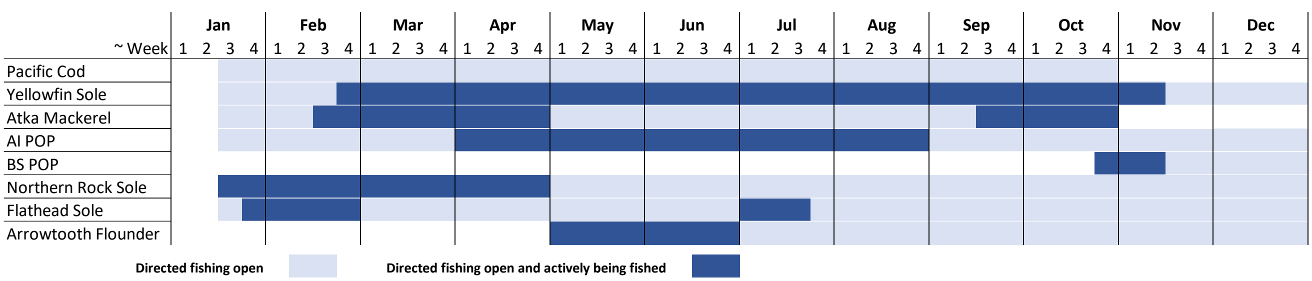
Amendment 80 established criteria for harvesters in the sector to apply for and receive quota share, and for NMFS to initially allocate and transfer quota share. Vessels may choose to operate in a cooperative or in an open access fishery. Cooperative participants can consolidate fishing operations on a specific Amendment 80 vessel or subset of Amendment 80 vessels, thereby reducing monitoring, enforcement, and other operational costs, and permitting more efficient harvest. The ability to trade harvest privileges among cooperatives encouraged efficient harvesting and discouraged waste. A80 cooperatives receive an exclusive allowance of crab PSC and halibut PSC that may not be exceeded while harvesting groundfish in the BSAI. These halibut and crab PSC cooperative quotas are assigned to a cooperative in an amount proportionate to the groundfish quota shares held by its members; PSC quotas are not based on the amount of crab or halibut PSC historically removed by the cooperative members. The cooperative structure allows Amendment 80 vessel operators to better manage PSC rates relative to operators who must race to harvest groundfish as quickly as possible before PSC causes a fishery closure or causes companies/vessels to deviate from their optimal harvest strategy. By reducing PSC through more efficient cooperative operations (e.g., gear modifications, “hot spot” avoidance, deck sorting, or the relative flexibility afforded in the timing of fishing), Amendment 80 vessel operators may also increase the harvest of valuable targeted groundfish species and improve revenues that would otherwise be forgone.

The A80 sector initially included a set of vessels that formed a cooperative (Alaska Seafood Cooperative; AKSC) and a set of vessels that fished in a competitive limited access fishery. Amendment 93 modified the requirements for a group of vessels to form a cooperative, removing unanticipated barriers, and also prevented “persons” (companies) from participating in both a cooperative and the A80 limited access fishery (Final Rule published at 76 FR 68354, November 4, 2011). This meant that a company could not fish its full amount of cooperative quota while also placing one company owned vessel in the A80 limited access fishery to harvest fish that would not have been allocated to that company based on qualifying catch history. The rule eliminated barriers for vessels fishing A80 limited access to form a cooperative and removed incentives for vessels that were in a cooperative to limit membership. The net effect was to increase cooperative participation and the associated benefits, such as more efficient targeting of catch, enhanced ability to avoid bycatch time and area combinations, and opportunities for improved product quality and value. Beginning in 2011, the A80 sector has been prosecuted solely by vessels operating in a cooperative. From 2011 to 2017 there were two cooperatives. Since 2017 all active A80 vessels are part of the AKSC cooperative. Though the single-cooperative model creates an environment for highly organized fishing and shared investment in bycatch avoidance research, the analysts note that the cooperative is still made up of five independent for-profit companies. Industry reports indicate that intra-cooperative inseason transfers of quota for constraining species – i.e., halibut PSC or Pacific cod – occur very rarely, if ever.

Figure 3-13 shows the typical BSAI non-pollock groundfish seasons for the species allocated to the A80 sector and several that are important unallocated catch (e.g., arrowtooth flounder and BS Pacific ocean perch). The trawl fisheries generally open on January 20 and close by regulation on November 1. For the A80 sector Pacific cod is—broadly speaking—an allocated, constraining non-target species that is encountered in multiple aspects of the sector's operations. A80 vessels might have trips that are recorded as directed fishing for Pacific cod in certain circumstances. However, in many cases, they are caught as an expected and commercially valuable incidental species along with other targeted groundfish. This is in contrast to other BSAI groundfish sectors such as the hook-and-line CP (HALCP) sector and the trawl CV limited access sector (TLAS), both of which target Pacific cod primarily.

The other non-pollock groundfish species highlighted in Source: https://www.fisheries.noaa.gov/alaska/resources-fishing/federal-fishery-seasons-alaska (Accessed August 2020; last updated 4/12/2019)

Figure 3-13 are mainly targeted by A80 vessels (except yellowfin sole, which is also targeted by the TLAS). The figure reflects the A80 sector's revealed preference for catching particular species at different points during the calendar year. For example, some flatfish species are more desirable or more valuable when roe is present – e.g., northern rock sole. In some cases, the sector might focus on a particular flatfish species when fish aggregation and CPUE are expected to be higher. Lower value species such as arrowtooth flounder might show up as "actively fished" during gap periods between more valuable species as vessels seek to keep their platforms productive while also retaining valuable secondary species within regulatory limitations. Finally, the reader should note that the non-pollock/non-cod species include both flatfish and roundfish (e.g., Atka mackerel and Pacific ocean perch (POP)). These flatfish and roundfish are both allocated to A80 companies on the basis of qualifying historical catch and, while intra-sector transfers are possible, companies' portfolios are not necessarily balanced between the two types of species in a uniform manner (see Figure 3-15). The figure should not imply that any A80 company would have an unrestricted choice to make between yellowfin sole, rock sole, flathead sole, Atka mackerel, AI POP or Pacific cod at a given point during the year. A company's species quota allocations are the key element of how it plans its fishing year, but companies must also consider the capacity and the capability of their vessels to fish in certain areas (e.g., farther west in the Aleutians), the timing of when fish will be aggregated in fishable areas, and the times when both fish quality is high and the market demands them. To the latter point, a company might start one species later in the A season one year versus another if prices are low due to holdover inventories from the previous season.



Source: https://www.fisheries.noaa.gov/alaska/resources-fishing/federal-fishery-seasons-alaska (Accessed August 2020; last updated 4/12/2019)

Figure 3-13 Typical seasons for selected A80 target fisheries.

The whole of Section 0 gives evidence that the A80 sector has been in a near-constant state of change during the analyzed period and that the way in which historical fishery data are used for impact analysis in Section 5.5 should be carefully considered. The shifting factors that underly the sector include the natural environment, external management (e.g., regulations, TACs, PSC limits), and internal management (e.g., cooperative structure, bycatch avoidance strategies).

Section 3.3 covers some of the exogenous factors that have influenced A80 sector operations and will likely continue to do so in the near-term. That section recognized that the natural environment plays an important role in how fisheries occur – from stock status to fish aggregation (and CPUE). One small but important part of the underlying natural environment for these fisheries is the presence or absence of the Bering Sea "cold pool." Recent ocean temperature anomalies have likely impacted – or may impact in the future – the movement of target and non-target species. To the extent that fishery participants must reckon with this change, historical fishery data on catch, location, bycatch encounter rates, and CPUE might become less representative of the future state of the fishery.

The sector has experienced regulatory changes ranging from which species it might target on the margins (i.e. flatfish flexibility; Section 3.2.1.1) to how halibut encounter is estimated as PSC mortality (i.e. discard mortality rates and fish handling procedures like deck sorting; Sections 3.2.2.1 and 3.4.4). Some pre-existing regulations have built-in uncertainty that affects A80 operational decisions on an annual basis, such as crab conservation areas that might be open or closed to non-pelagic trawling from one year to the next (Section 3.2.4).

Participants in the A80 sector are linked to other groundfish fisheries to varying degrees. For example, a subset of A80 companies or vessels might also have direct linkages to the TLAS sector or to CDQ groups through ownership or at-sea processing relationships (Section 3.3.2.1). Recent changes in the regulations governing at-sea processing of CV catch (mothershipping) have shaped or limited revenue diversification opportunities for the A80 sector, and potential regulatory changes to the BSAI trawl CV sector (TLAS) could convey harvest privileges on CVs that deliver to A80 vessels in a mode that would not be affected by PSC limits subject to ABM.

Internally, the A80 sector has evolved since its establishment in 2008. Section 3.3.1 describes how the sector evolved from a mix of cooperatives and limited access participants to a single cooperative. That evolution involved companies exiting the sector or merging with the current managing cooperative, which is diverse in its mix of business plans but has made coordinated steps as a group to prioritize halibut mortality reduction on a progressive basis (Section 3.4.4). In certain years, these business transitions may have affected the catch and bycatch rates that the analysts can report at the sector level.

Recognizing the dynamics of the A80 sector, the analysts attempt to present time series data that reflect the shifts in internal and external management while acknowledging the stochastic effects of exogenous environmental factors. The full time series of A80 history is instructive in terms of how the sector arrived at the operational point where it currently exists, but in some cases the analysts have determined that the most recent set of years (e.g., 2017 through 2019) is most representative of the sector for the purpose of considering future outcomes under the considered ABM alternatives. Data from 2020 are included to the extent that they are currently available – i.e., for catch but not for revenue – with the caveat that the 2020 fishery encountered unique operational challenges and constraints due to the COVID-19 pandemic.

Throughout this document the analysts focus on fishery data for the years 2010 through 2020. The analysts sought to use as much data as possible to identify trends and historical events, while relying on years for which high-quality estimates are available and during which data are comparable across years. Years were also selected to focus on the period that best represents the current state of BSAI groundfish fishery management. While efforts to collect and process better data are always ongoing, it was determined that 2010 marks the earliest year after the implementation of Amendment 80 – as it is related to effects on other fisheries like TLAS and AFA – that the benefits of the eLandings system were achieved. The eLandings system began in 2006, but it took several years for it to be fully utilized and for its benefits to be realized in catch accounting and PSC estimation. The implementation of Amendment 80 in 2008 represented much change for managers as well as for fishery participants. Improvements in data collection and estimation procedures for the A80 sector were made in 2008 and 2009. In addition to eLandings and A80 implementation, the analysts note that NMFS Catch Accounting System (CAS) was modified over the course of 2013 and 2014; the current version of CAS is best applied to the years from 2010 to present. While CAS can still be used to query data from prior to 2010, the catch and bycatch estimates for earlier years were generated using a different set of programming procedures than the current practice. As a result, any data “fixes” needed to retroactively tag fishing activity to a sector definition that was developed specifically for this analysis would be difficult and potentially unreliable prior to 2010. In consultation with the Alaska Fisheries Information Network (AKFIN) and NMFS, the analysts determined that data beginning in 2010 offers the best achievable quality and consistency of sourcing, while also providing a 10-year sample through 2019 for revenues.

3.3.1 Fleet composition

Since 2010, the A80 fleet has consisted of 18 to 20 catcher processors, four to eight of which have also participated in the CDQ fishery in a given year (Table 3-12).[24] A majority of these vessels are owned by companies registered in Washington. Nine A80 CPs acted as motherships taking at-sea deliveries from the BSAI trawl CV limited access fishery (TLAS) in 2018, 2019, and 2020. NMFS has recently limited the number of CPs that can receive deliveries of TLAS Pacific cod (BSAI FMP Amendment 120, 84 FR 70064, December 2019) and the CVs that can deliver TLAS yellowfin sole to CPs acting as motherships (BSAI FMP Amendment 116, 83 FR 49994, October 2018). Only one A80 CP is allowed to receive TLAS Pacific cod deliveries (as is one AFA CP). Eight CVs are able to deliver TLAS yellowfin sole to CPs acting as motherships. The majority of those eight CVs are owned by A80 companies that also own the CP mothership to which they would likely deliver.

Table 3-12 Active A80 vessels that harvested A80 and CDQ allocations

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
A80	19	20	19	18	18	18	19	19	19	20	19	23
CDQ	7	8	7	6	6	4	6	7	8	8	7	12
Total	19	20	20	18	18	18	19	19	19	20	19	23

From 2010 through 2017, A80 consisted of two cooperatives that received annual allocations from NMFS, the Alaska Seafood Cooperative (AKSC)[25] and the Alaska Groundfish Cooperative (AGC). In 2017 the Fishing Company of Alaska began the process of terminating operations and selling its vessels, leading to the sector consolidating into a single cooperative, the AKSC. Apart from this, vessel ownership and cooperative membership has remained relatively stable through the years (Figure 3-16) and appears likely to remain stable in the foreseeable future. For some A80 companies, acquiring more of the limited number of permits is constrained by quota share ownership caps. While the sector has experienced a recent wave of newly built or refurbished vessels, total fleet transformation to high-capacity platforms may be tempered by the availability of catch (TAC), bycatch constraints (halibut PSC and others), and market demand for U.S. flatfish volume.

A80 companies vary in the A80 permits that they control, the number of CPs they own, whether or not they own the CVs with which they partner in the TLAS fisheries (vertical integration), and – importantly – the portfolio of groundfish species and PSC limits available to them each year. The cooperative receives annual catch allocations and PSC limits for specific species. Subsequently the cooperative calculates individual vessel harvest shares and PSC limits and establishes a mechanism for quota transfers within the cooperative and with the other A80 cooperative (if applicable). AKSC manages allocations by "initially apportion(ing) its annual NMFS-issued allocation to individual companies or vessels. Subsequently, AKSC companies can engage in transfers with other AKSC companies or vessels to maximize harvesting efficiencies. Because allocations are managed under hard caps, some portion of each of AKSC's allocations will be left unharvested to serve as a buffer prior to reaching allocation amounts" (Concepcion and Fina 2019). The A80 fleet sorts roughly into companies or groups of vessels that focus more on flatfish or roundfish based on the qualified catch history associated with their permits.

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[24] The F/V Golden Fleece qualified for a small amount of A80 cooperative quota based on 1998-2004 catch history but has elected not to participate in the sector (does not apply for quota) so that it is not subject to A80 sideboards on fishing in the GOA FMP area where it is historically highly engaged and reliant.

[25] http://www.alaskaseafoodcooperative.org/

Figure 3-14 shows the relative distribution of quota share for allocated A80 species associated with each of the 22 permits issued for the 2020 fishing year.[26] The allocation to 15 of the 22 permits is at least 50% flatfish. Only three of the permits are comprised of mostly roundfish (AI POP and Atka mackerel, excluding Pacific cod). Overall, 56% of QS units are for flatfish, 29% are for AI POP or Atka mackerel, and 15% are for Pacific cod. The QS units associated with a given permit does not reflect how a particular vessel will fish within the sector. Companies own multiple permits, and allocated pounds are transferable within the A80 cooperative(s).

Figure 3-15 illustrates the contrast between the five A80 fishing companies that are operative in 2020 in terms of the species mix upon which they rely. The vertical axis expresses the percentage that a species or species group comprises of a company's total catch or gross wholesale revenue over the entire 2010 through 2019 time period. The figure defines companies by the historical catch of the vessels for which they claim current ownership in the most recent A80 Cooperative Report provided to NMFS and the Council. Data are obscured to preserve confidentiality; the purpose of the figure is to show that the A80 sector includes companies with different levels of dependence on flatfish and roundfish, and thus different degrees of exposure to expected PSC rates when bycatch is constraining as well as a different set of options in terms of how they might continue their operation in the context of an effectual halibut limit. For example, it was noted above that companies have not historically transferred halibut PSC with one another, but at some point a greatly reduced PSC limit could force a company to either tie up vessels until lower-PSC fishing opportunities become available or pay what would presumably be a steep price for the ability to keep vessels working; a company in that situation is more likely to be one whose quota portfolio is tilted towards Bering Sea flatfish.

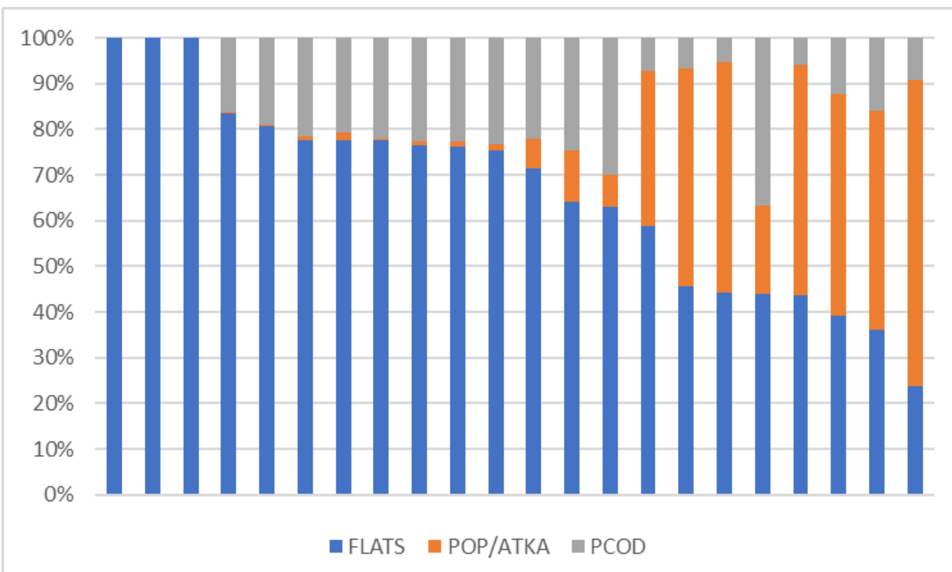

Figure 3-14 Proportion of species allocated on the 22 A80 quota share permits issued in 2020, by allocated species (FLATS = YFS, FHS, and NRS)

[26] Source: https://www.fisheries.noaa.gov/alaska/commercial-fishing/permits-and-licenses-issued-alaska. The annual NMFS report shows the gross number of quota share units associated with each permit. Fifteen of the permits were allocated an average of 56 million QS units while five permits were allocated seven million or fewer QS units.

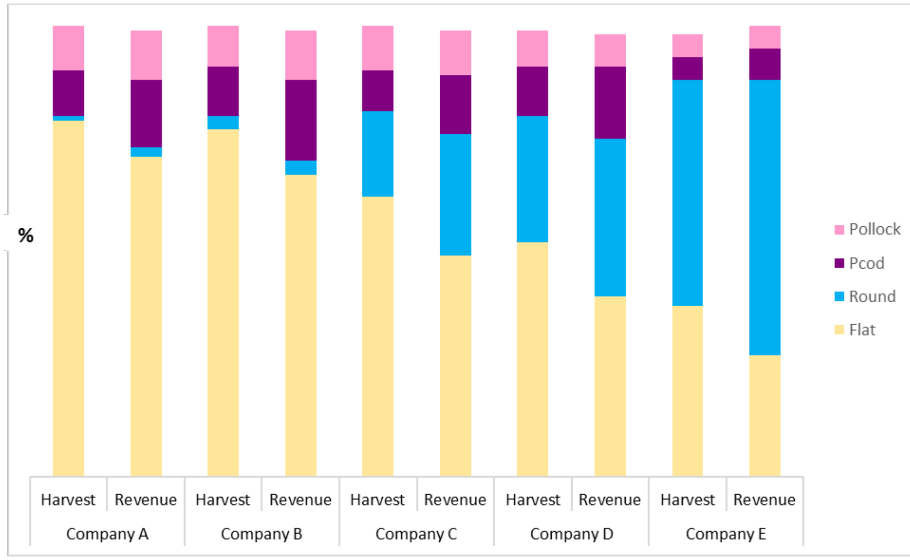

Figure 3-15 Aggregate 2010-2019 percentage of A80 harvest (t) and gross wholesale revenue ($) by species group for fishing company fleets as comprised in 2020 (Sources: NMFS Alaska Region Catch Accounting System, data compiled by AKFIN in Comprehensive_BLEND_CA; Vessel company affiliations taken from Alaska Seafood Cooperative Reports).

Figure 3-16 identifies the 28 CPs that have been enrolled in the A80 sector since 2010 by company and cooperative affiliation. Five of those 28 vessels were enrolled in a cooperative but have not actively fished in A80 during the analyzed period. Nevertheless they are shown in the figure because they appear on a cooperative roster; a vessel may be enrolled in the cooperative but not fishing due to the initial vessel-based-allocation structure of the A80 program so that quota pounds can be fished on active platforms.[27] Inactive vessels might also be enrolled in a cooperative to meet the minimum requirements for a cooperative to be formed. One additional vessel that has been listed on a cooperative roster is not shown because it has not ever fished within A80. Vessels that drop out of the figure in more recent years (e.g., Alaska Voyager, Tremont, Ocean Alaska, Ocean Cape, and Alliance) have either been sold to another company or remain owned but are not active in the sector and their permit has been assigned to an active A80 vessel. Some of those permits were reassigned to vessels that only appear in recent years (e.g., Seafreeze America, Araho, and America's Finest), which are newly built vessels.

[27] The vessel-based initial structure of A80 also explains why the Alaska Ranger, which sank in 2008, appears in the figure; the permit and associated catch history linked to that vessel remained in the cooperative until the controlling company's assets were transferred in 2017.

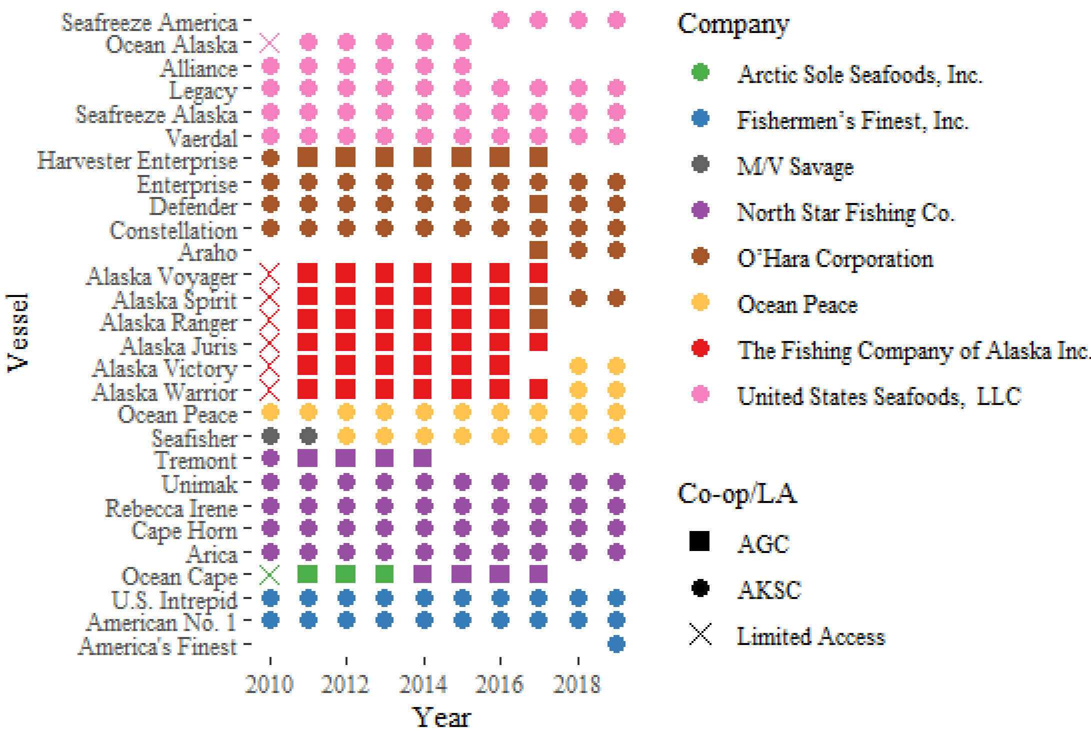

Figure 3-16 A80 Vessels by Company and Cooperative, 2010-2019. (Source: Adapted from information published in annual A80 Cooperative Reports and NMFS Permits & Licenses Issued)

The crew onboard A80 CPs typically includes between 30 and 40 individuals at a given time, and crews are rotated onto a vessel during the course of a fishing year. From 2015 through 2019, the annual number of people who worked on A80 vessels ranged between 1,729 and 2,181. In 2018, the average number of workers by position on an A80 vessel was roughly five deck crew, 27 processing workers, and 8 "others" comprising the officers, engineers, and cooks. Section 10.2 of the SIA details the crew data that are available from the A80 Economic Data Reporting (EDR) program. Crew size on A80 vessels tends to be higher than that of other BSAI groundfish sectors. HAL CP vessels typically carry around 20 individuals while trawl and HAL CV vessels, including directed halibut CVs, tend to have a crew of around four people.

3.3.2 Catch and Revenue

A80 CPs target an array of flatfish and roundfish species and retain secondary groundfish species for commercial use. In addition to the six species for which BS and/or AI TAC is allocated to A80 QS holders – yellowfin sole (YFS), northern rock sole (NRS), flathead sole (FHS), AI Pacific ocean perch (POP), Atka mackerel (Atka), and Pacific cod (Pcod) – A80 vessels also catch and process arrowtooth flounder (ATF), Alaska plaice (AKPL), sablefish (Sabl), and pollock (Plck). The "Other" category shown throughout this section includes northern and other rockfish, Kamchatka flounder, Greenland turbot, "other" flatfish, skates, sculpins, squids, sharks, and octopuses.[28]

Table 3-13 reports the total gross revenues and catch by all A80 sector vessels during the 2010 through 2020 period; dollar values are standardized to 2018 values to better isolate productive value without the

[28] During the three most recent years (2017-2019) the "Other" category is comprised by volume (mt) of roughly 44% Northern and other rockfish, 26% Kamchatka flounder, 13% Greenland turbot, 12% skates, 5% other flatfish, and negligible amounts of other listed species.

effect of inflation across the broader economy.[29] Revenue data for the 2020 fishing year are not available at the time of publication. Typically, the highest grossing species for the sector in terms of cumulative gross value are YFS, Atka mackerel, and rock sole. Figure 3-17 shows catch (mt) and gross first wholesale value (2018$) by individual species or species group from 2010 through 2019. Figure 3-18 reports the utilization rate of the A80 allocated species, showing stable high proportion of catch relative to TAC across both flatfish and roundfish species.[30] A80 vessels are not uniform in the mix of species that they catch. Figure 3-14 showed the diversity of allocated species across A80 QS permits. As those permits are assigned to vessels and as A80 companies deploy quotas across their fleets, certain vessels might be more or less dependent on flatfish versus roundfish in a given year. The difference in fishing portfolios across companies and vessels can also mean that individual companies or vessels are more or less exposed to potential halibut bycatch (refer to Figure 3-15 for rough depiction of company portfolios and to Table 3-20 in Section 3.4 for halibut PSC rates by target species).

NMFS's Catch Accounting System categorizes A80 vessels' catch by trip target. A trip for a CP captures a week of harvesting activity and a target species is assigned based upon the predominate species caught.[31] According to the Council's BSAI Pacific cod allocation review (NPFMC 2019c), most of the targeted Pacific cod originates from test tows for other Amendment 80 species that were not intended as Pacific cod target tows. In some instances, however, a vessel could target Pacific cod to facilitate that vessel's mothership processing activity as it works with trawl CVs operating in the TLAS sector. The ability to target Pacific cod is limited by the relatively small allocations of that species to A80 QS holders (13.4% of the BSAI TAC) and the need to reserve Pacific cod quota to cover incidental catch of cod while targeting other A80 species throughout the fishing year. The amount of Pacific cod allocated to the A80 sector is small relative to the tonnage allocated or accessed from the nonspecified reserve for some other species, but it is utilized at a high rate (Figure 3-18). Figure 3-20 shows that while cod is a small component of total A80 catch it occurs throughout the year concurrent with primarily targeted species (e.g., rock sole and yellowfin sole). Figure 3-35 shows that cod catch occurs throughout the geographic range prosecuted by A80 vessels.

[29] In this section and throughout the document (including the analysis of revenue impacts), dollar values are indexed to 2018 based on the U.S. Bureau of Economic Analysis, Gross Domestic Product: Chain-type Price Index, which is also the method most commonly applied by the Alaska Fisheries Science Center.

Citation: U.S. Bureau of Economic Analysis, Gross Domestic Product: Chain-type Price Index [GDPCTPI], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/GDPCTPI, August 24, 2020. Available at: https://fred.stlouisfed.org/series/GDPCTPI.

[30] Note that this information was drawn from A80 cooperative reports that are not available for 2020 at the time of publication.

[31] A trip is categorized as a flatfish target trip if the sum of flatfish catch (YFS, NRS, FHS, and other flatfish) is dominant over other species in the total catch. For YFS to be assigned as the trip target, the YFS catch must be greater than or equal to 70% of total catch. If that bar is not met on a flatfish target trip then the target is designated as the one of the other three flatfish species that made up the largest proportion of the trip's catch.

Table 3-13 A80 gross first wholesale revenue (2018 dollars) and catch (metric tons), 2010 through 2020. Source: NMFS Alaska Region Catch Accounting System, data compiled by AKFIN in Comprehensive_BLEND_CA

Year	Revenue (2018$)	Total Harvest (t)
2010	323,787,060	305,192
2011	385,153,549	302,157
2012	397,530,330	307,406
2013	307,582,132	306,775
2014	316,928,372	308,022
2015	290,450,269	289,169
2016	306,495,840	298,443
2017	359,357,539	278,771
2018	379,443,654	290,173
2019	335,260,125	288,302
2020		290,382

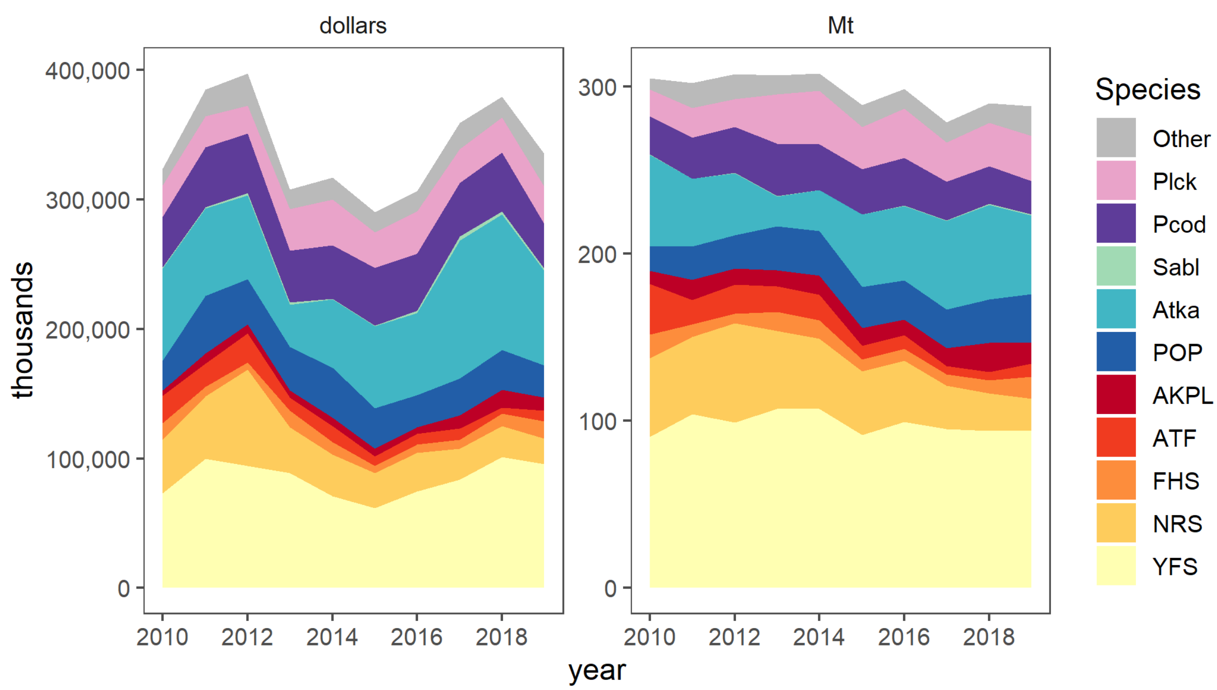

Figure 3-17 A80 gross first wholesale revenue (2018 dollars) and catch (metric tons) by species, 2010 through 2019. Source: NMFS Alaska Region Catch Accounting System, data compiled by AKFIN in Comprehensive_BLEND_CA

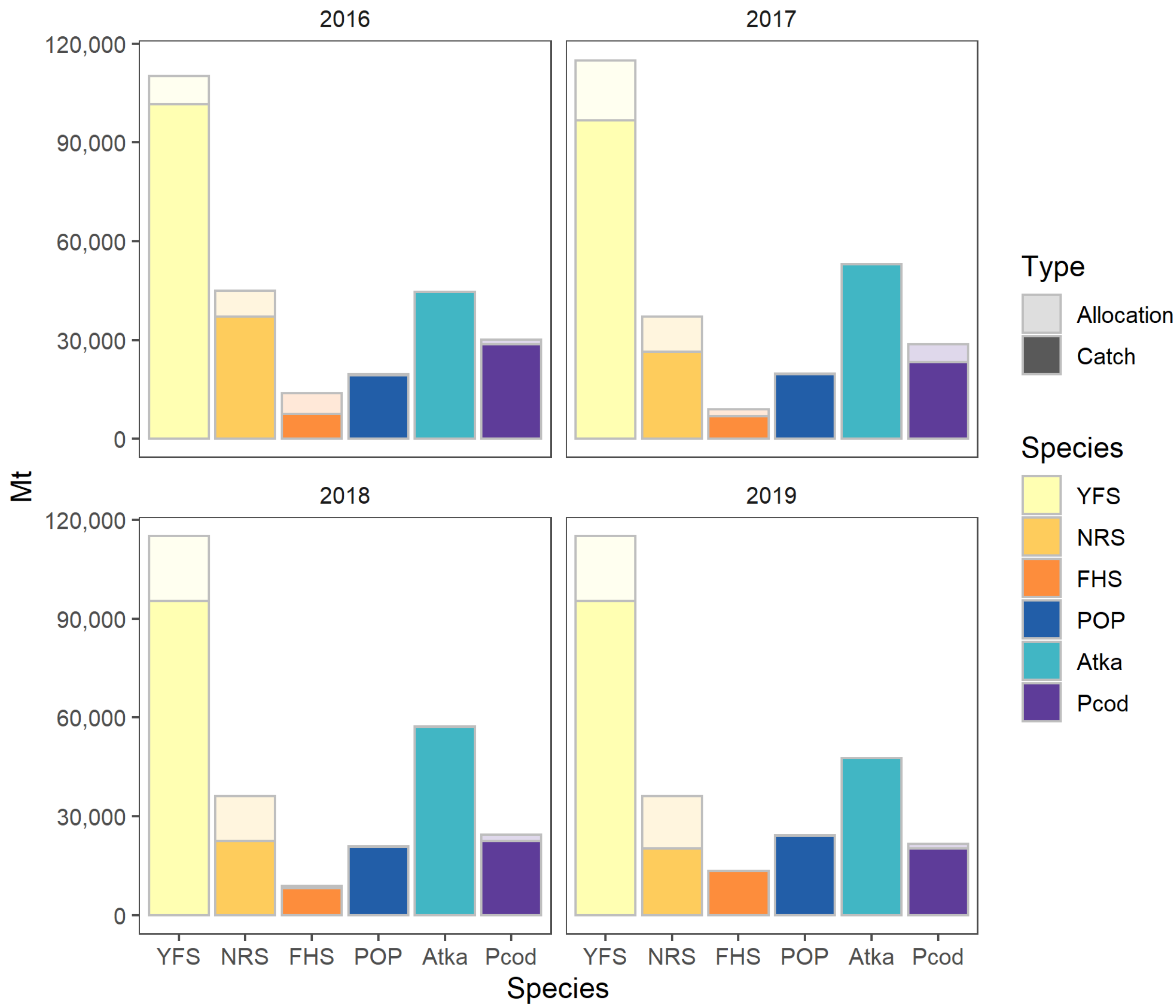

Figure 3-18 A80 allocation and catch 2016 through 2019. (Source: Adapted from information published in annual Cooperative Reports)

3.3.2.1 Consideration of first wholesale versus ex-vessel values for the A80 sector

In this document, Amendment 80 catch values are reported as gross first wholesale revenues. These values are derived from prices taken by AKFIN from Commercial Operators Annual Reports (COAR) that are then are linked to round weights and product weights by product type, and linked to a specific processor by production reports. The first wholesale price is the market price of the primary processed fishery product. This is the value of a processed product when sold by a processor to an entity outside of their affiliate network; it is typically equivalent to the value of product as it leaves Alaska (AFSC 2019). The first wholesale value is the most appropriate value to represent A80 revenues given the typical supply-chain of A80 product. While there is some variation across operations and for specific groundfish species/products, most A80 product is exported to secondary processors as frozen head and gut product.

For fisheries harvested by catcher/processors, there is no reliable ex-vessel price generated from the sale of raw fish by a harvester to a primary processor. Approximate conversions can be made and are, in some cases, used in the fishery management world. Two examples where estimated ex-vessel values are imputed from A80 catch are NMFS cost recovery and the application of the State of Alaska's Fishery Resource Landing Tax. However, those estimates do not claim to represent real product values for catcher/processors and it is generally accepted that ex-vessel estimates have varying degrees of accuracy across species and product types. For the purposes of cost recovery and taxation, the estimate is based on the value of processed products from catcher/processors (from COAR) divided by the retained round-weight (unprocessed weight) of catch and then multiplied by a factor of 0.4 to correct for the value added to the fish product by processing (NOAA Fisheries 2020). This document generally does not report wholesale to ex-vessel value conversions for A80 due to the imprecision of a generic conversion factor and the relative lack of utility in characterizing a catcher/processor fishery in ex-vessel terms. One exception to this is Section 3.3.2.4 (A80 fishery taxes). In that section, the analysts estimate the ex-vessel value of A80 catch from 2010 through 2019 (2018$) to reflect the order of magnitude for fishery taxes paid to the State of Alaska (Table 3-16). A reader who is intent on viewing the value of A80 catch in terms of ex-vessel revenue will find it there and is advised to apply all appropriate caveats to those estimates. The reader may find a different estimate – the total A80 fishery value used to calculate the cost recovery fee – in Section 3.3.2.5.

3.3.2.2 Diversification of revenue on A80 vessels

This subsection looks at the proportion and scale of gross wholesale revenues that A80 vessels generate from their allocated quotas (and secondary catch associated with that fishing), from acting as a mothership to CVs, from partnering with CDQ groups to harvest CDQ allocations, and from fishing in the sideboarded GOA trawl CP fishery. (Note that the operational relationship between A80 and the CDQ sector, as well as catch/revenue outcomes, is further described in Section 3.3.4).

In general, the A80 fleet is highly focused on BSAI non-pollock groundfish. That said, only two of 24 vessels active between 2010 and 2020 fished *exclusively* within the A80 sector. Table 3-14 shows the seven different fishery combinations that active A80 vessels displayed over the entire period considered, and in 2019 as a snapshot. In 2020, there were 19 active A80 vessels; seven fished CDQ (9,550 t of groundfish catch), nine operated as a mothership, and nine fished in the GOA. The analysts note that revenue derived from catching and processing CDQ fish, processing at-sea deliveries as a mothership, and operating in the GOA would not be directly “at risk” if the ABM alternatives result in A80 halibut PSC limits that suppress the reliable productivity of fishing the annual A80 cooperative quota and associated marketable secondary species.

Table 3-14 Modes of operations by A80 vessels active during 2010-2019: entire period and 2019 (M = mothership)

	Period	2019
A80	2	6
A80-CDQ	1	
A80-M-CDQ	1	4
A80-M-CDQ-GOA	6	2
A80-CDQ-GOA	4	2
A80-M-GOA	3	3
A80-GOA	7	3
Total	**24**	**20**

None of the currently active A80 vessels derive any revenue from Washington, Oregon, or California groundfish fisheries.[32] One A80 vessel is qualified as an AFA pollock CP. That vessel has not fished AFA pollock in the five most recent years reported and, while catch or revenue data cannot be reported for an individual vessel, pollock fishing did not comprise a significant portion of its activity during the analyzed period.

[32] One A80-qualified vessel that is no longer active in the sector had catch history in the West Coast region.

Figure 3-19 shows total gross first wholesale revenues for all A80 vessels that were active during the 2010 through 2019 period. For the entire period, A80 vessels generated 80% of total wholesale revenues from the catch and processing of quotas allocated to the sector and catch of unallocated species or marketable secondary species that was made on A80 trips. On an annual basis, that proportion never reached higher than 84% (2010) or fell lower than 76% (2017).

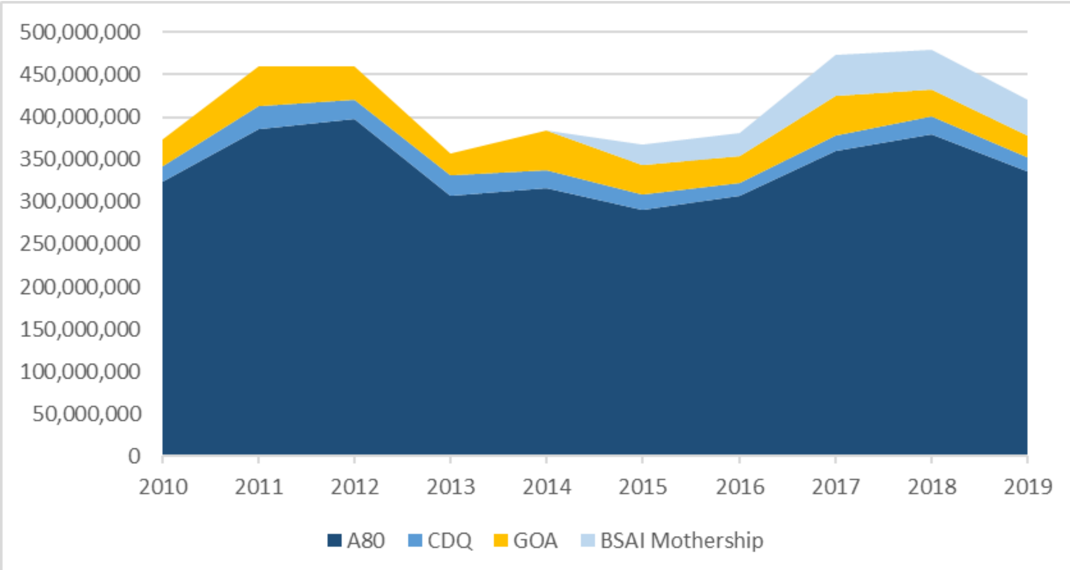

Figure 3-19 Total gross first wholesale revenues for A80 vessels across all activities (2018$), 2010 through 2019. (Note: BSAI mothership activity occurred from 2010 through 2014 but revenues are not shown because the data include fewer than three vessels.)

Since 2010, 10 different A80 vessels have acted as a mothership, processing Pacific cod and yellowfin sole target fishery catch delivered by CVs. Some of the CV catch delivered to A80 mothership vessels may have been catch of CDQ fish, but the analysts consider this mothership activity as opposed to the catching and processing of CDQ fish all on an A80 platform, which is described below and captured as "CDQ" in Figure 3-19. Only two A80 vessels participated in mothership processing from 2010 through 2014. From 2015 through 2019, the number of A80 vessels taking at-sea deliveries from CVs increased to six, seven, eight, nine, and nine in those years sequentially.

As noted in the previous section, recent regulatory changes now allow only one A80 CP to process Pacific cod as a mothership (Amendment 120) and only eight CVs may deliver yellowfin sole to motherships (Amendment 116). The latter regulation effectively caps A80 vessels' activity as yellowfin sole at-sea markets to those owned by companies that are associated with these eight CVs through direct ownership or existing business arrangements. The vessels that have acted as motherships are owned by three of the five current A80 companies. From 2017 through 2020, the number of A80 CPs that took yellowfin sole target deliveries from CVs was eight or nine vessels each year. Seven or eight A80 CPs took target Pacific cod deliveries from CVs in 2017 through 2019, but under the newly implemented regulation only one such vessel is currently able to do so.[33]

The estimated gross wholesale value generated by A80 mothershipping activity increased from around $24.7 to $27.6 million in 2015 and 2016 to $49.6 million in 2017 and then declining to $46.8 million and

[33] CPs acting as a mothership that are not permitted to function as an at-sea Pacific cod market may still receive and process cod up to an MRA, since Pacific cod is a maximum retention species. It is possible that a CP that is excluded from Pacific cod mothershipping might show up in observer data as having a mothership Pacific cod target if vessels targeting other species delivered more cod than intended, but the mothership's retention limit is still expected to be applied as fish are sorted in the processing factory.

$42.6 million in 2018 and 2019 respectively (2018$). The tailing off of mothershipping revenue in 2019 could be an effect of the recent regulations limiting mothership activity, but is more likely reflecting lower unit values for key mothership species (Table 3-15). In 2019, the average mothershipping wholesale revenue among the nine participants was $4.7 million but the median was $2.1 million, indicating that a few vessels are highly engaged in this mode of operation. In 2019 the average revenue from mothership processing among the three most highly engaged vessels was around $11.3 million. As a group, those three vessels generated 36% of their combined 2019 total gross wholesale revenues across all activities from processing as a mothership.

As shown in Table 3-12, 12 A80 vessels have harvested CDQ fish between 2010 and 2019. In recent years, the number of A80 vessels working with CDQ groups to harvest their non-pollock groundfish – either through a royalty arrangement or joint ownership – has been between six and eight vessels. Since 2010, three A80 companies have caught and/or processed CDQ fish; company-level participation cannot be reported over a smaller set of years due to confidentiality. Figure 3-23 reports that the average total annual wholesale revenue from CDQ catch on A80 vessels has been in the range of $17 million to $21 million in recent years. From 2017 to 2019, the average wholesale revenue generated by an A80 vessel's harvest and/or processing of CDQ fish was between $2.2 million and $2.7 million (2018$). In aggregate, the eight A80 vessels that have partnered in CDQ harvest from 2017 to 2019 generated between 8% and 9% of their total wholesale revenues from that activity.

From 2010 to 2019, 20 of 24 A80 vessels that were active at some point generated wholesale revenue when operating in the GOA. Sixteen A80 vessels fished the GOA from 2010 through 2012; no more than 13 A80 vessels fished the GOA since 2013, and in three most recent years it was eight or 10 vessels.[34] All five of the current A80 companies were represented by at least one vessel in the GOA during the 2019 fishing year. At the sector level, GOA wholesale revenues accounted for between 6% and 12% of total A80 revenues annually, with the lowest proportion occurring in 2019. The average annual proportion was 8% of total sector revenue. The period average total GOA wholesale revenue for A80 vessels (2018$) was $35.8 million (median = $32.8 million). The highest value occurred in 2014 ($47.8 million) and the lowest values occurred in 2013 and 2019 (~$25.6 million). The PSC limitations governing A80 vessels fishing in the GOA are described in Section 0.

3.3.2.3 Market information for selected A80 species

Table 3-15 reports the average annual gross first wholesale value per pound of the groundfish species that make up the bulk of A80 catch and revenue reported in Figure 3-17. The NMFS At-Sea Production Reports that underly the table are pulled only from vessels fishing within the A80 sector so, for instance, values reported for at-sea pollock production do not reflect AFA CP activity. The values aggregate across all product forms for each species that might come out of the A80 sector. Value-per-pound is reported here in nominal terms, meaning no adjustment for inflation has been made. A species for which external determinants of nominal value are stable would be expected to display a slightly upward trend over a period of years, without placing too much importance on small year-on-year variations. The principal factors that influence average wholesale values per pound include the strength of international demand relative to supply for a species (or a group of highly substitutable species), the at-sea processors' emphasis on producing higher-value product forms, and the strength of the global market for U.S.-produced seafood in the context of currency valuations, tariffs, and competition from foreign fisheries that produce similar types of fish. The time series of available data does not capture market shifts related to disruptions from the 2020 global health and trade crisis, which is likely to impact the marginal value of A80 products in the near-term.

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[34] This does not include one A80-qualified vessel that has opted out of receiving cooperative quota share so that is not subject to A80 sideboards in the GOA, where that vessel conducts all of its fishing.

The first four species listed in Table 3-15 are the ones that make up the greatest proportion of sector-level catch and gross revenue. Of those, POP diverges the most from the expect upward trend over the full time series. Prices for marketable non-target species such as pollock are likely not reflective of the general market of at-sea pollock because A80 platforms are not necessarily set up to produce and market the higher value products forms that would increase average annual unit prices. Sablefish makes up a small amount of total A80 catch but is notable for a recent sharp decline in nominal wholesale unit value. While no single explanation is apparent, it is likely that sablefish prices are down due to smaller average fish size and a general softening in demand markets. Unlike many flatfish species or species primarily allocated to the A80 sector (e.g., Atka mackerel), Alaska sablefish prices could be influenced by the ability of the hook-and-line sectors to catch their quotas and the prices at which they set the market.

Table 3-15 Annual average gross wholesale value (nominal $/lb. for selected A80 groundfish species, 2010 through 2019. Order of species roughly reflects total A80 catch by volume in 2019.

Species	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Yellowfin sole	0.53	0.64	0.62	0.50	0.45	0.48	0.54	0.65	0.82	0.77
Atka mackerel	0.84	1.03	1.13	1.22	1.39	1.03	1.00	1.37	1.36	1.15
Pacific ocean perch	1.17	1.74	1.41	1.07	1.20	1.06	0.93	1.13	1.05	0.81
Northern rock sole	0.61	0.77	0.92	0.57	0.55	0.55	0.61	0.71	0.90	0.83
Pollock	0.61	0.73	0.69	0.65	0.57	0.55	0.88	0.46	0.52	0.60
Pacific cod	1.07	1.34	1.18	0.85	1.00	1.18	1.12	1.37	1.73	1.45
Alaska plaice	0.46	0.51	0.58	0.49	0.48	0.43	0.44	0.80	0.63	0.64
Flathead sole	0.69	0.90	0.93	0.85	0.70	0.62	0.74	0.86	0.98	0.86
Arrowtooth flounder	0.48	0.72	0.86	0.63	0.83	0.74	0.84	1.30	0.87	0.86
Greenland turbot	1.52	2.19	1.89	1.45	1.60	1.56	2.05	2.00	2.00	2.04
Kamchatka flounder	-	0.70	1.00	0.55	0.74	0.67	0.83	1.48	1.28	0.99
Sablefish	5.61	6.28	3.76	4.31	5.10	4.93	4.66	4.67	2.89	2.88

Source: NMFS Alaska Region At-Sea Production Reports, data compiled by AKFIN in Comprehensive_WPR.

Notes: Greenland turbot and Kamchatka flounder are part of the “Other Species” category in previous catch/revenue figures. No average annual value for 2010 Kamchatka flounder was retrieved from NMFS At-Sea Production Reports by AKFIN.

The remainder of this subsection are adaptations from three Economic Performance Reports (EPR) on A80 species or species groups that were produced by the Alaska Fisheries Science Center’s Resource Ecology and Fisheries Management Division (REFM). The most recent available reports were produced in 2020 and focus on the 2019 fishing year as a baseline for retrospective trend analysis. The Groundfish Plan Teams recommend that stock assessment authors incorporate EPRs as an appendix to the assessment chapter, though that may not happen in cases when an assessment is in an “off-year” or if the EPR is for a broad species complex such as BSAI Flatfish. The three 2019 EPRs excerpted below are for BSAI flatfish, BSAI rockfish, and Atka mackerel.[35] The analysts caution that these reports do not necessarily represent the status of BSAI groundfish markets in the unique circumstances of the 2020 fishing year.[36]

BSAI Flatfish 2019 Economic Performance Report

BSAI FMP flatfish are predominantly caught in the Eastern Bering Sea by catcher/processors in the Amendment 80 Fleet. The two most significant flatfish species in terms of market value and volume are yellowfin and rock sole. These two species accounted for 64% and 12%, respectively, of the retained flatfish catch. Flathead sole, arrowtooth flounder, and Kamchatka flounder are also caught in significant

[35] Source: B. Fissel. AFSC REFM Division, personal communication, February 2021.

[36] One publicly available in-season tracker of fishery performance is a monthly report distributed by the McKinley Group for the Alaska Seafood Marketing Institute. That report draws on NMFS Office of Science and Technology (OST) data. Once 2020 value and export data are reconciled in 2021, analysts will be able to provide a more thorough analysis of the unique effects of 2020 on fishery value. Because NMFS OST data are not disaggregated by sector, management area, or even region of the county, the analysts continue to rely primarily on data provided directly by AKFIN for the analysis of impacts.

quantities accounting for approximately 5-10% of the retained flatfish. The remainder of the catch volume is comprised of other flatfish which includes Alaska plaice and Greenland turbot.

First-wholesale value in the BSAI flatfish fisheries decreased 1% to $209.8 million with a 4% decrease in yellowfin sole price, a 6% decrease in the rock sole price, an 11% decrease in the flathead sole price, and an 8% decrease in the arrowtooth flounder price.[37] Prices for most flatfish were at a decadal high in 2018 and the marginal decreases in 2019 left prices at a high level relative to prices over the last decade.

Flatfish are primarily processed into the headed-and-gutted (H&G) and whole fish product forms and changes in production largely reflect changes in catch. The export volume of yellowfin sole and rock sole is approximately 75-90% of the annual volume of processed products.[38] Exports are primarily destined for China and South Korea, with China typically accounting approximately 80-85% of total exports. In 2019 China's share of exports dropped to 71% and South Korea's share of value increased from approximately 15% to 20% in 2019. A significant share of this product is re-processed into fillets and re-exported to North American and European markets. Flatfish can serve as a substitute for other higher priced whitefish products, and price changes for these other species can influence flatfish demand. Some rock sole is processed as H&G with roe, which is a higher priced product which is primarily destined f or Japanese markets.

The Alaska flatfish fishery became MSC certified in 2010 and received the Responsible Fishery Management (RFM) certification in 2014. Certification provides access to some markets, particularly in Europe, and may enhance value. Some media reports have attributed the price increase in 2011 to the MSC certification and Asian markets where demand is expected to increase with growth in the middle class population. Reduced fishing opportunities in 2013-2014 for higher valued Atka mackerel may have diverted additional fishing effort towards flatfish increasing catch in these years. Increased supply and inventories from the additional catch put downward pressure on prices. As Atka mackerel fishing resumed more normal levels in 2015 and later, flatfish supply and inventories were reduced, prices began to rise. Atka mackerel catches were high in 2017 and 2018 which may have contributed to the reduced catch of flatfish despite high prices. Because of China's significance as a re-processor of flatfish products, the tariffs between the U.S. and China have put downward pressure on flatfish prices and may inhibit value growth in some flatfish markets. Industry lacks immediate alternative reprocessing options to China. Export quantities of yellowfin sole and rock sole increased in 2019 from 2018 and the share of exports to China decreased despite rising export prices.

BSAI Rockfish 2019 Economic Performance Report

Rockfish catch in the BSAI increased in 2019 from 2018 with a total catch of 54 thousand t and a retained catch 49.8 thousand t with significant catch increases for both of the primary rockfish species: northern rockfish and Pacific ocean perch. Catch levels in 2019 were the highest observed over the 2003-2019 time series analyzed, and were 30% higher than the previous high in 2018. Rockfish are an important component of the Amendment 80 fleet's catch portfolio. First-wholesale value of rockfish was down 2% in 2019 to $42.5 million despite the increased catch and production as first-wholesale prices decreased 21% to an average of $0.80 per pound.

The most significant rockfish species caught in the BSAI in terms of volume and value is Pacific ocean perch, which typically accounts for approximately 90% of the total BSAI rockfish value. In 2019, Pacific ocean perch's value share fell to 80% as it's price declined was larger than other rockfish species.

[37] Because BSAI flatfish are primarily targeted by catcher/processor vessels there is not a substantive ex-vessel market.

[38] Yellowfin sole and rock sole are the only species with species specific trade data. The other primary BSAI flatfish are aggregated into a non-species specific flatfish category.

Northern rockfish, which typically accounting for under 10% of the value, increased to 14% in 2019. Other rockfish, such as rougheye and shortraker rockfish are caught in significantly smaller quantities.

Rockfish are among the more valuable species caught by the Amendment 80 fleet with an average price per pound is typically higher than the flatfish prices (though this was not the case in 2019), however the volume of catch is significantly smaller than flatfish catch. Rockfish are typically harvested close to the total allowable catch (TAC) and TACs for Pacific ocean perch are set close to the Allowable Biological Catches (ABC). Because of this, annual changes in catch and production largely reflect changes in abundance and TAC. In recent years approximately 90-95% of the total rockfish catch has been retained.

First-wholesale prices decreased 22% for Pacific ocean perch to $0.80 per pound and decreased 12% for northern rockfish to $0.69 per pound. Increases in catch and production were not enough to offset the decrease in price for Pacific ocean perch and first-wholesale values were down to $34 million. Northern rockfish value increased to $5.9 million.

The majority of rockfish produced in the U.S. are exported, primarily to Asian markets. Pacific ocean perch is the only rockfish species with specific information in the U.S. trade data. Other species are aggregated into a non-specific category. Approximately 70% of the Pacific ocean perch exported from the U.S. went to China in 2019. This is an increase relative to recent years where approximately 60% of exports went to China. Exported H&G rockfish to China is re-processed (e.g., as fillets) and re-exported to domestic and international markets. Rockfish are also sold to Chinese consumers, as whole fish. The U.S. has accounted for just over 15% of global rockfish production in recent years and 85-90% of global Pacific ocean perch production. Global production of rockfish has increased 15% from the 2010-2014 average to 337 thousand t in 2018 and global production of Pacific ocean perch has increased 22%. Global production of Atlantic redfish, a market competitor to Pacific ocean perch, increased slightly to 52 thousand t but in recent years has remained relatively stable at roughly 50 thousand t. The U.S. dollar was relative stability in 2019 against other currencies, such as the Chinese Yuan, which mitigates its potential impact on market price. Because of China's significance as a re-processor of rockfish products, the tariffs between the U.S. and China have put downward pressure on rockfish prices and has inhibited value growth in rockfish markets. Industry lacks immediate alternative reprocessing options to China. Export quantities of Pacific ocean perch decreased in 2019 from 2018 and the share of exports to China increased despite declining export prices and increased production.

Atka Mackerel 2019 Economic Performance Report

Atka mackerel is predominantly caught in the Aleutian Islands, and almost exclusively by the A80 fleet. Atka mackerel is an important source of revenue for A80 because of its high price relative to other species. In 2019 Atka mackerel total catch decreased to 58.5 thousand t and retained catch decreased to 57.5 thousand t. Catch levels peaked in 2018 after significant reductions in the TAC in 2012 and 2013 when catch levels were low due to area closures to protect endangered Steller sea lions, and survey-based changes in the spatial apportionment of TAC. The 2019 decrease in the catch is a result of a reduction in the Allowable Biological Catch and TAC. Commensurate with the change in catch, first-wholesale production decreased to 34 thousand tons. The decrease in production coupled with a 14% decrease in price to $1.16 resulted in a 34% drop in first-wholesale revenue to $86.6 million.

The U.S. (Alaska), Japan and Russian are the major producers of Atka mackerel.[39] Typically, approximately 90% of the Alaska caught Atka mackerel production value is processed as head-and-gut (H&G) products, the remainder is mostly sold as whole fish. In 2019 99% of the catch was processed as H&G as whole fish production dropped off. Virtually all of Alaska's Atka mackerel production is exported, mostly to Asian markets. In Asia it undergoes secondary processing into products like surimi,

[39] Japan and Russia catch the distinct species Okhotsk Atka mackerel which are substitutes as the markets treat the two species identically.

salted-and-split and other consumable product forms. Industry reports that the domestic market is minimal and data indicate U.S. imports are approximately 0.1% of global production.

The upward trend in first-wholesale and export prices through 2018 had been influenced by international factors. In particular, global supply of Atka mackerel was in decline because of substantial decreases in catch volume in Japan. In 2018 catch volumes in Japan began to increase, coupled with increasing supply from the U.S. in 2018, which may be putting downward pressure on prices that carried through into 2019. Despite the decrease, Atka mackerel prices remain high relative to pre-2017 levels.

Global production dropped from an average of 226 thousand t between 2008-2012 to an average of 108 thousand t between 2015-2017. The reductions in international supply meant that the U.S. has captured a larger share of global production in recent years relative to the 2008-2012 average. The global supply reductions put upward pressure on the price which is reflected in the higher price after 2011. Additionally, the opening of previously restricted areas off the Aleutians has given industry more access to larger fish which yield a higher price per pound in the market. The increased price of Atka mackerel in recent years has helped to increase first-wholesale value. International production of Atka mackerel was on the decline because of reductions in Japanese, and Russian catch and production which were particularly severe in 2015. The U.S. supplied 55% of the global market of Atka mackerel in 2018. This resulted in increased demand for U.S. Atka mackerel in Japan where it is used to make surimi among other products. Because Atka is primarily exported to Japan, which constitutes roughly 70% of the export value, the U.S. exchange rate can influence first-wholesale prices, and the exchange rate has remained stable since 2016.

3.3.2.4 A80 fishery taxes

The A80 sector's production generates taxes that are important revenue sources for communities, boroughs, and the State of Alaska. That production includes the catch and processing of A80 groundfish species, the catch and processing of CDQ groundfish on A80 platforms, and the processing trawl limited access sector (TLAS) catch on A80 platforms. In addition to taxes paid, the A80 sector remits cost recovery fees to NMFS to defray direct costs of management, data collection, and enforcement. This section summarizes the taxes levied on the Amendment 80 sector's fishing activity and estimates the fish tax liability and cost recovery payments incurred by the sector in recent years. Additional analysis of tax revenues related to the ABM action is provided in Section 10.4 of the SIA attached to this DEIS. Taxes and other fees that pertain to the directed commercial halibut fishery are addressed in Section 4.4.1.3 of this DEIS.

There are two main sources of fishery taxes in Alaska: shared taxes administered through the State of Alaska – described below – and municipal fisheries taxes independently established and collected by select municipalities. Municipal fish taxes are typically levied on raw fish landings, and thus would not apply to vessels that catch and process BSAI groundfish at-sea. A80 vessels contribute to municipal tax bases through non-fishery tax programs related to marine fuel sales and transfer, port usage, sales tax related to provisioning, and bed and other commerce taxes related to crew rotation through Alaska communities. There is no single source for data on these revenue streams and available municipal-level tax summaries do not disaggregate non-fishery tax payments by business sector (i.e. fisheries), much less by fishery management sector (e.g., A80). The Alaska Department of Commerce, Community, and Economic Development (DCCED) provides a summary of municipal taxes.[40] Port calls by A80 vessels are a rough measure of the sector's interaction with Alaskan communities and the potential for local taxes on spending by the vessel and its crew, but they are the best available proxy. Section 4.5.3 of the SIA attached to this DEIS summarizes A80 port calls by community (Table 6). The SIA reports that the A80

[40] The 2019 Alaska Taxable Supplement is available at https://www.commerce.alaska.gov/web/Portals/4/pub/OSA/Official%202019%20Alaska%20Taxable.pdf. At that site the reader can refer to Table 1A ("Reported Tax Rates") for sales tax and other commerce taxes and revenues for 2019.

sector typically makes between 215 and 250 port calls each year. Since 2015, the prevalent trend in port calls has been roughly 67% to Unalaska, 12% to Adak, 7% to Togiak, and a small number of calls to St. Paul, Atka, and Sand Point. According to Observer Data, roughly 10% of port calls are attributed to "Other/Unknown Community. Transfers at sea are rare in the A80 sector; dating back to 2010 only five are documented (four in 2010 and one in 2016). A transfer at sea could be relevant to State of Alaska taxation if it occurs outside of the 3nm state boundary.

The two State of Alaska fish taxes paid by the A80 sector are the Fishery Resource Landing Tax and the Seafood Marketing Assessment.

The Fishery Resource Landing Tax (FRLT) is levied on fish processed outside the 3-mile limit but, within the U.S. EEZ, and first landed in Alaska. The tax liability is based on the estimated unprocessed (ex-vessel) value of the resource. The State determines the unprocessed value for CP production by multiplying a statewide average price per pound of unprocessed fish – as derived from ADF&G data – by the unprocessed weight. The tax is collected primarily from CPs that bring their products into Alaska for transshipment and applies whether the product is destined for local consumption or shipment abroad. Under Alaska Statute (AS) 43.77, CPs and motherships are required to pay this tax at a rate that is equivalent to rates paid by catcher vessels and shore-based processors under the Fisheries Business Tax (AS 43.75). The levy is set at 3.0% for fisheries classified by ADF&G as "established," as would be the case for the A80 sector. According to state statute, all revenue from the Fishery Resource Landing Tax is deposited in the state's General Fund but half of the revenue is available for sharing with the municipalities where fishery resources are landed. If the offload or landing occurs at a community in an "un-organized borough" (as is the case for communities like Unalaska and Adak), the fish taxes are shared primarily between that community and State; a small portion could go to other communities in the un-organized borough. This tax was established in 1994. The State of Alaska Department of Revenue reports that the FRLT brought in between $9.72 million and $9.95 million from 2016 through 2018, and $12.47 million in 2019, though it should be noted that much of that revenue was likely generated in the at-sea sector of the AFA pollock fishery.[41] The footnoted report shows that the amount of the FLRT that is shared with municipalities is highly variable by year. Table 3-16, described below, provides an estimate for the order of magnitude in tax payments generated by A80 vessels.

The State of Alaska also levies a Seafood Marketing Assessment of 0.5% on all seafood processed or first landed in Alaska and any unprocessed fishery products exported from the state (AS 16.51.120).[42] Revenues from the Assessment are deposited in the State's General Fund by statute but are historically appropriated to the Alaska Seafood Marketing Institute.

Table 3-16 provides an estimate of the State of Alaska tax revenues generated on A80 vessels from 2010 through 2019. The estimated tax rate of 3.5% is the sum of the FRLT and the Seafood Marketing Assessment. AKFIN uses a proxy value to estimate the unprocessed value of A80 catch because the sector does not trade in unprocessed fish by definition. The AKFIN estimate of ex-vessel value is based on an assumed 40% relationship between ex-vessel value and first wholesale value. That assumption is augmented, when possible, by ADFG Fish Tickets that are not required of A80 vessels but may be submitted with the vessel's own estimate of unprocessed value. The reader should be aware that the values presented in Table 3-16 are not the same values used by the State of Alaska to calculate fish tax liabilities. From 2010 through 2019, AKFIN estimates the average annual unprocessed value of production on A80 vessels at roughly $158 million (2018$). At a 3.5% tax rate accounting for the FRLT and the Seafood Marketing assessment, the A80 sector would have paid roughly $5.5 million per year in Alaska fish taxes (2018$).

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[41] Alaska Department of Revenue – Tax Division: Fishery Resource Landing Tax Annual Report Data: http://www.tax.alaska.gov/programs/programs/reports/AnnualData.aspx?60631, accessed August 2020.

[42] Processors or harvesters who produce less than $50,000 worth of seafood products during the year are exempt.

Table 3-16 Estimated ex-vessel value of production on A80 CP vessels and estimated State of Alaska tax revenues, 2010 through 2019. Estimated tax based on sum of Fishery Resource Landing Tax and Seafood Marketing Assessment (3.5%).

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
Sector					Estimated Ex-Vessel Value (2018$)						
A80	134.2M	154.3M	161.9M	128.8M	123.7M	116.3M	125.4M	144.8M	150.6M	140.7M	1,380.6M
CDQ	8.3M	12.5M	11.7M	10.2M	8.3M	8.2M	9.0M	11.5M	10.8M	11.0M	101.5M
TLAS	3.7M	9.5M	10.5M	9.7M	8.0M	8.8M	8.9M	16.0M	13.8M	12.7M	101.5M
Total Ex-Vessel	146.2M	176.3M	184.1M	148.7M	140.0M	133.3M	143.3M	172.2M	175.2M	164.3M	1,583.6M
Sector					Estimated Tax at 3.5% Rate (2018$)						
A80	4.7M	5.4M	5.7M	4.5M	4.3M	4.1M	4.4M	5.1M	5.3M	4.9M	48.3M
CDQ	0.3M	0.4M	0.4M	0.4M	0.3M	0.3M	0.3M	0.4M	0.4M	0.4M	3.6M
TLAS	0.1M	0.3M	0.4M	0.3M	0.3M	0.3M	0.3M	0.6M	0.5M	0.4M	3.6M
Total Tax	**5.1M**	**6.2M**	**6.4M**	**5.2M**	**4.9M**	**4.7M**	**5.0M**	**6.0M**	**6.1M**	**5.8M**	**55.4M**

Source: NMFS Alaska Region Catch Accounting System, data compiled by AKFIN in Comprehensive_BLEND_CA

The activity on A80 vessels captured in Table 3-16 includes the harvest of groundfish quotas allocated to CDQ groups (Sector = CDQ). Under AS 43.77.040, a taxpayer – i.e., an A80 company or the LLC associated with an A80 permit holder – may claim as a credit *up to* 45.45% of the tax liability on CDQ fish revenues if contributions are made to one of a set of qualifying purposes defined in the statute. Qualifying purposes include scholarships for in-state study related to fisheries management or related business, training in the state for employment in the seafood industry, capital contributions to fishery infrastructure construction or improvement, or Alaska fisheries research grants. This provision does not mean that CDQ fish are taxed by the State of Alaska at a lower rate; rather, those gross revenues may be offset to a limited extent by voluntary tax-deductible contributions to qualifying purposes.

3.3.2.5 NMFS Cost Recovery

The A80 sector is subject to NMFS cost recovery fees assessed on the estimated ex-vessel value of catch. The MSA authorizes the collection of cost recovery fees for LAPPs, the CDQ program, and the halibut/sablefish IFQ program (MSA 304(d)(2)). Cost recovery fees recover actual costs directly related to the management, data collection, and enforcement of the programs. The MSA mandates that cost recovery fees do not exceed 3% of the annual ex-vessel value of fish harvested by a program subject to a cost recovery fee (MSA 305(d)(2)(B)). The fee calculation is based on NMFS standard prices for the species relevant to a fishery subject to cost recovery. NMFS's Cost Recovery and Fee Programs web page[43] links to the Federal Register notice announcing each subject fishery's standard prices and fee percentages by year through 2019, as well as to cost recovery annual reports by sector for 2016 through 2019. Fees are determined by dividing direct program costs by the value of the fishery's landings. The factors and methods that go into the fee calculation are described at 50 CFR 679.95(c)(2). Table 3-17 reports cost recovery fees for selected programs from 2017 through 2020.[44] From fiscal year 2017 through fiscal year 2020, direct costs for A80, which is the amount paid by the sector, increased from $836,924 to $962,757 to $1,048,481 to $1,058,662. For those years, respectively, the assessed fishery value in estimated ex-vessel terms was $118.2 million, $127.7 million, $111.6 million, and $89.2 million. (Note that these values differ from what is shown in Table 3-16 due to the difference between the NMFS standard pricing methodology, which incorporates rolling average annual species values, and the method that AKFIN utilizes to estimate CP ex-vessel value from at-sea production reports and ADFG Fish Tickets that are supplied by A80 vessels.)

[43] https://alaskafisheries.noaa.gov/fisheries/cost-recovery-fee-programs

[44] 2020 cost recovery fee percentages for A80 and CDQ are published at 85 FR 77180 (December 2020); the 2020 cost recovery fee percentage for IFQ is published at 85 FR 82442 (December 2020).

Table 3-17 NMFS cost recovery fees for selected fisheries (Source: NMFS Cost Recovery Reports)

Cost Recovery Program	*Year Implemented*	*2017 Rate*	*2018 Rate*	*2019 Rate*	*2020 Rate*
Amendment 80	2016	0.71%	0.75%	0.94%	1.19%
CDQ	2016	0.55%	0.66%	0.70%	0.84%
Halibut/Sablefish IFQ	2000	2.20%	2.80%	3.00%	3.00%

For CP sectors such as A80, there is no reliable ex-vessel price generated from the sale of fish from a harvester to a processor. Therefore, NMFS estimates the ex-vessel price for those species using reported information on the first wholesale price from CPs that harvest A80 species. The first wholesale price is the market price of the primary processed fishery product. The estimated standard ex-vessel price is the value of processed products from CPs divided by the retained round-weight (unprocessed weight) of catch and multiplied by a factor of 0.4 to correct for the value added to the fish product by processing. NMFS calculates an annual standard price for A80 Pacific cod using volume and value data reported in the Pacific Cod Ex-Vessel Volume and Value Report, which includes data from January 1 through October 31. Each landing made under the program is multiplied by the appropriate NMFS standard price to arrive at an ex-vessel value for each landing. These values are summed together to arrive at the total ex-vessel value of the A80 fishery.

3.3.3 Operations and Annual Planning

A qualitative understanding of the A80 fishing year – and the diversity of company-level business plans and vessel-level fishing plans within the sector – is especially important because the sector works with a highly varied portfolio of allocated target species and marketable unallocated groundfish species compared to other BSAI sectors. Annual data on harvest volume and gross revenue – either by Catch Accounting System (CAS) "target species" or by individual species (see Figure 3-17) – do not reflect how species are physically comingled or, critically, the decisions that vessel operators make to derive value from a trawl tow. For example, CAS might retrospectively show that fishing occurred in the arrowtooth flounder or flathead sole target based on the relative proportion of catch, but the fishing was made profitable by the value of other retained species. Annual data also smooth over calendar-based decision factors like roe content, flesh quality, aggregation (CPUE), fishing conditions (e.g., water temperature or lunar cycles), market demand, the timing of inseason reallocations from other fisheries (e.g., non-pollock TAC from AFA, PSC from TLAS), and unallocated fishing opportunities that may be opened by NMFS inseason managers at unpredictable times based on TAC that would otherwise go unharvested (e.g., BS POP or WGOA rockfish).

The information in this section is bolstered by anecdotal information and local knowledge offered by A80 company and vessel managers as well as skippers. The analysts have verified information about the timing and location of fishing using available catch data. The inclusion of this narrative description of A80 sector operation is important for understanding the factors that can dictate a company or a vessel's response to external constraints, which includes – but is certainly not limited to – halibut PSC limits. This section represents one of the analysts' best tools to characterize the *practicability* of maintaining historical levels of groundfish fishing under severely reduced PSC limits, and how the amount of the PSC limit reduction would be experienced across the diversity of business/fishing plans that exists within the sector. That said, the analysts do not contend that this qualitative information allows the reader to draw "bright lines" where a sector-level PSC limit of, say, 1,350 t is "practicable" but a limit of 1,300 t is not.

Skippers make in-season decisions about targeting and location based on expected halibut PSC rates associated with a given target, area, or time of year. At the same time, a vessel operator must manage an annual allocation of important "choke species" such as Pacific cod or risk losing the opportunity to keep the vessel working later into the year in other profitable targets that have an intrinsic cod encounter rate. Section 3.1.7.2 of the Amendment 80 Program 5-Year Review (Northern Economics & NPFMC 2014) describes how allocation of Pacific cod transitioned the species from a target to an incidental catch species and how that reality influences vessels' annual fishing plans. After Pacific cod was allocated to A80 cooperatives, fleet managers have had to calculate the amount of cod their vessels will need in fall fisheries and adjust their targeting decisions in the earlier part of the year.

The A80 5-Year Review noted that 55% to 75% of the fishery's Pacific cod was taken in a CAS "target" fishery prior to the program's 2008 implementation, whereas recently cod "targeting" accounts for less than 10% of the sector's cod catch. The Review cited as examples that effort in high cod-rate fisheries like flathead sole has declined in favor of arrowtooth and Kamchatka flounder, for which directed fishing is not opened until May 1. Among the key allocated A80 species, YFS has a relatively low cod catch rate, as do roundfish like Atka mackerel and POP. While cod rates are low in the YFS fishery, managing cod quota is important due to the high TAC for YFS relative to other flatfish species. Rock sole, which can be a higher-value flatfish species during the early-year roe season, has among the highest cod rates. It is important to acknowledge that cod can drive decision-making as much as halibut, and that each company or vessel enters the fishing year with a different intra-cooperative cod allocation based on the qualifying catch history of the permits they hold.

A80 companies and vessel operators work within constraints other than halibut PSC and allocations of choke species like Pacific cod. Trawl vessels are excluded from certain areas by regulation – e.g., crab protection zones (see Section 3.2.4) or Steller sea lion critical habitat – and might be excluded de facto if fishing grounds are preempted by fixed-gear vessels (including crabbers) in Federal or state-waters fisheries. Vessel operators might not be able to follow an aggregation of "clean" (low-bycatch) A80 species if it moves into a prohibited or preempted area. Some areas are only prohibited in certain years, dependent on exogenous factors. For example, the Subarea along the southern edge of the Bristol Bay Red King Crab Savings Area is open or closed annually based on BBRKC stock status (Figure 3-10). Other constraints might be temporal.

A80 companies and vessels respond to bycatch constraints in the context of other non-regulatory factors that determine when and where vessels target certain groundfish species. The allocation of BSAI non-pollock species to A80 CPs has allowed companies to plan for groundfish fisheries that span most of the calendar year and has insulated companies that want or need to pursue late-year opportunities from the effects of other participants whose incidental catch or PSC might have otherwise closed the entire sector. Many vessels strive to stay working from January 20 to November. Most overall catch occurs from February through October with catches falling off November through January (Figure 3-20). Other monthly patterns include higher catches of POP in the summer months (particularly July) and a larger proportion of Pacific cod and rock sole earlier in the year (February through April or May) (Figure 3-20). The focus on cod and rock sole early in the year is driven in part by fish aggregation (cod) and roe content (rock sole).

An A80 vessel that is experiencing unacceptable Pacific cod bycatch or halibut PSC rates in an early-season flatfish target might switch focus to an unallocated target that is not yet open to directed fishing. Those unallocated species might include arrowtooth/Kamchatka flounder or Greenland turbot which open on May 1, or BS POP which is only opened to directed fishing as the BS pollock fishery winds down in the fall. Some flatfish species might be technically open prior to May but the fish are not aggregated or catchable until later in the year (e.g., flathead sole). "Fall-back" opportunities for A80 vessels when early season fisheries are utilizing too much of a constraining species vary depending an operation's ability to target roundfish – particularly in the AI – or its endorsement to fish in the GOA (arrowtooth flounder in the spring or the Central GOA Rockfish Program after May 1). Variation across A80 companies in terms of access to roundfish are illustrated in Figure 3-15; diversification of total revenue across A80 cooperative fishing, mothershipping, CDQ partnerships, and fishing in the GOA are described in Section 3.3.2.1. Broadly speaking, alternatives to BS flatfish for A80 vessels are not an option for some vessels to consider until May or June.[45] Prior to that, a company with limited options might have no better response to high PSC rates than to deck sort aggressively and testing different locations. Accessibility to non-flatfish species can also vary within a company if, for instance, the smaller vessels are not equipped with the fuel, horsepower, or packing capacity to fish safely and effectively in the Aleutians.

While this analysis does not estimate companies' operational costs or their net profitability, participants report that most A80 companies rely on a full and varied season to run their business. When constraints such as high Pacific cod or halibut bycatch rates emerge, vessel operators do not have the option to cease fishing completely because cost accrual on such large platforms would be unsustainable. Participants also noted that a mid-year stand down could result in crew-retention issues. Moreover, it was noted that shutting down and restarting a CP factory could actually cause mechanical challenges, spinning off new costs. As a result, A80 operators do not follow a uniform progression from one target to the next over the course of the season. Annual fishing plans are designed with contingency in mind, and when all options are suboptimal the response is often to stay active and look for areas with the right species combinations even if it is in a time/area that history would not have predicted. Participants noted that "looking" for the right fish does not necessarily require a net in the water, and that it is better to continue learning the present situation on the grounds than to leave and have to reestablish that knowledge later. Vessels have increasingly utilized shorter test-tows to gauge haul composition and the presence of limiting species, though. Vessels are likely evaluating the benefit of a test tow in light of the cost of running a factory at less than full capacity and also the risk of bringing in a haul of constraining or PSC-limiting species. Regardless of these complicating factors, A80 vessels are unlikely to preemptively cease fishing due to an unpredicted mid-year constraint.

The annual planning process begins the preceding fall with harvest specifications. The A80 sector has a unique consideration in the harvests specifications flexibility procedure where the cooperative(s) (and CDQ groups) can exchange TAC of YFS, rock sole, or flathead sole for TAC of another species from that group, up to the limit of the ABC and the 2 million metric ton cap. It is possible that flexibility exchanges could be made with expected bycatch rates in mind if the PSC limit were to become the preeminent decision-driver for the sector. In practice, flatfish specification flexibility has mostly been used in recent years to maximize the availability of species that are catchable. For example, in years when the early season rock sole roe fishery does not materialize to the point that all TAC is harvested, the cooperative might utilize specifications flexibility to exchange rock sole TAC for YFS TAC that can be prosecuted later in the year.

A80 operators tend to spend the early months of the year in the BS, striking a balance between CPUE, profitability, and market demand while managing Pacific cod and halibut bycatch to preserve opportunities to fish later in the year. Some opportunities are only available early in the year, such as the rock sole roe fishery (and its associated Pacific cod bycatch rate). Monthly catch data display this pattern with generally higher catch of rock sole and Pacific cod early in the year, tailing off by May (Figure 3-20). The timing of YFS targeting is more variable and can be opportunistic depending on the availability of other species and bycatch rates. In some cases, vessels might target YFS earlier in the year in the Togiak/Bristol Bay area; that activity can include bycatch of other flatfish species like Alaska plaice that is marketable at a lower value. The optimal timing of allocated species catch is also driven by market quality. Markets for flatfish and roundfish can differ, meaning that not all companies are facing the same decision-set when selecting targets at a given time of year. In some years, holdover inventories from the previous year's market might incentivize a company to delay harvest of a certain species until prices rebound, but that option might not be available if a vessel does not have viable alternative target

[45] While 2020 data are incorporated into this analysis to the extent they are available, the analysts note that market disruptions due to international trade relations and a global health pandemic affecting demand for A80 species might have shaped companies' business plans as much or more than halibut PSC rates.

opportunities at the time or if a company plans to deploy that vessel in other areas/targets later in the season.

Operators must also manage their catch of unallocated species that NMFS accounts for under the "non-specified reserve". NMFS Inseason management uses this reserve to account for unallocated species on a BSAI-wide basis, meaning that bycatch in other fisheries (e.g., AFA pollock) can affect how much of a species like BS POP is available for a directed fishing allowance by A80 CPs at a given point in the calendar year. For example, the availability of turbot as a secondary species might determine whether arrowtooth flounder is a viable fall-back fishery if other targets are yielding high halibut or cod bycatch. If incidental catch causes the TAC for an unallocated species such as skates to be exceeded, NMFS may use the non-specified reserve from other species to cover that catch under the 2 million ton cap. Drawing down the reserve could, in some instances, reduce the opportunity to catch species that are typically of more value to the sector later in the year, such as BS POP.

May through August is typically when A80 vessels might branch out to the GOA or to the AI depending on their area endorsements – to the CGOA Rockfish Program, or to other GOA rockfish and flatfish participation. YFS fishing can remain productive and clean through May or June until they spawn and disaggregate. Opportunities to diversify in the case of constraining bycatch expand for some participants in June and July as AI rockfish are pursued. Summer fishing for Atka mackerel tends to offer lower CPUE, so after rockfish vessels might move back into BS flatfish before returning to the AI for the mackerel B season. Vessels that overuse cod or other allocations early in the year might be forced to trade within the cooperative in order to fish in the fall. Similarly, vessels that accrue halibut in spring or summer fisheries might jeopardize their ability to fish YFS in October and November. Because some fall fisheries for unallocated species such as BS POP are reliant on usage in other fisheries, companies might plan their business strategy and bycatch usage differently from one year to the next.

Many A80 vessels will return to allocated species in the fall, with the fleet breaking down across YFS vessels and Atka mackerel vessels depending on the history that they brought to the cooperative. These patterns can be seen in monthly catch figures with the year bookended by relatively high YFS catch in February through May and again in September through October (Figure 3-20). The 2020 fishing year followed the familiar pattern in terms of target catch by month. One difference from the most recent years was that catch in the rock sole target tilted earlier in the year, similar to the timing seen from 2010 through 2015.

A80 companies are not uniform in their area endorsements or their cooperative allocations of flatfish and roundfish, and thus might have different levels of exposure to a lower halibut PSC limit (Figure 3-15). Operators that have greater Atka mackerel and AI POP allocations are more able to move out of the BS if early-year halibut bycatch rates are unusually high. Flatfish-oriented operations might only have the option to remain in the BS or to move into the GOA. The ability to fish in the GOA is limited in regulation by endorsements and season-date limitations, but can also be limited by halibut PSC limits in that area. The number of A80 vessels that have fished in the GOA and the relative proportion of their total revenues generated in that fishery were discussed in Section 3.3.2.1; that section demonstrates that GOA revenues are likely not enough to replace what would be lost if an A80 company with no BSAI alternatives to flatfish was effectively closed out early by PSC. GOA CPs and CVs share seasonal halibut PSC apportionments, and GOA deep-water complex flatfish fisheries could be closed if effort and bycatch by GOA CVs targeting arrowtooth flounder are high. It is possible that an A80 vessel could move to the GOA due to poor fishing in the BS but would exhaust its GOA opportunities well before the end of the year and have no alternative to returning to the BS and search for fish.

Finally, A80 companies differ in their engagement in fishing CDQ groundfish through partnerships and in acting as a mothership for CVs, as detailed in Section 3.3.2.1.

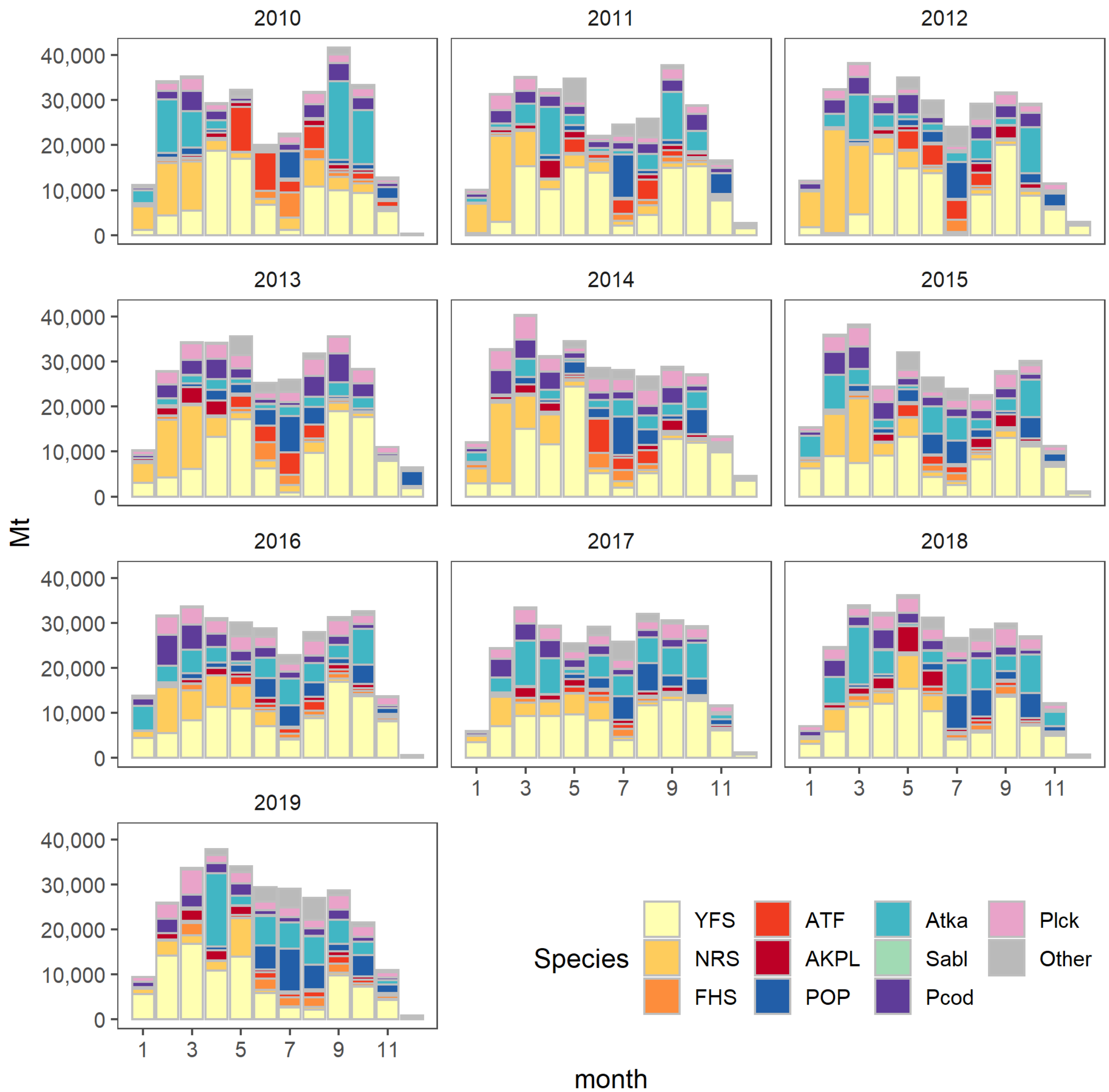

Figure 3-20 Amendment 80 monthly catch (metric tons), 2010 through 2019. (Source: NMFS Alaska Region Catch Accounting System, data compiled by AKFIN in Comprehensive_BLEND_CA)

There are several important caveats to any notion that companies with access to roundfish quotas in the AI can easily move into those fisheries if PSC is high or catch rates are low elsewhere. Aside from the limitations of quota allocation and area endorsements, the AI region is heavily restricted in the amount of area open to trawl gear (Figure 3-21). AI Atka mackerel fishing is even more restricted than AI rockfish because it is an designated prey species for Steller sea lions (SSL), leading to additional area closures of directed fishing and a seasonal split of the TAC. In 1993, NMFS established critical habitat (CH) for SSLs in the GOA, AI, and BS. Directed fishing for Atka mackerel and other SSL prey species is prohibited within some CH areas (grey areas in Figure 3-21). In 2005 the Council adopted additional closures to conserve essential fish habitat (EFH) in the AI, prohibiting all bottom trawling in the AI except in small, discrete open areas where bottom trawling had previously occurred in order to minimize the effects of fishing on EFH (red areas in Figure 3-21). In total, over 95% of the AI management area is closed to bottom trawling. In addition to area closures, AI trawl fishing is spatially constrained by practical factors like untrawlable bottom surfaces, grounds preemption by fixed-gear vessels (e.g., WAI golden king crab), or just the size of the "open" areas relative to what an A80 vessel needs to tow. Some of the relatively smaller A80 vessels may not have the option to fish quotas in the western AI due to range capacity or the operational and safety issues of larger seas. The fishery is temporally constrained by seasonal TAC allocation and the movement of target fish inshore to closed areas prior to spawning. Together, this means that AI fishing could not likely support an influx of all the vessels with mackerel quota in a short span. As it stands currently, Area 541 accounts for the largest share of AI TAC and has the most spatially concentrated fishing area. Moreover, the behavior of roundfish like Atka mackerel in the presence of trawl nets is said to mean that additional effort would reduce catch on a rate basis (CPUE) for all participants in a localized open area.

For evidence of the spatial concentration in the AI, even relative to the limited open areas shown in Figure 3-21, NMFS Habitat Conservation Division provided the analysts with spatial catch data from 2003 through 2020. By the numbers, roughly 42,000 km^2 are open to non-pelagic trawling across all of Areas 541/542/543. Roughly half of that area (21,000 km^2) is open to directed Atka mackerel fishing. Since 2003, there were 4,247 observed tows with an Atka mackerel designation in areas open to directed mackerel fishing. Drawing on VMS data, it was shown that the total area contacted by the fishery was 1,672 km^2. That means that the footprint of the fishery during that span covered only 8% of the area that was open to it.

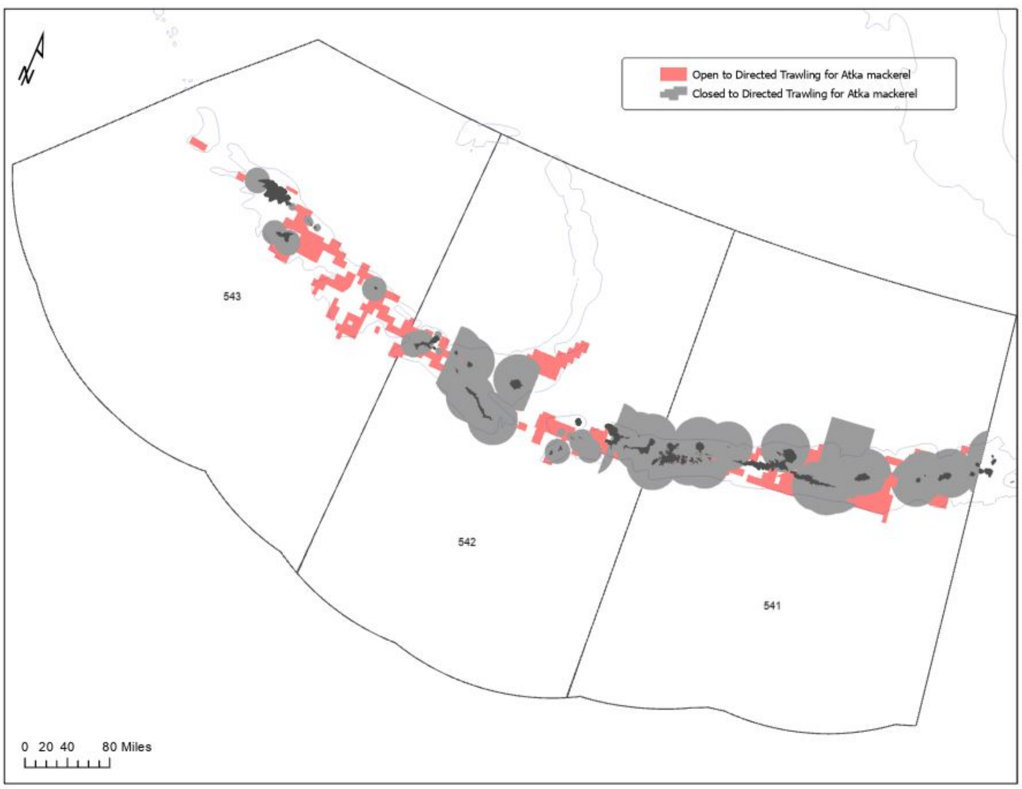

Figure 3-21 Aleutian Islands areas open/closed to directed trawl fishing for Atka mackerel; White area is closed to all trawl fishing, Grey areas are closed due to SSL critical habitat protection measures (Source: NMFS AKRO Habitat Conservation Division)

3.3.4 Community Development Quota (CDQ) program as related to the A80 sector

This section provides a brief description of the CDQ Program and accounts for the amount of CDQ harvest activity that occurs on A80 vessels. The halibut PSC limit that applies to CDQ hauls on A80 vessels is not subject to change under the considered alternatives, but the overall business sustainability of those vessels is necessary for CDQ groups to be able to access the portion of their allocations of non-pollock groundfish that is typically caught with trawl gear. The SIA attached to this DEIS provides greater detail on CDQ communities and their organizing non-profit entities' engagement and reliance on a variety of commercial and subsistence fisheries off Alaska.

The CDQ Program was established by the Council and NMFS in 1992 and authorization for the Program was incorporated into the Magnuson-Stevens Act in 1996. The purpose of the CDQ Program is (1) to provide eligible western Alaska villages with the opportunity to participate and invest in fisheries in the BSAI, (2) to support economic development in western Alaska, (3) to alleviate poverty and provide economic and social benefits for residents of western Alaska, and (4) to achieve sustainable and diversified local economies in western Alaska (16 U.S.C. § 1855(i)(1)(A)). The CDQ Program consists of six different non-profit managing organizations (CDQ groups) representing different geographical regions in Western Alaska. The CDQ Program receives annual apportionments of total allowable catches (TACs) for a variety of commercially valuable species in the BSAI groundfish, crab, and halibut fisheries, which are in turn allocated among the six CDQ groups.

The six CDQ groups represent 65 eligible villages in Western Alaska. Geographically dispersed, the member communities extend westward to Atka on the Aleutian Islands chain and northward along the Bering Sea coast to the village of Wales near the Arctic. CDQ communities generally are remote, isolated places with relatively few commercially valuable natural assets with which to develop and sustain a viable, diversified economic base.

Aleutian Pribilof Island Community Development Association (APICDA) represents the villages of: Akutan, Atka, False Pass, Nelson Lagoon, Nikolski, and Saint George.

Bristol Bay Economic Development Corporation (BBEDC) represents the villages of: Aleknagik, Clark's Point, Dillingham, Egegik, Ekuk, Ekwok, King Salmon, Levelock, Manokotak, Naknek, Pilot Point, Port Heiden, South Naknek, Togiak, Twin Hills, and Ugashik.

Central Bering Sea Fishermen's Association (CBSFA) represents the village of Saint Paul on Saint Paul Island.

Coastal Villages Region Fund (CVRF) represents the villages of Chefornak, Chevak, Eek, Goodnews Bay, Hooper Bay, Kipnuk, Kongiganak, Kwigillingok, Mekoryuk, Napakiak, Napaskiak, Newtok, Nightmute, Oscarville, Platinum, Quinhagak, Scammon Bay, Tooksook Bay, Tuntutuliak, and Tununak.

Norton Sound Economic Development Corporation (NSEDC) represents the villages of Brevig Mission, Diomede, Elim, Golovin, Gambell, Koyuk, Nome, Saint Michael, Savoonga, Shaktoolik, Stebbins, Teller, Unalakleet, Wales, and White Mountain.

Yukon Delta Fisheries Development Association (YDFDA) represents the villages of Alakanuk, Emmonak, Grayling, Kotlik, Mountain Village, and Nunam Iqua.

Under the CDQ Program, a portion of the federal TAC for commercially important BSAI species — including pollock, crab, halibut, and various groundfish — is allocated to participants in the CDQ Program. In 1992, CDQ groups received their initial allocations of pollock based on population, quality of proposed economic development plans, and dependence on fisheries. Since 1992, the CDQ Program has expanded several times and now includes allocations of pollock, halibut, sablefish, crab, all of the remaining groundfish species (cod, Atka mackerel, flatfish, and rockfish), and prohibited species catch (i.e., as bycatch allowances for salmon, halibut, and crab). The percentage of each annual BSAI catch limit allocated to the CDQ Program varies by species and management area. Currently, the CDQ Program is allocated approximately 10.7% of the groundfish directed fisheries. The percentage of other catch limits allocated to the CDQ Program (as CDQ reserves) is determined by: the BSAI Crab Rationalization Program (10% of crab species, except for Norton

Sound red king crab, which is 7.5%); the BSAI Fishery Management Plan for all other groundfish and prohibited species (7.5%, except 20% for fixed-gear sablefish); and 50 CFR part 679 for halibut (20% to 100%, depending on IFQ management area – see Section 4.4.1.1 of this document). These allocations position CDQ groups as stakeholders in both the directed halibut fishery and the groundfish fisheries that encounter halibut as a limited bycatch species.

Annual CDQ allocations provide a revenue stream for CDQ groups through various channels, including the direct catch and sale of some species and the leasing of quota to various harvesting partners. CDQ groups receive royalty payments on each allocation harvested by a partnering firm. In addition to direct and indirect participation in fishing, CDQ group earnings are also derived from investments distributions in subsidiary companies and vessels. Since the implementation of the CDQ Program, individual groups have made large capital investments in vessels, infrastructure, processing capacity, and specialized gear.

Local programs purchase limited access privileges in a fishery and acquire equity position in existing fishery businesses including halibut, sablefish, and crab. CDQ groups have invested in peripheral projects that directly or indirectly support commercial fishing for halibut, salmon, and other nearshore species. These projects include seafood branding and marketing, quality control training, safety and survival training, construction and staffing of equipment maintenance and repair facilities, and assistance with bulk fuel procurement and distribution.

Investments by individual CDQ groups include ownership interest in the at-sea processing sector and in catcher vessels and are made with the expectation of financial gain or expanding equity in the fishing fleet. Investments in subsidiaries, such as limited liability corporations, allow CDQ groups to wholly or partially own vessels directly related to fisheries, including in the A80 sector. These vessels provide revenue through the direct catch and sale of target species and, in some cases, vessel ownership increases a subsidiary’s holdings of quota in fisheries, such as BS pollock. In addition, investments in harvesting and processing capacity provide revenue through profit sharing, contractual agreements to harvest other CDQ groups’ quota, and chartering commercial fishing vessels to government agencies conducting stock assessment surveys. Vessel ownership varies by CDQ group, target species, and affiliation with subsidiary corporations

CDQ revenue also supports permit brokerages and revolving loan programs that build and sustain fisheries development within their regions. Such programs are intended to retain limited entry salmon permits within CDQ communities, provide the financing necessary for resident fishermen to purchase new boats and gear, and supporting market development for locally-harvested seafood products.

CDQ catch and revenue is dominated by pollock harvest in the AFA fishery (Figure 3-22). Halibut PSC caught when directed fishing CDQ pollock accrues to the CDQ halibut PSQ. CDQ non-pollock, non-IFQ groundfish catch is dominated by Pacific cod, yellowfin sole, and to a lesser extent Atka mackerel and northern rock sole. Non-pollock, non-IFQ CDQ groundfish catch is driven early in the year by Pacific cod in the HAL CP sector and rock sole on A80 platforms. Later in the year this category of CDQ harvest shifts more toward yellowfin sole on A80 platforms. Figure 3-23 and Figure 3-24 detail the CDQ harvest and revenue generated on A80 vessels. Figure 3-22 provides a relative sense of how much CDQ activity occurs on A80 vessels; the “Other_GF” category includes non-trawl gear types and trawl CVs that harvest CDQ fish. Note that the revenues reported in Figure 3-22 are AKFIN’s estimates of ex-vessel revenue; ex-vessel revenue is not the natural metric for at-sea operations, but is necessary to incorporate revenue data from crab fishing which is an important piece of the CDQ portfolio. The wholesale revenue estimates for CDQ catch on A80 vessels (Figure 3-23) are recently in the range of $17 million to $21 million (2018$). Total CDQ non-pollock, non-IFQ groundfish wholesale revenue (also excluding crab) across all platforms has been around $70 million to $75 million in recent years.

A80 vessels that harvest CDQ fish must record whether a haul is a CDQ haul within two hours after completion of weighing all catch in the haul (679.5(c)(4)(ii)(B)(2)). This may be advantageous for A80 vessels fishing CDQ alongside their cooperative quota as they can more flexibly manage to which sector tows are allocated based on different operational portfolios and allocations. Halibut PSC that occurs on a CDQ haul accrues to the CDQ halibut PSC limit (315 t), which is not being considered for change under this action.

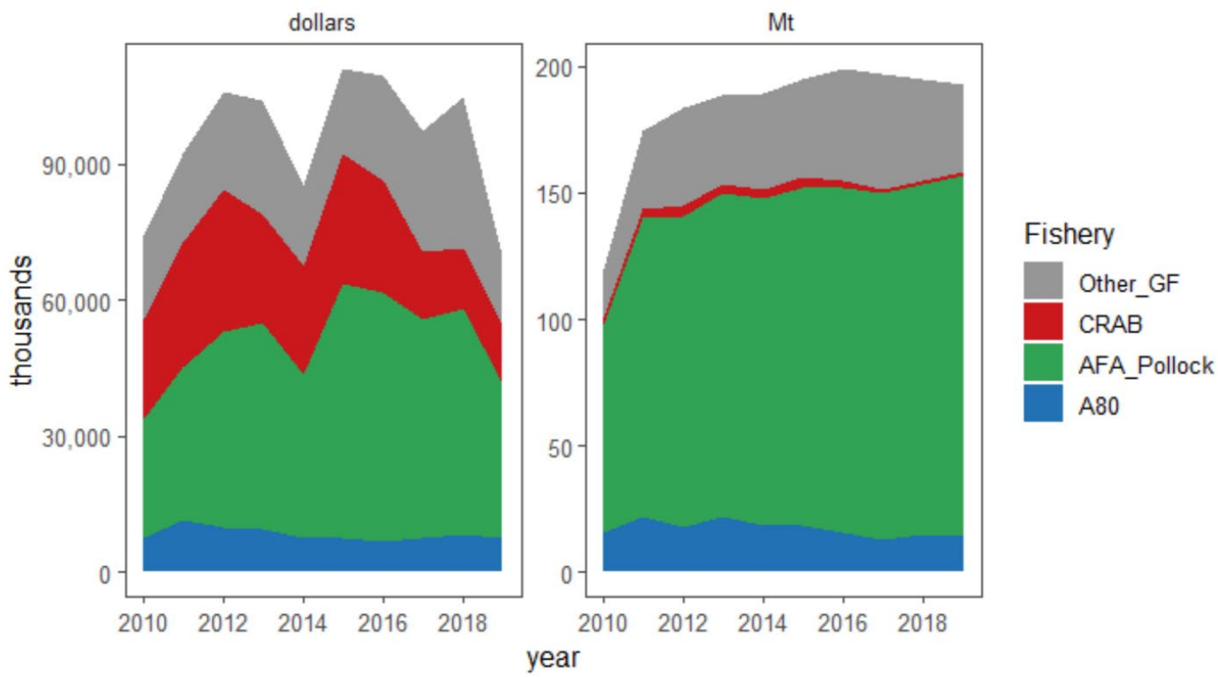

Figure 3-22 **Distribution of CDQ estimated ex-vessel revenue (2018 dollars) and catch (metric tons) by fishery or fishery group, 2010 through 2019. (Source: NMFS Alaska Region Catch Accounting System, data compiled by AKFIN in Comprehensive_BLEND_CA)**

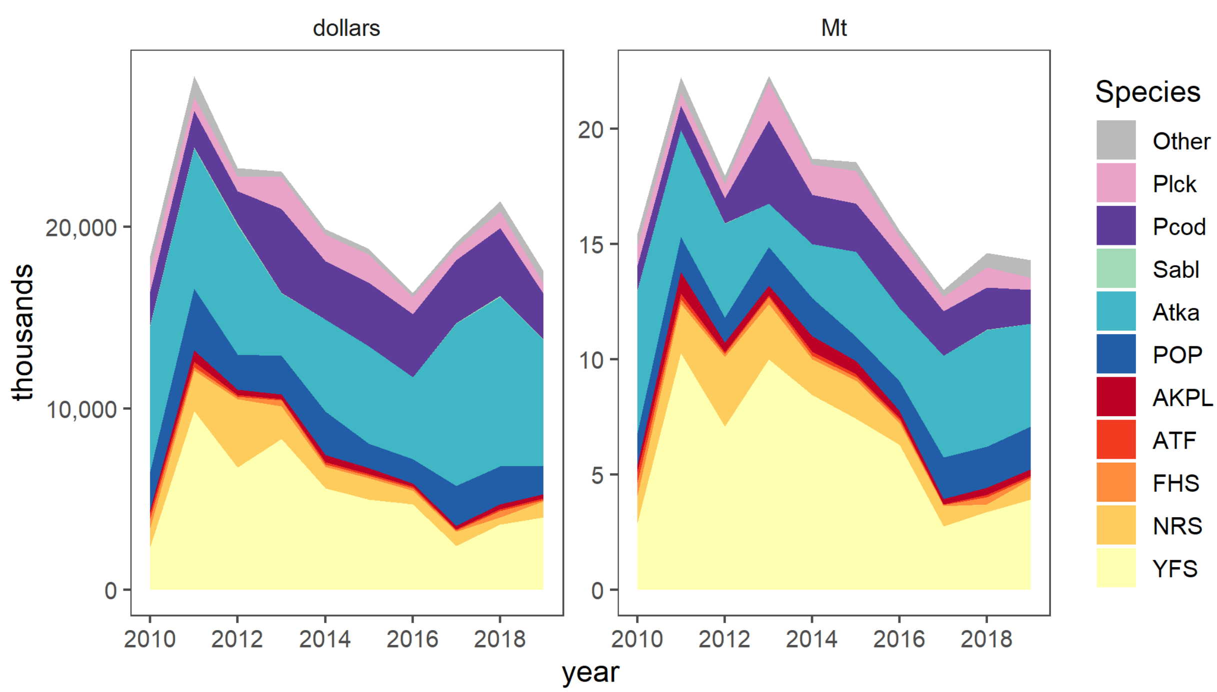

Figure 3-23 **CDQ harvest on Amendment 80 vessels: gross first wholesale revenue (2018 dollars) and catch (metric tons) by species, 2010 through 2019. (Source: NMFS Alaska Region Catch Accounting System, data compiled by AKFIN in Comprehensive_BLEND_CA)**

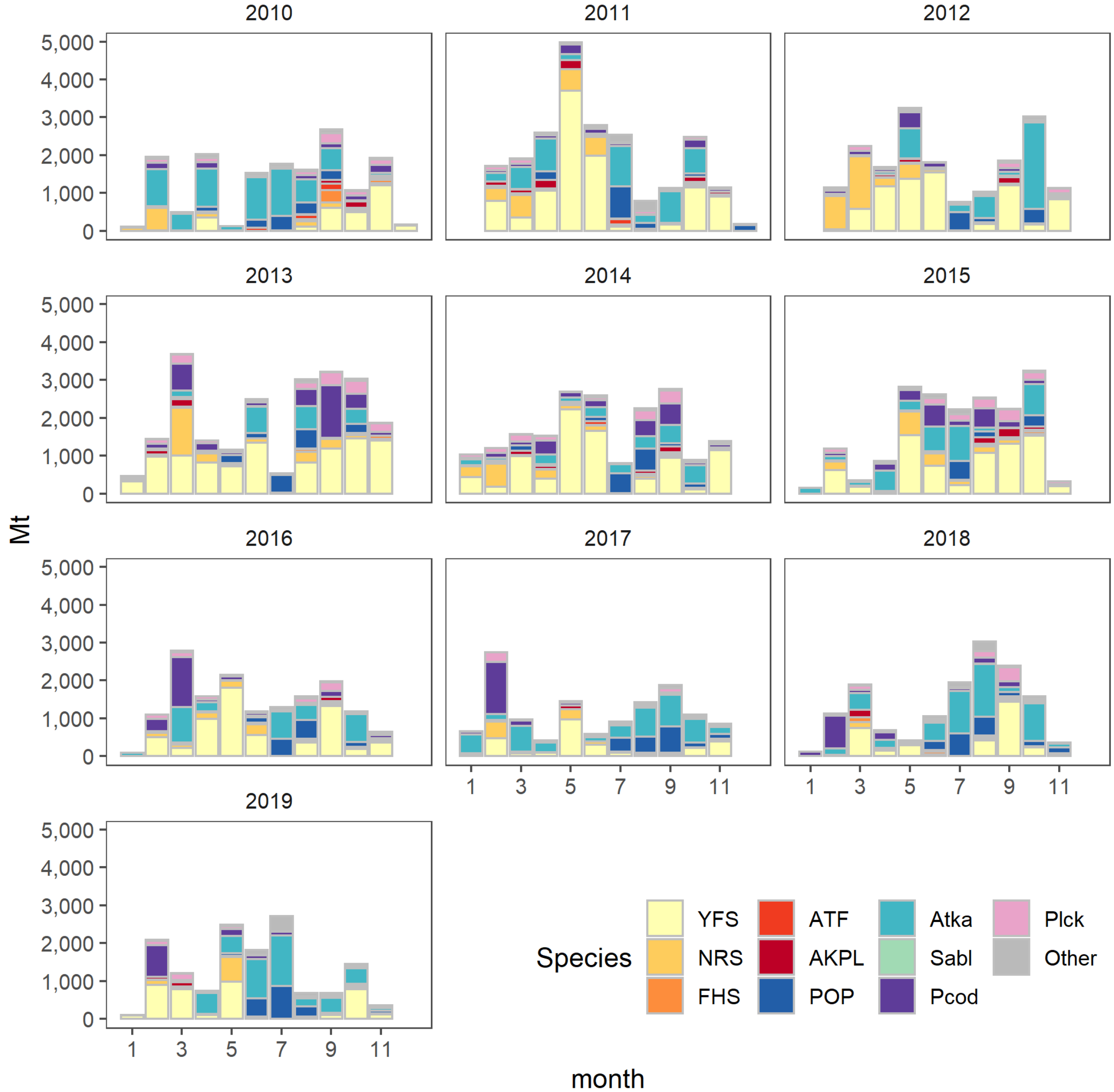

Figure 3-24 Monthly CDQ harvest on A80 vessels (metric tons), 2010 through 2019. (Source: NMFS Alaska Region Catch Accounting System, data compiled by AKFIN in Comprehensive_BLEND_CA)

The volume of commercial halibut harvested by CDQ stakeholders is reported in Section 4.1.1.

3.4 Amendment 80 Pacific halibut bycatch

This section details the A80 sector's direct interaction with Pacific halibut as a PSC species, focusing on the period from 2010 through 2020. For this draft, displays that are linked to revenue data terminate in 2019; revenue data are not presently available for 2020. This section presents data on final assessed halibut PSC totals, halibut encounter rates, and effective mortality (mortality divided by catch). Spatial data on effort and halibut PSC are presented to compare the A80 fishery to the EBS trawl survey. Halibut PSC is also described in terms of A80 revenue generated per metric ton of PSC at the sector level and by groundfish target species.

This section also summarizes publicly available information regarding the A80 cooperative's effort to reduce bycatch mortality by minimizing catch or improving catch handling procedures to the extent practicable on a high-volume platform.

3.4.1 Amendment 80 halibut PSC summary

Irrespective of halibut encounter and mortality rates, it is the assessed volume of Pacific halibut mortality that accrues to the A80 sector is the metric that defines the relationship between the PSC limit and the sector's operation. Table 3-18 places the A80 sector in context with regard to the other BSAI groundfish sectors. For reference, the current mortality limit for A80 halibut PSC is 1,745 t, the TLAS limit is 745 t, the CDQ limit (all gears) is 315 t, and the non-trawl limit that covers both HAL CP and HAL CV is 710 t. From 2010 through 2020, the A80 sector has accounted for roughly 60% of BSAI groundfish PSC mortality. This total is not surprising given the species mix that that A80 sector catches and the associated halibut PSC rates (Table 3-20). Table 3-19 compares A80 halibut catch and PSC mortality to other BSAI groundfish sectors from 2010 through 2019. In 2020, the A80 sector recorded 2,031 t of halibut catch and was credited with 1,097 t of halibut PSC mortality, which was the lowest total during the analyzed period (see also Figure 3-25).

Examining trends in A80 halibut PSC catch and mortality is complicated by the fact that many variables that affect these metrics have changed in recent years. PSC limits, DMR estimation methods, and halibut handling procedures have all changed to varying degrees since 2010. PSC limits have decreased multiple times since 2010, most significantly in 2015 with the implementation of Amendment 111. Figure 3-25 illustrates that A80 sector annual halibut mortality has declined since 2014 and, more notably, has declined relative to total halibut catch since 2015. Halibut catch – sometimes referred to as encounter – is the weight of halibut caught before the DMR is applied. The ratio of estimated halibut PSC mortality to halibut catch is defined here as "effective mortality rate". Effective mortality in the A80 sector declined from 2015 to 2019, breaking from a consistent relationship between catch and mortality. The effective mortality rate increased slightly in 2020, but that is largely an artifact of the greatly reduced encounter rate shown in Figure 3-25. The 2015 breakpoint coincides with the implementation of proactive strategies by the A80 sector in response to the request of the Council as it made its final action recommendation on BSAI Amendment 111 in June 2015 (Figure 3-26). The published DMRs – shown in Table 3-7 might differ from the sector-level effective mortality rate when fishery data with and without deck sorting is combined since deck-sorted hauls have a specific DMR applied based on sampling.

The specific measures taken by the A80 sector to reduce halibut PSC mortality are described in Section 3.4.4 of this document. Those measures are not limited to deck sorting of halibut bycatch, but Figure 3-27 provides a compelling correlation of deck sorting effort to effective mortality.[46] Effective mortality rates also capture the effect of reduced halibut DMRs achieved through deck sorting, noting the reduced reference period for halibut DMR estimation that rewards bycatch handling performance on a more immediate timeline – as described in Section 3.2.2.1 (refer to Table 3-7).

Table 3-18 Proportion of Pacific halibut mortality by BSAI groundfish sectors (2010 through 2019)

A80	TLAS	HALCP	CDQ	HALCV	*POT**	*AFA**
60.3%	16.1%	11.1%	6.9%	0.1%	*0.1%*	*6.3%*

* The Pot and AFA sectors' halibut mortality does not accrue to annual PSC limits.

[46] Observer data for 2020 do not include a purpose code for deck sorting so the table is not extended beyond 2019 at this time.

Table 3-19 Bycatch of Pacific halibut by year and sector by estimated catch (t) and PSC mortality (t)

Year	Measure	A80	TLAS	HALCP	CDQ	HALCV	Total
2010	Catch	**2,808**	399	4,814	837	37	8,895
	Mortality	**2,243**	286	482	151	4	3,166
2011	Catch	**2,277**	469	4,698	844	22	8,310
	Mortality	**1,810**	346	470	203	2	2,831
2012	Catch	**2,469**	824	5,380	796	20	9,489
	Mortality	**1,944**	606	538	258	2	3,348
2013	Catch	**2,676**	669	5,280	817	40	9,482
	Mortality	**2,165**	503	476	253	4	3,401
2014	Catch	**2,667**	673	4,523	604	74	8,541
	Mortality	**2,178**	508	407	224	7	3,324
2015	Catch	**1,719**	508	3,313	339	20	5,899
	Mortality	**1,406**	381	299	122	2	2,210
2016	Catch	**1,965**	689	2,192	451	1	5,298
	Mortality	**1,412**	488	198	165	0	2,263
2017	Catch	**1,976**	654	2,133	436	5	5,204
	Mortality	**1,167**	394	171	147	1	1,880
2018	Catch	**2,556**	649	1,440	412	25	5,082
	Mortality	**1,343**	412	115	148	4	2,022
2019	Catch	**3,067**	880	975	418	39	5,379
	Mortality	**1,461**	539	78	189	2	2,270

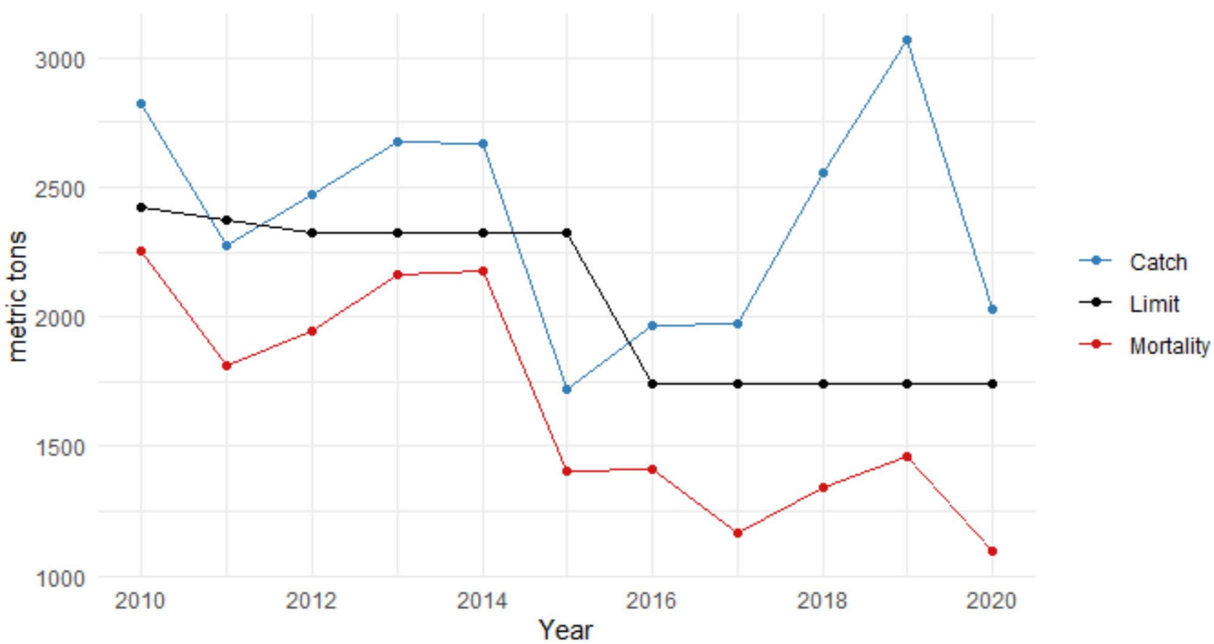

Figure 3-25 A80 halibut PSC limit, catch, and mortality, 2010 through 2020

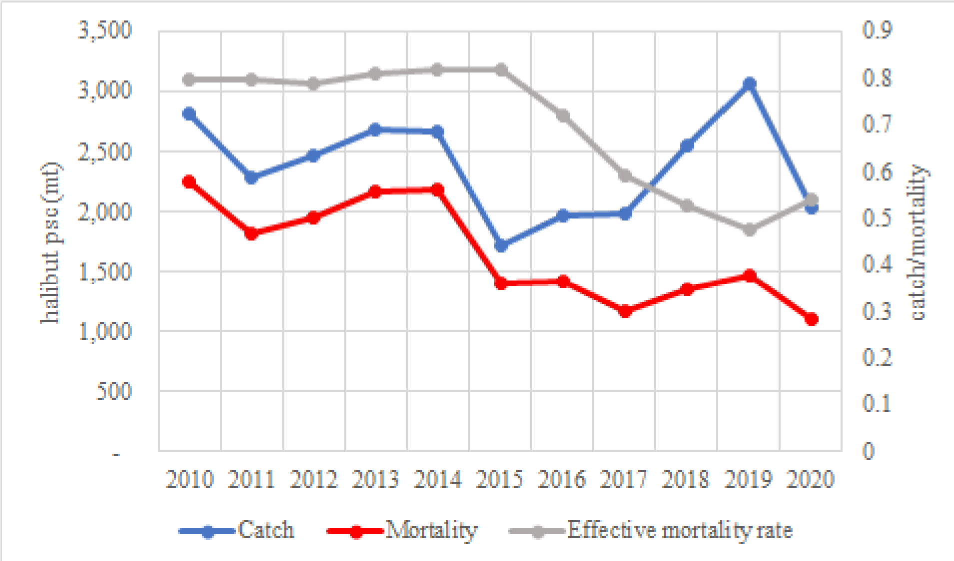

Figure 3-26 A80 sector effective mortality rate: function of halibut catch and mortality (2010 – 2020)

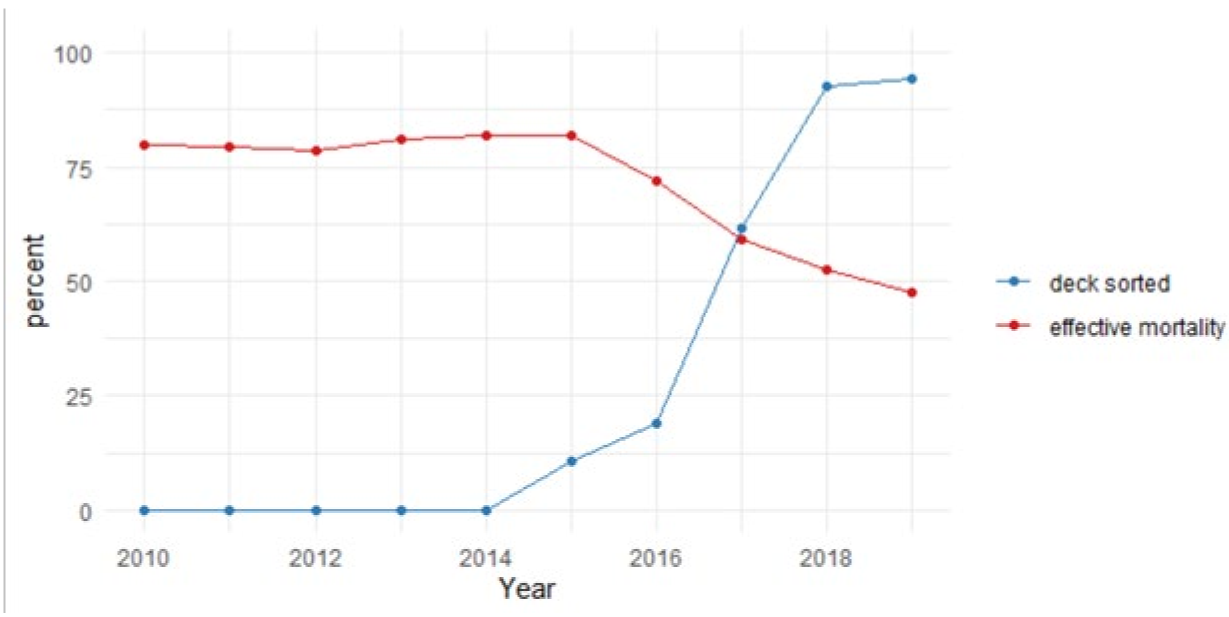

Figure 3-27 A80 halibut PSC effective mortality (%) versus hauls deck sorted (%), 2010 through 2019

Figure 3-28 plots the A80 halibut encounter rate by target species for 2010 through 2019. Yellowfin sole target fishing clearly accounts for the highest groundfish catch volume and the highest halibut encounter rate, followed by northern rock sole. After those two, halibut encounter drops off due to either lower effort (other flatfish) or lower PSC rates (Atka mackerel and POP). Refer to Figure 3-14 for the relative proportion of allocated flatfish versus roundfish species on A80 permits, and refer to Table 3-20 for PSC rates by target species.

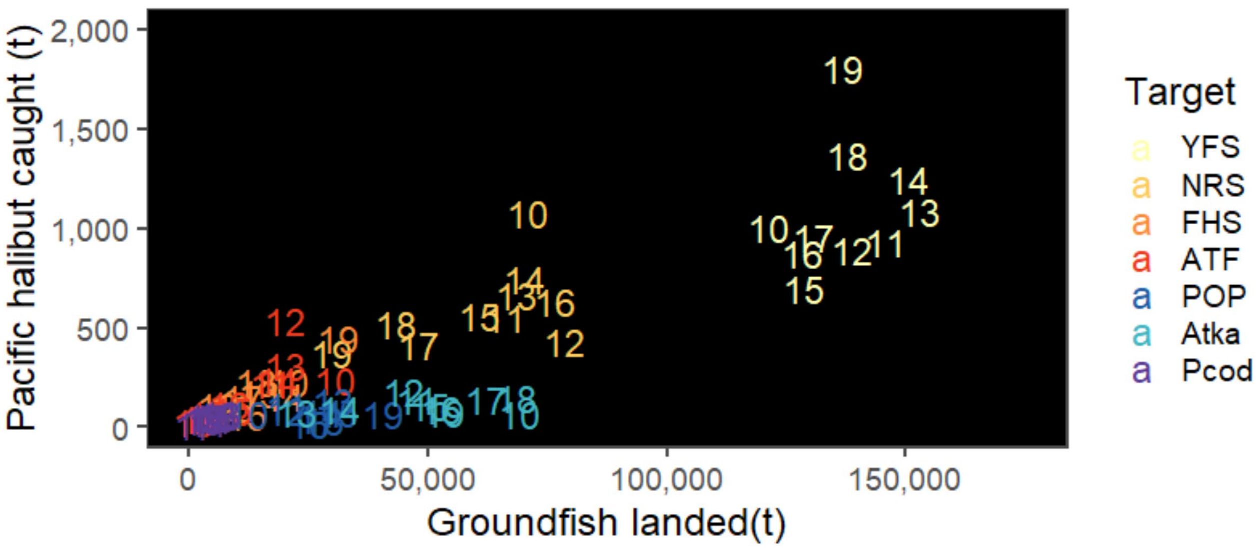

Figure 3-28 A80 sector bycatch of Pacific halibut (t) versus groundfish catch by target species, 2010 through 2019.

Table 3-20 lists the halibut PSC rate for selected A80 targets species, shown as kilograms of halibut PSC mortality per metric ton of groundfish catch. The species are ordered descending by the target with the highest PSC rate. The order is unchanged whether looking at average or median values over the entire period or only at the three most recent years. The table omits species that are sometimes assigned as an A80 trip target in the CAS but are not typically explicitly targeted by A80 vessels – e.g., Pacific cod, "other flatfish", sablefish, and pollock.

Table 3-20 A80 Pacific halibut PSC mortality rate by selected groundfish target species (kg halibut mortality per metric ton of groundfish catch), 2010 through 2019

Target	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Arrowtooth flounder	6	10	20	12	10	7	9	9	13	8
Northern rock sole	13	7	4	8	9	8	7	5	6	7
Flathead sole	8	9	14	9	6	4	6	5	7	6
Yellowfin sole	7	5	5	6	7	4	5	5	5	6
Alaska Plaice	2	3	2	5	16	1	3	4	5	5
POP/Rockfish	4	4	3	3	2	2	1	1	1	1
Atka Mackerel	1	2	3	3	2	2	1	2	1	1

Source: NMFS Alaska Region Catch Accounting System, data compiled by AKFIN in Comprehensive_BLEND_CA

Figure 3-29 and Figure 3-30 break down A80 PSC mortality by month for the entire 2010 through 2019 period and by year. The figures demonstrate the predominance of halibut PSC in flatfish targets relative to other targets, and also reflect annual fishing patterns within the flatfish category; for example, northern rock sole tend to be targeted earlier in the year for valuable roe content. Halibut PSC by target fishery tends to reflect effort as translated through the PSC rates reported in Table 3-20; there are no surprising results where the analysts can point to an outlier species-specific PSC rate for a given month. The yearly panels in Figure 3-30 reflect the sector-wide reduction in halibut PSC beginning in 2016, which is generally attributed to the investment of time and resources in halibut avoidance and mortality rate mitigation (i.e. deck sorting). Lower gross levels of halibut PSC in the later months of the year might also be attributable to the sector's Halibut Avoidance Plan that requires vessels to maintain a certain rate-performance standard regardless of where the sector stands in relation to the annual limit of 1,745 t (Section 3.4.4). Additional detail on targeting patterns during the course of the A80 fishing year are included in Section 3.3.3. The most notable deviation from the recent trend in 2020 was the reemergence of PSC attributed to the arrowtooth flounder target, which largely occurred in May and June. This likely has more to do with more trips being counted in CAS as arrowtooth trips due to catch rates than a change in fishing strategy or time/location, since arrowtooth is generally a commercial bycatch species. Flathead sole catch was low in 2020; some of the PSC that occurred in that target fishery around July-September of 2019 shows up in roughly similar magnitudes in 2020 but attributed to the yellowfin sole and rock sole targets.

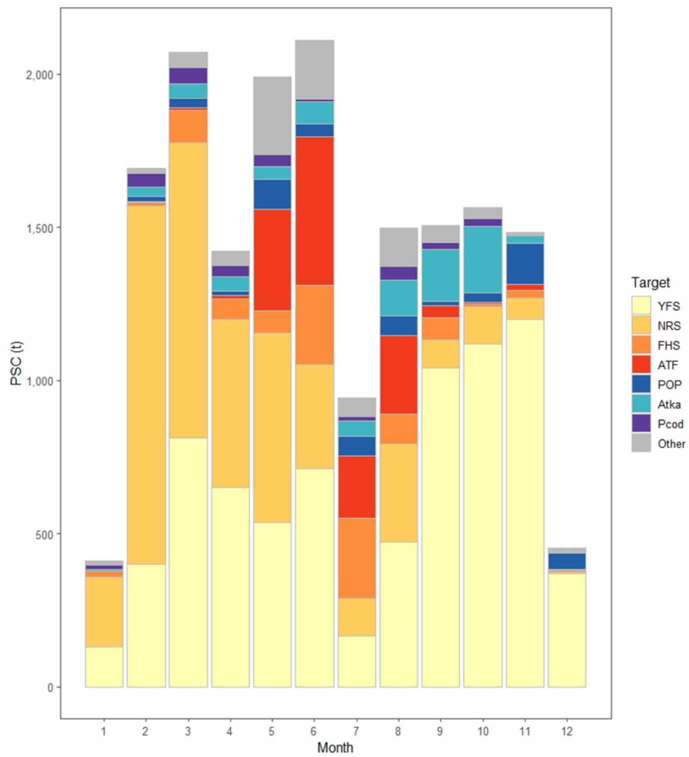

Figure 3-29 A80 Pacific halibut PSC mortality (t) by month and target fishery, aggregated over 2010 through 2019.

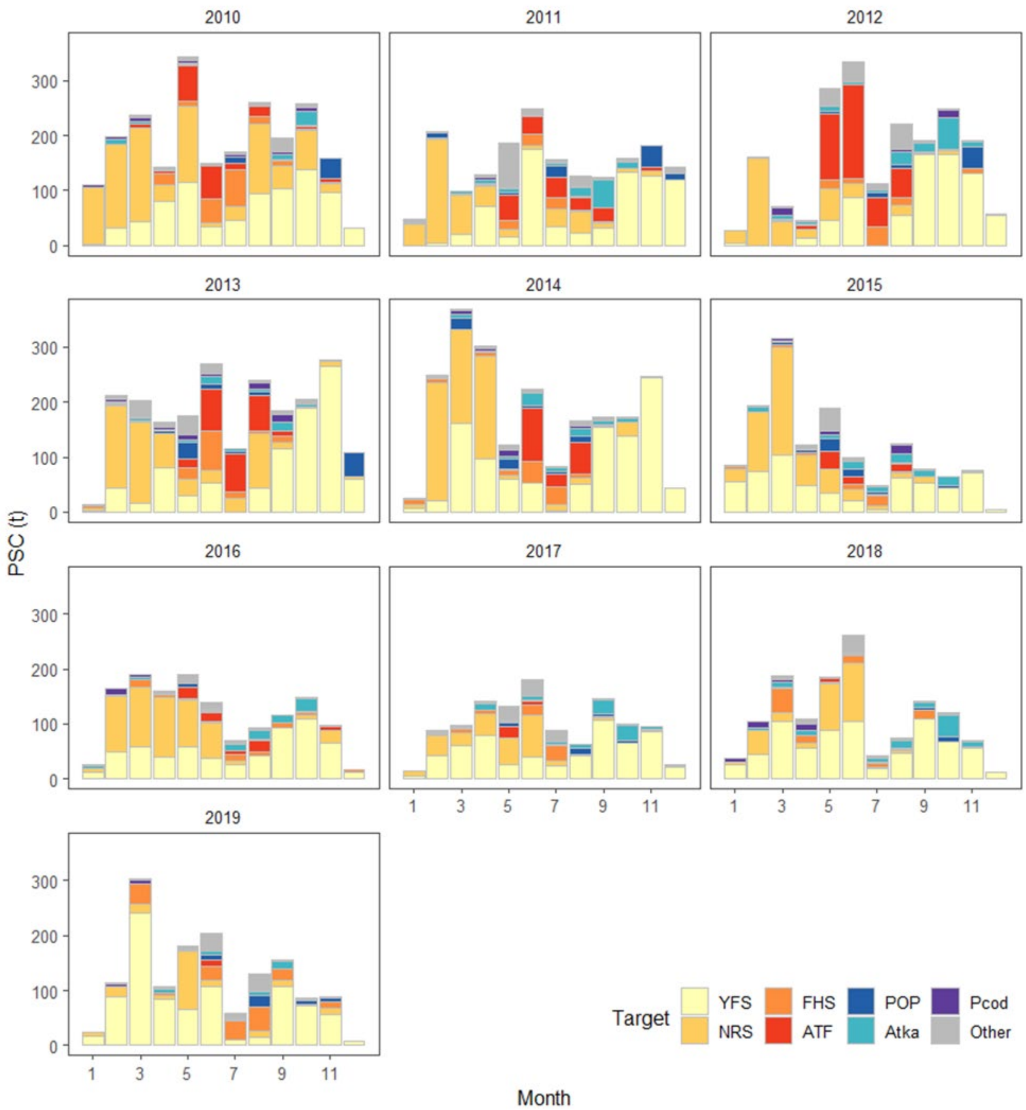

Figure 3-30 **A80 Pacific halibut PSC mortality (t) by month and target fishery, with panels corresponding to years 2010 through 2019.**

3.4.2 Pacific halibut mortality as related to groundfish revenue

The relationship between halibut PSC mortality and A80 groundfish revenue is a key indicator of the sector-level and distributional impacts of potential changes to halibut PSC limits. The revenue/PSC relationship encompasses the full array of possible determinants: groundfish harvest levels (TAC; effort; CPUE), bycatch mortality (encounter rates; DMRs and effective mortality), and other external factors (wholesale markets; environmental/ecosystem conditions that affect the co-occurrence of halibut and groundfish species). Figure 3-31 plots the relationship between metric tons of halibut mortality (PSC use) and groundfish wholesale revenue for 2010 through 2019 (2018$). It is important to note that the figure is plotting gross revenues that do not account for operational costs. It is possible that lower PSC mortality was achieved at a higher cost in some years (e.g., search costs, fewer or less efficient tows). The figure reflects that yellowfin sole is the highest volume target in the A80 sector, and with a relatively high PSC rate it typically incurs the greatest amount of halibut mortality. Northern rock sole performs similarly but at a lower volume. As evident from the unit values and PSC rates shown in Table 3-15 and Table 3-20, respectively, Atka mackerel and Pacific ocean perch generate greater revenue per ton of PSC. The other species shown are clustered because they are less often designated as A80 trip targets in CAS data. Aside from visible outliers like arrowtooth flounder in 2012, the other species' revenue/PSC relationship is driven mainly by harvest intensity.

At the sector level (not shown), lower PSC rates can result in similar levels of groundfish harvest volume with different PSC totals. For example, PSC use in 2014 and 2016 were quite different – 2,667 t versus 1,965 t – but gross wholesale revenues were similar ($317 million in 2014 versus $306 million in 2016, 2018$). The difference has many causative factors; lower effective mortality is likely a key factor, but species composition of catch and market conditions should not be discounted.

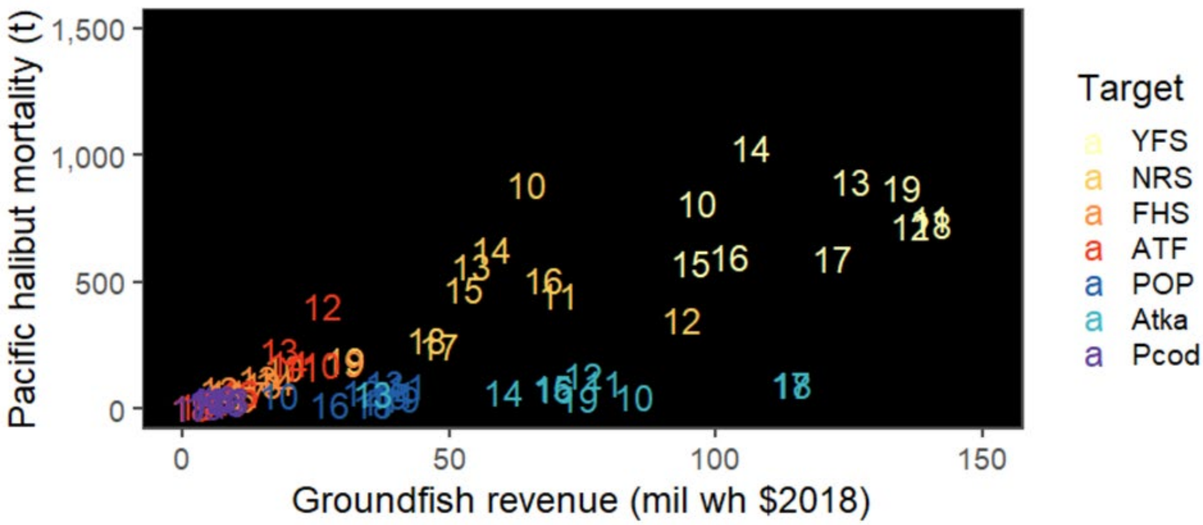

Figure 3-31 A80 Pacific halibut PSC mortality (t) versus groundfish revenue (2018$ millions in wholesale) by target and year, 2010 through 2019.

Another metric to evaluate the productive value that halibut PSC contributes to the A80 sector is the wholesale revenue generated per metric ton of estimated halibut mortality. The more wholesale revenue that can be generated per ton of halibut PSC, the more valuable that unit of halibut PSC becomes. In general, wholesale revenue per halibut PSC can be increased three ways: (1) increased wholesale revenues (holding halibut PSC constant); (2) decreased halibut PSC (holding wholesale revenues constant); or (3) a combination of both. If wholesale revenue increases or halibut PSC decreases by the same relative amount, wholesale revenue per halibut PSC remains the same. Figure 3-32 shows the annual value of a metric ton of halibut PSC from 2010 through 2019. Noting that the values in the table are adjusted for inflation, the sector-level increase since 2014 is likely attributed to lower PSC rates. The lower panel in Figure 3-32 shows gross revenue per ton of PSC by target species, aggregating across all years.[47] This panel underlines the fact that a metric defined as a ratio can be strongly determined by one factor. The low PSC rate for Atka mackerel and POP target trips separates that target group from other A80 species. If the A80 sector were able to restructure its total activity around the harvest of low-PSC groundfish species it could achieve high gross revenues at a low PSC rate, but that is not possible given that roundfish species have defined catch limits and A80 companies cannot alter the flatfish/roundfish quota share mix that they are allocated under the program. In effect, the only levers that the sector can use to increase its revenue per metric ton of PSC is to reduce usage in flatfish targets or to generate higher value from flatfish, which may be occurring but is inevitably limited by market and operational factors.

[47] Previous versions of this analysis included revenue per metric ton of halibut PSC by month but no discernable pattern with a plausible explanation to link available seasonal catch, its value, and the observed PSC rate was apparent.

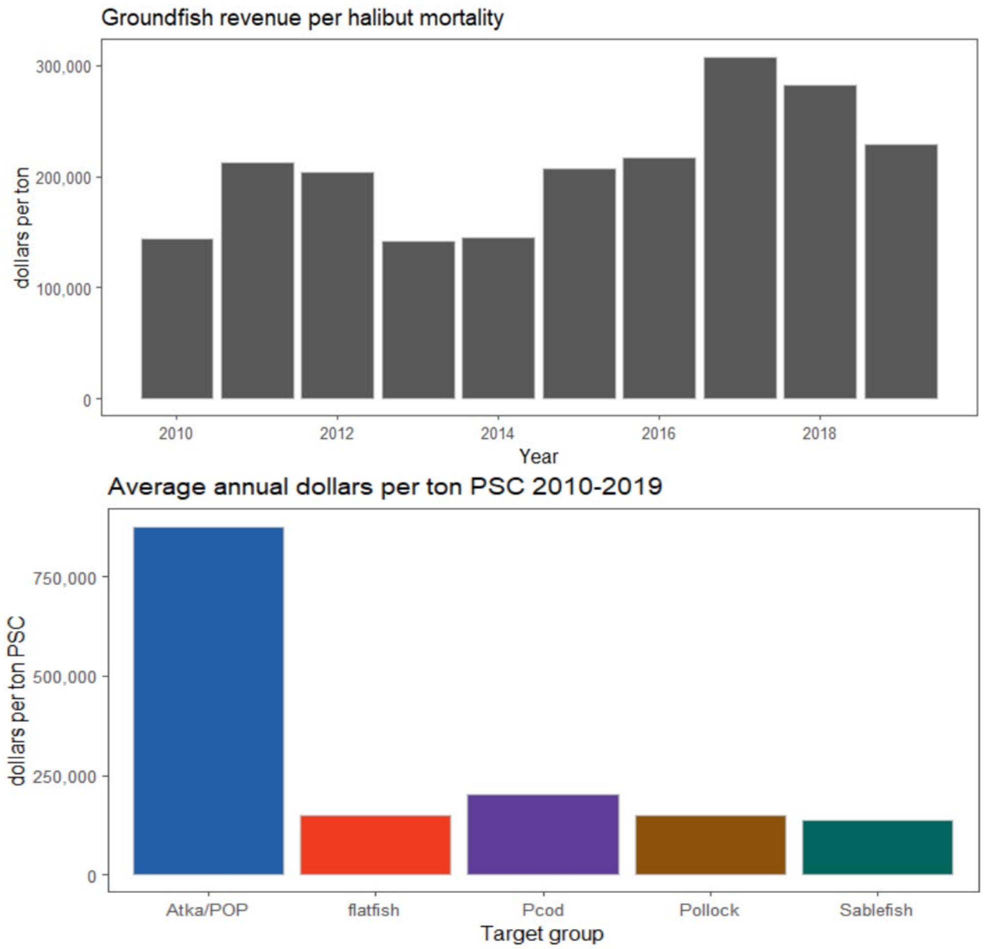

Figure 3-32 A80 wholesale groundfish revenue (2018$) per metric ton of halibut PSC, 2010 through 2019. Top panel: Sector-level revenue per metric ton by year; Bottom panel: revenue per metric ton by targets species aggregated over years.

Figure 3-33 further illustrates the consistent difference in target categories' revenue per ton of halibut PSC. Atka mackerel and POP ratios stand out from flatfish and Pacific cod. Pacific cod ratios should not be overly interpreted because the A80 sector often records "trips" that are assigned a cod target designation as a byproduct of other operational factors; the analysts are led to understand that it is rare for an A80 vessel to truly target Pacific cod over the course of a week's fishing. The difference in revenue per ton of PSC by flatfish/roundfish species group is an integral part of understanding the distributional impacts of a constraining halibut bycatch limit within the A80 sector. Figure 3-15 shows that the A80 companies are heterogeneous in terms of their flatfish/roundfish quota mix. While intra-sector transfers are possible, they likely come at a cost that is not observable by public analysis, and transfers on the margin would not change the essential disposition of an A80 company as one that is "flatfish-dependent" versus one that is less so. To the analysts' knowledge, intra-sector transfers may occur within a company's fleet of vessels but are not being made between companies, even within the single cooperative.

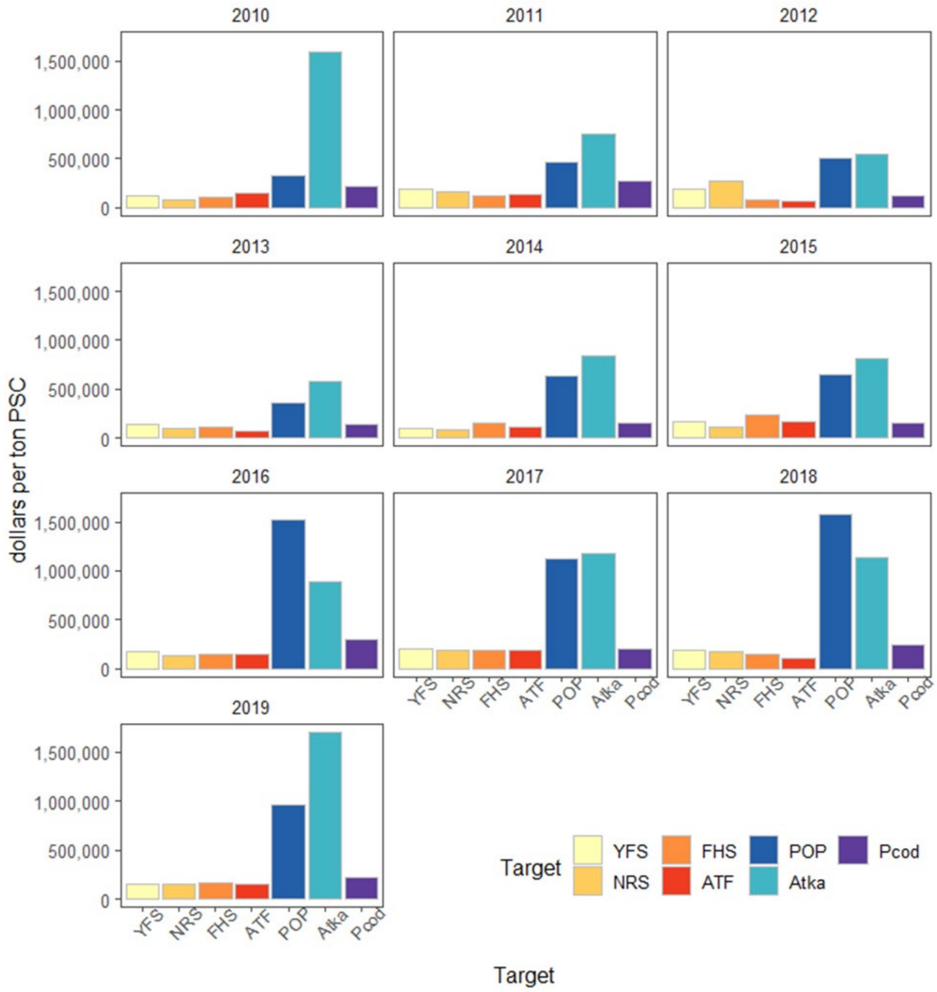

Figure 3-33 A80 wholesale groundfish revenue (2018$) per metric ton of halibut PSC by selected target species, 2010 through 2019.

3.4.3 Spatial data on A80 fishery and EBS trawl survey

This section presents visual comparisons of the A80 sector's spatial range and halibut PSC to that of the EBS trawl survey. Data are pulled from the three most recent years that were used in the development of the ABM operating model reviewed in October 2020 – i.e., 2017 through 2019. The EBS trawl survey is typically conducted in June and July so, in some figures, data are selected to provide a direct comparison. The purpose of this section is not to affirm or question the approach of linking PSC limits to abundance estimates derived from the trawl survey – as seasonal surveys are utilized in many instances to condition management of year-round fisheries in Alaska. These spatial data are simply provided to give the reader the best publicly available understanding of where the fishery occurred, where halibut PSC typically occurs, and where the EBS trawl survey encountered halibut. The selected years represent the groundfish stock and environmental conditions as they occurred in the background of this fishery and survey data. Note that all mapped data are drawn from Observer Program information and are presented by ADF&G statistical area.

Figure 3-34 shows where the A80 sector operated from 2017 through 2019 based on the number of hauls recorded in Observer Program data. The figure also pares back to the activity that occurred in June and July to mirror the EBS survey season. Figure 3-35 depicts where halibut PSC occurred within the main A80 target species. Halibut PSC is not a direct representation of all fishing activity, but all of the targets represented in the figure incurred halibut PSC at a known rate (Table 3-20) so the figure provides an adequate depiction of the fact that flatfish species tend to be targeted in the eastern Bering Sea while roundfish (Atka mackerel and POP) are generally targeted along the Aleutian Island chain. Targets that predominately show up along the shelf break (i.e., flathead sole and arrowtooth flounder) are species that sometimes end up as "targets" in the CAS when a vessel was primarily working on other species up to their retainable amounts, like POP or Pacific cod.

Figure 3-36 shows where halibut PSC occurred from 2017 through 2019, with a breakout for the EBS survey months of June and July. When compared with Figure 3-35, it is apparent that PSC tracks with the areas fished for flatfish (YFS, NRS) plus a cluster around Unalaska and Unimak Pass where roundfish, Pacific cod, and arrowtooth flounder are predominant.

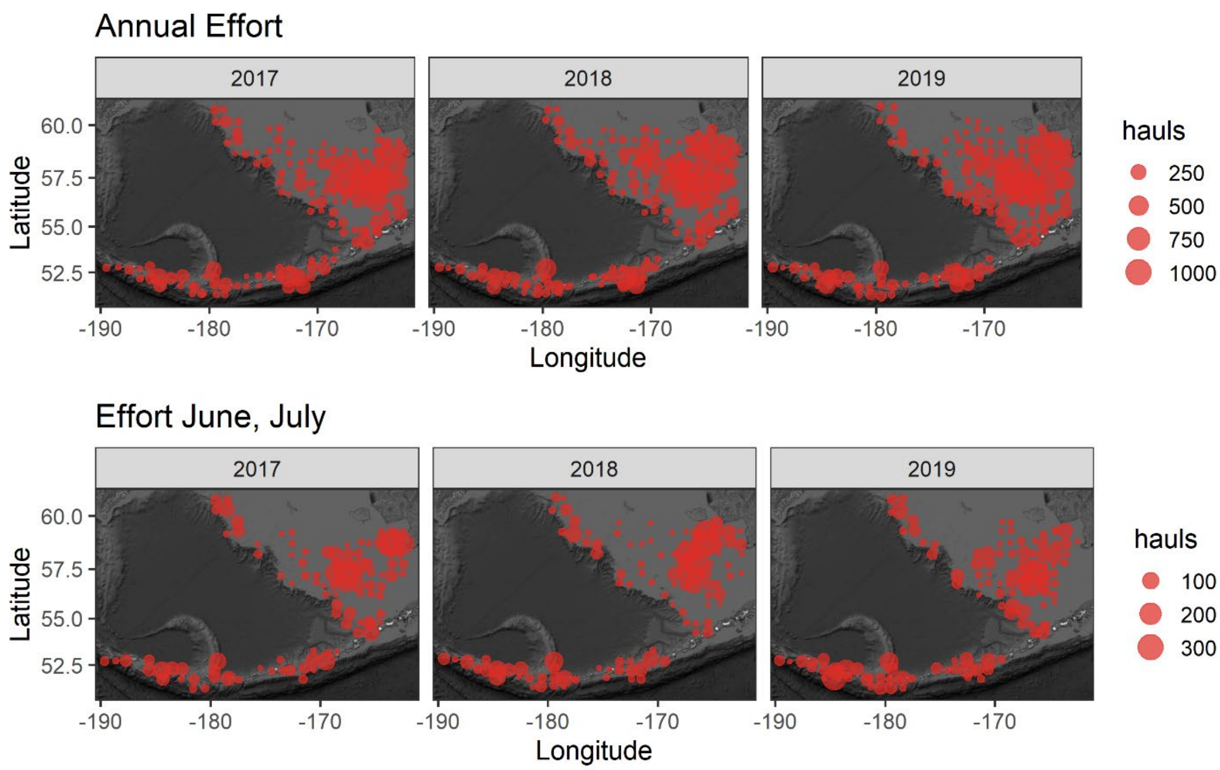

Figure 3-34 A80 sector effort by ADF&G statistical area, 2017 through 2019. Lower panel shows fishery data for months when the EBS survey is conducted. Size of plotted circles is proportional to number of hauls.

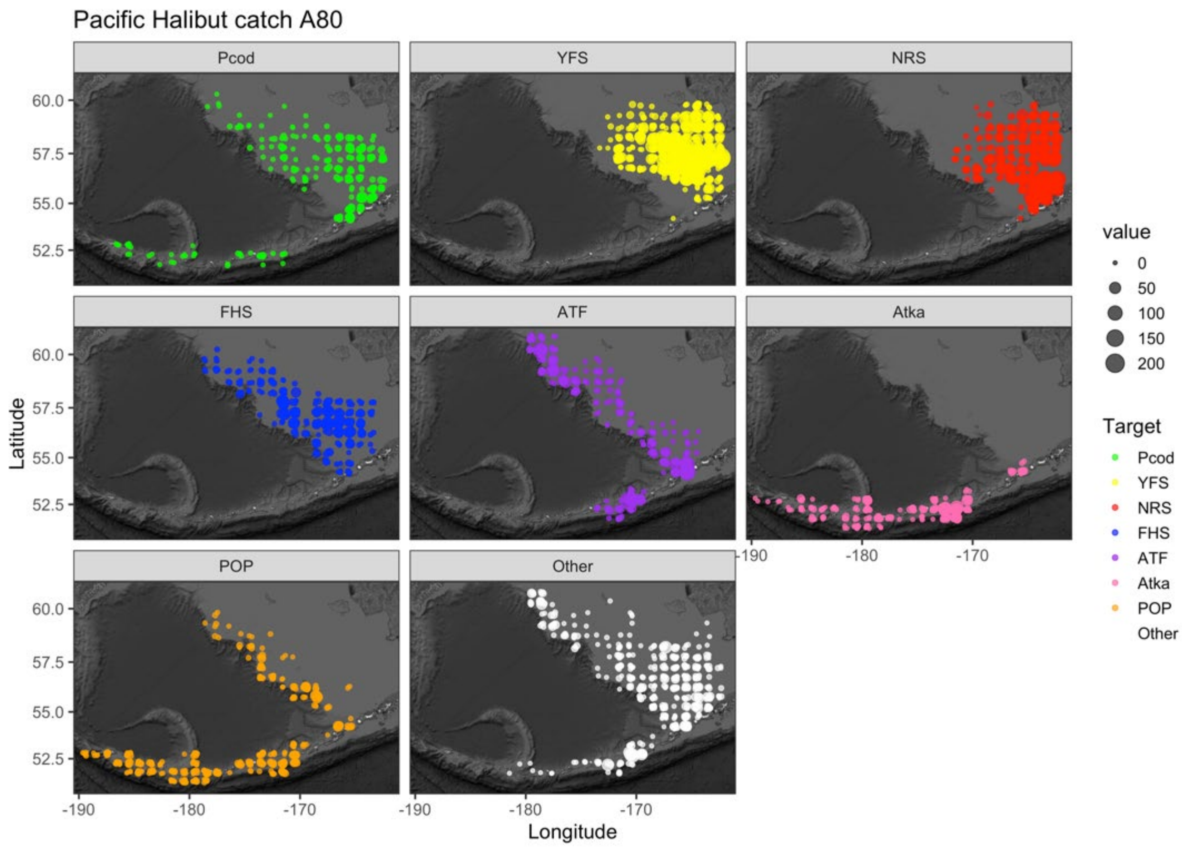

Figure 3-35 A80 sector catch (pre-mortality) of Pacific halibut by ADF&G statistical area and target groundfish species, aggregated over 2010 through 2018. Size of plotted circles proportional to volume ("value" in legend equals metric tons).

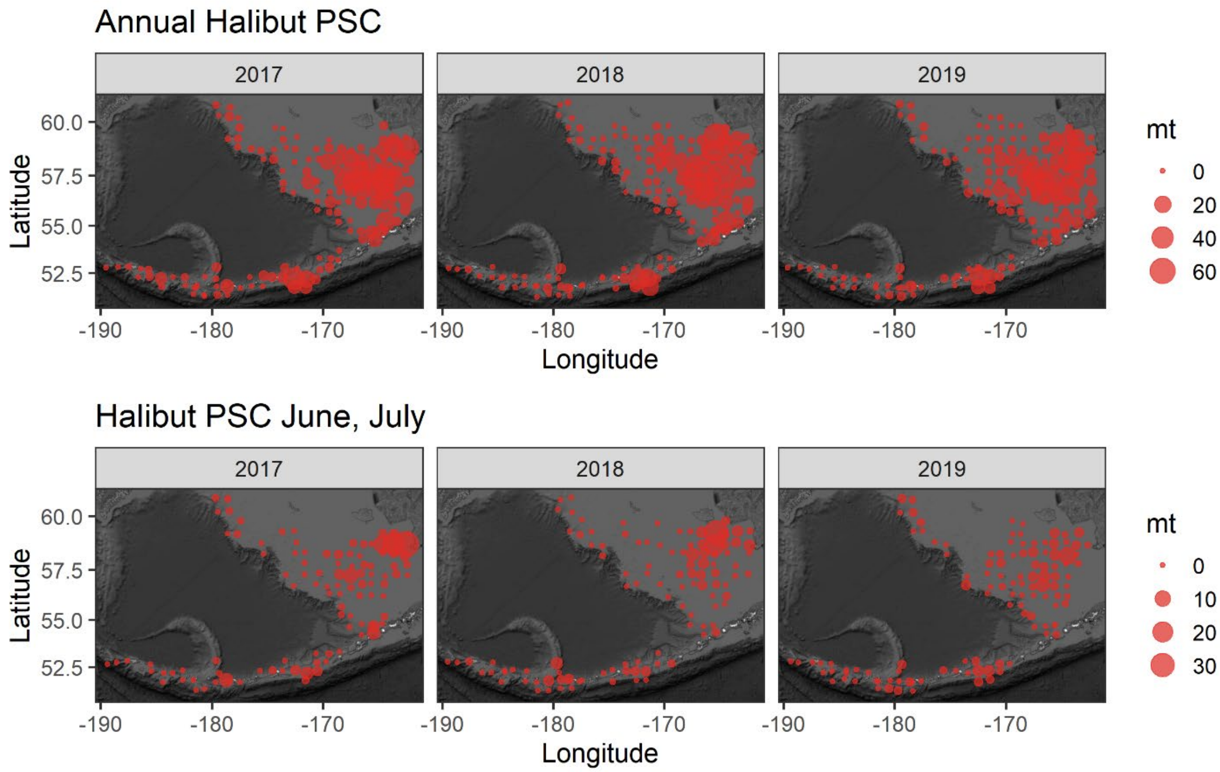

Figure 3-36 A80 sector Pacific halibut PSC (metric tons of mortality) by ADF&G statistical area, 2017 through 2019

Figure 3-37 compares the ADF&G statistical areas where fishing occurred during the EBS survey season (June/July) with areas where the survey encountered halibut. Figure 3-38 overlays ADF&G statistical areas where halibut occurred in the fishery throughout the year and during the survey season on the surveyed areas that encountered halibut.

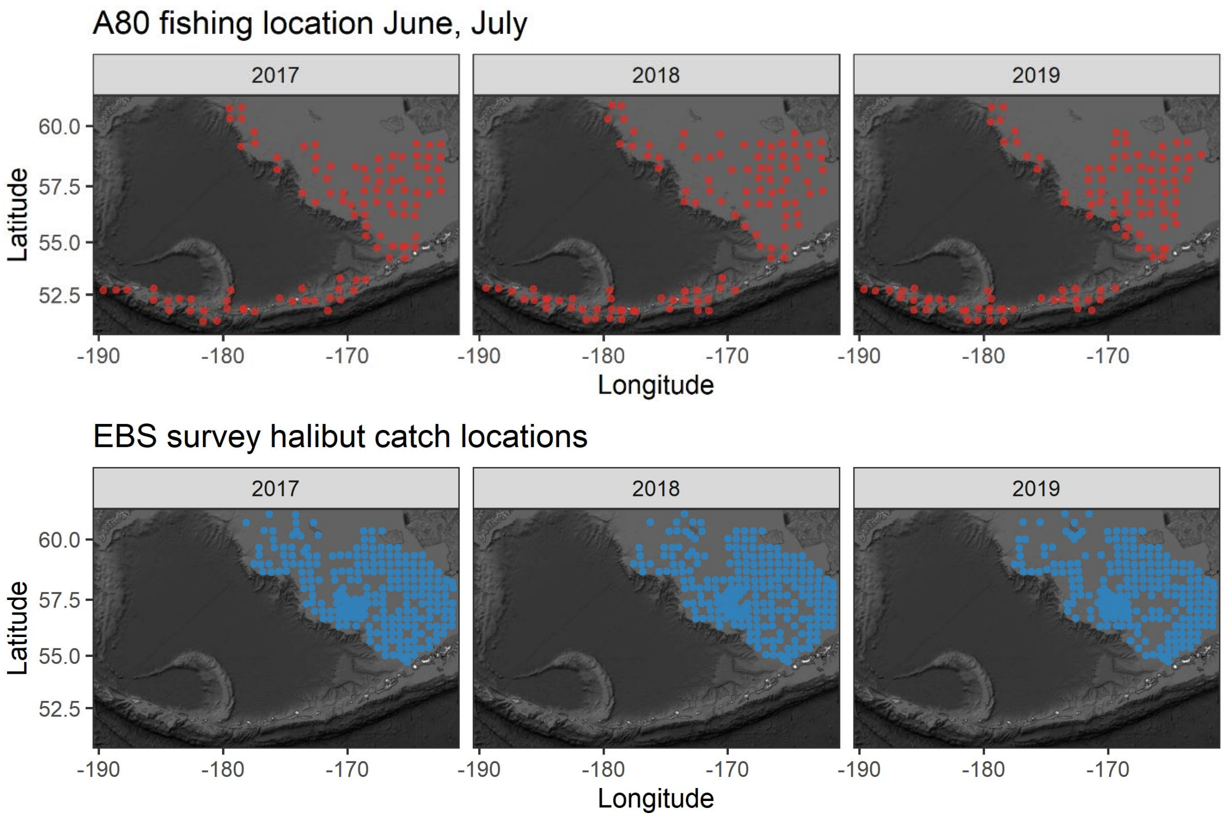

Figure 3-37 ADF&G statistical areas where the A80 sector fished during the months when the EBS trawl survey (EBS) typically occurs and ADF&G statistical areas where the EBS survey encountered halibut, 2017 through 2019

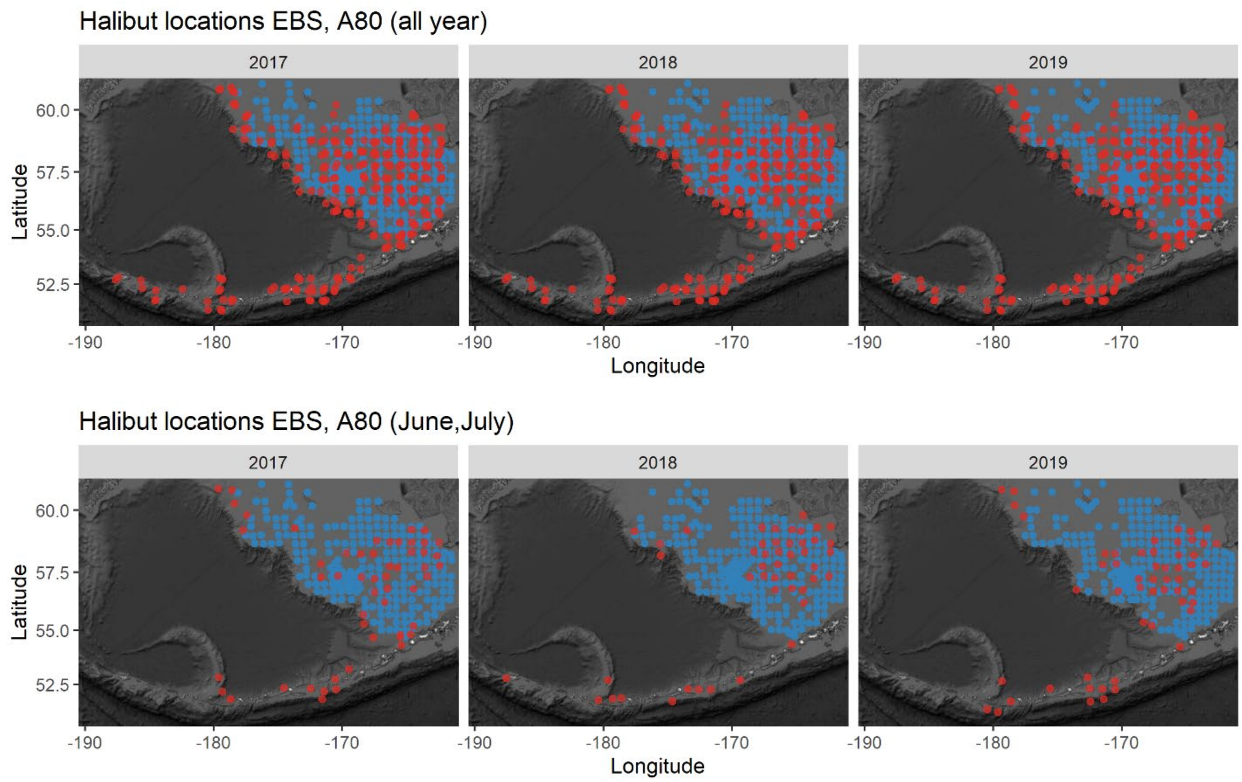

Figure 3-38 ADF&G statistical areas where halibut PSC occurred in the A80 fishery overlaid on areas where the EBS trawl survey (EBS) encountered halibut, 2017 through 2019. Top panel shows areas with A80 halibut catch throughout the year; bottom panel show areas with A80 halibut catch for the months during which the EBS trawl survey typically occurs.

3.4.4 Bycatch mortality reduction strategies

This section describes existing efforts and projects in development within the A80 cooperative to minimize halibut PSC catch and mortality. Note that Section 3.5.1 of the preliminary DEIS (NPFMC 2019a) and Section 1.4.4 of the October 2017 ABM Discussion Paper (NPFMC 2017) provided earlier iterations of this information as well as contrasting and overlapping avoidance strategies in the BSAI TLAS and HAL CP sectors. Those other sectors are no longer directly regulated by the alternatives under consideration and thus have been excised from this section.[48] Some of the information reported below is

[48] In summary, halibut avoidance in TLAS is structured around existing affiliations by most – but not all – TLAS CVs with A80 and AFA companies and/or cooperatives. Unaffiliated TLAS vessels receive information from cooperatives regarding halibut avoidance and encouragement to voluntarily adopt best practices and information sharing. Specific measures include the A80 tools described in this subsection as well as Better Practices Protocols established for AFA CVs when trawling for BSAI Pacific cod. Those protocols include halibut excluders that meet certain specifications, no night fishing, minimum mesh size for escapement of small fish, voluntary full observer coverage, and real-time catch/location information sharing through their cooperative managers. AFA CVs also subject to internal cooperative bycatch allocations. AFA cooperatives may impose internal accountability measures through vessel rankings of PSC rates and monetary sanctions for vessels that do not comply with the Protocols. AFA cooperatives manage such that the PSC limit is not exceeded and allows the managers of cooperatives that do not need their full suballocated PSC to harvest the cooperative's non-pollock sideboard catch to redistribute PSC to other AFA cooperatives at no cost.

The HAL CP sector (Freezer Longline Coalition Cooperative, or FLC) approaches halibut avoidance and PSC minimization through real-time communication facilitated by a third-party data manager. That information includes location data on catch rates and observed discard mortality, which incentivizes careful release practices to increase halibut discard viability. Vessel-specific internal reports on PSC rates promote social incentives to avoid activity that drawn from the most recent cooperative report submitted to the Council by the lone A80 cooperative that is currently operating, which includes all active A80 vessels as members.[49]

Vessels that currently participate in the A80 sector have been engaged in halibut avoidance to some degree since the years prior to A80 implementation when limited access BSAI flatfish fisheries were often closed due to halibut bycatch limits. The implementation of A80 in 2008 created a binding constraint on the qualifying vessels. Since 2011, all A80 vessels have participated in one or two voluntary A80 cooperatives (as opposed to the A80 limited access fishery), resulting in additional capabilities to take organized steps to minimize bycatch. All A80 vessels have participated under a single cooperative since 2017, the Alaska Seafood Cooperative (AKSC). According to AKSC's most recent report to the Council, the sector increased its focus on voluntary halibut bycatch avoidance in 2014 as the Council was considering hard cap PSC limit reductions for A80 and other BSAI groundfish sectors. Those reductions were implemented under Amendment 111 in 2016. Upon taking action to reduce PSC limits in 2015, the Council requested a proactive plan to maintain low bycatch rates. The A80 sector responded with a Halibut Avoidance Plan that was agreed to by the two cooperatives that covered all A80 vessels at the time: AKSC and the Alaska Groundfish Cooperative.

The Halibut Avoidance Plan defined operational practices and accountability measures to avoid halibut and reduce halibut mortality. The Plan imposed rate-based halibut PSC standards for the calendar year and, separately, for the last quarter of the year. The latter measure is meant to prevent overuse of halibut PSC if the annual rate does not appear to be a constraint in that year. Acceptable rates are established on the basis of target species due to the different intrinsic halibut bycatch rates among the A80 species groups (see Table 3-7). Intra-cooperative accountability measures for failure to meet the standards include monetary fines, increased monitoring, and possible reduction in vessel-level halibut PSC allocations within the cooperative for the following year. The AKSC report to the Council on the 2019 fishery notes that all vessels complied with the Plan's standards in that year.

The three principal halibut avoidance measures used by the sector are choice of fishing time and location, use of halibut excluders, and deck sorting of halibut. Active communication among vessel captains on the fishing grounds, facilitated through the cooperative and a third-party data manager, is central to the effectiveness of halibut bycatch minimization under changing fishery conditions. Captains are informed of avoidance measures and operational decisions that are yielding good results at that particular time. Performance reports are shared internally, characterizing the areas being fished by cooperative members in terms of halibut mortality rates, target species, excluder effectiveness, deck sorting, halibut movement, fishing depths, and bottom temperatures. The fleet does not presume seasonal halibut movement to be constant from one year to the next, underlining the importance of continuous data collection and real-time communication. An A80 skipper's primary decision-drivers are the catch and bycatch rates in the particular area where they are fishing. Participants also noted that actively looking for clean fishing can be more productive and less risky than leaving the grounds and returning to make their next decisions based on older information.

The most recent AKSC Cooperative Report states that operators incur direct costs to avoid bycatch and/or reduce mortality rates. For example, participants cite that halibut excluders not only reduce target catch per effort but also increase fuel consumption. Fuel costs and efficiency loss is also incurred when vessels transit to move away from time/area combinations that are resulting in high encounter rates. Transit time also increases total fishing time and reduces productivity for the vessel and its crew, who are compensated based on harvest. Another category of cost is shorter tows that yield fewer groundfish. Shorter tows include test tows to ascertain halibut rates in that area and reduced tow time to increase the

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could result in lost fishing opportunities for the voluntary cooperative as a whole. All vessels in the HAL CP sector operate with flow scales and 100% observer coverage or greater.

[49] Alaska Seafood Cooperative Report to the NPFMC for the 2019 Fishery (April 8, 2020). Accessible at: https://www.npfmc.org/wp-content/PDFdocuments/catch_shares/CoopRpts2019/AKSC.pdf.

viability of the halibut that are caught when a vessel is practicing deck sorting. Costs related to deck sorting and the amount of deck sorting occurring are described below.

The total annual number of hauls made by A80 vessels had been increasing in recent years until a relative drop in the unusual 2020 year. The fleet-wide number of hauls peaked in 2019 at 16,574 (Table 3-21). From 2010 through 2014 the number of annual hauls ranged between roughly 11,000 and 12,500. Since 2015, total hauls were between roughly 12,500 and 16,500. Haul-level data on groundfish catch (t), wholesale value (2018$), and PSC (catch and mortality) are shown in Figure 3-39.[50]

The total number of hauls may be influenced by a variety of factors including TACs, CPUE, and business plans, but is likely driven at least in part by efforts to minimize halibut mortality. While 2015 is somewhat of an arbitrary demarcation for this particular metric, that year does correspond to the implementation of active measures by the fleet to mitigate PSC. In the impacts section of this analysis (Section 5.5), 2015/2016 is used to broadly distinguish a shift in how the A80 sector approaches halibut mortality mitigation. Table 3-13 shows that the most recent years have yielded lower PSC use with total gross wholesale value and harvested groundfish weight remaining in a range comparable to the preceding period. PSC mitigation efforts could result in making more hauls of shorter duration for several reasons.[51] First, test tows with lower intended catch volume are used to assess the time/area fishing conditions and the risk of a high bycatch rate on subsequent longer tows. Second, marginally reducing the duration and volume of a normal tow allows captains to manage the risk of a high magnitude bycatch encounter and provides more frequent opportunities to move out of an area if necessary. Finally, shorter tows increase the expected viability of halibut that are brought onboard due to less time spent in the codend. The A80 fleet has placed an emphasis in recent years on reducing discard mortality, as evidenced by the broad adoption of deck sorting (Table 3-22).

Table 3-21 Total A80 sector hauls by year, 2010 through 2020

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
A80 Hauls	12,507	11,163	10,892	11,338	11,702	12,443	14,167	13,821	15,908	16,574	14,430

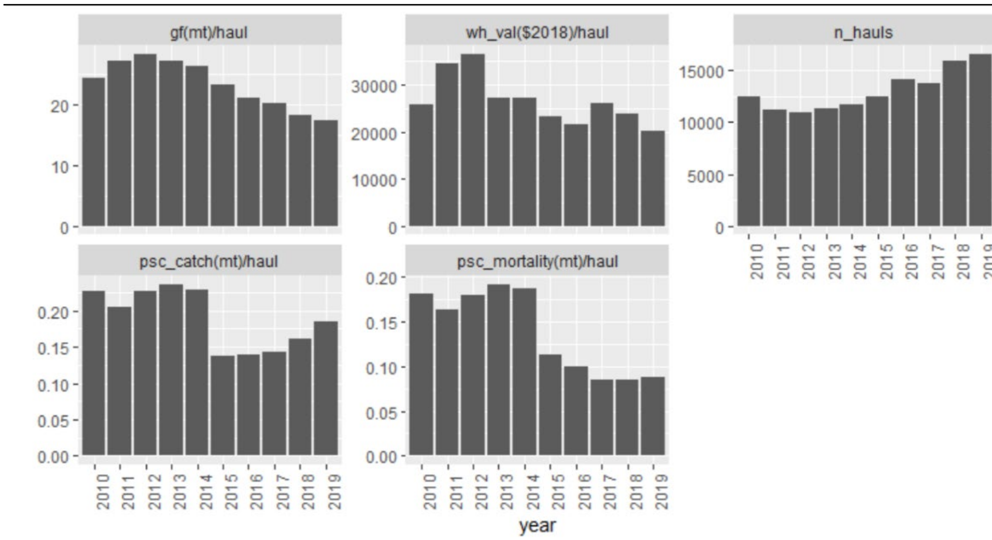

Figure 3-39 Haul-level data on A80 groundfish catch (metric tons), first wholesale revenue (2018$), and halibut PSC encounter/mortality (metric tons)

[50] The data in this figure are drawn from the same observer dataset that was used for the revenue analysis in Section 5.5. Data from 2015 are included here – in contrast to their exclusion in the impacts analysis – because confidence in annual aggregate haul-level data is high whereas specific haul data in 2015 were complicated by the early implementation of a deck sorting EFP.

[51] Alaska Seafood Cooperative, via personal communication. August 2020.

The 2019 AKSC report states that A80 vessels continue to experiment with halibut excluder designs to improve effectiveness and reduce target loss. The cooperative stated that excluder effectiveness varies across fisheries and vessels with conditions, vessel and net characteristics, and operating practices. Metrics for effectiveness are not well measured. For example, fishery participants and managers can only speculate about whether excluders might be less effective when encountering a higher proportion of small size halibut. In February 2021, the A80 cooperative brought an EFP proposal to the Council, seeking to better study the efficacy and efficiency of the most up-to-date excluder designs. The Council recommended that the EFP application be approved by NMFS.[52]

Previous iterations of the ABM analysis and associated discussion papers had noted a possible trade-off in the efficacy of excluder use and deck sorting – in other words, they were not viewed as purely complementary because it was thought that excluders increased mud or siltation on fish in the net, reducing release viability. Continuing gear experimentation may have reduced this effect by bringing the excluder section of the net higher in the water, reducing mud and increasing the proportion of tows when excluder use could be advantageous (AKSC, personal communication, July 2020). Innovations that work well with deck sorting are increasingly important now that all A80 vessels are deck sorting at least some of the time (Table 3-22). In 2019, nine of the 10 A80 vessels that fished in the GOA utilized deck sorting at least some of the time that they were fishing in that area.

Table 3-22 A80 vessel participation in deck sorting exempted fishing permit (EFP), 2015 through 2019

Year	A80 Vessels in EFP	Deck Sorted BSAI	Deck Sorted GOA
2015	9	9	-
2016	10	10	-
2017	15	15	-
2018	19	19	8
2019	20	20	9

The A80 sector has invested substantial time and labor in the development of deck sorting as an EFP, and in 2020 deck sorting was implemented as a regulation and is fully incorporated as an option within the observer program. Note that – as a byproduct of deck sorting implementation – observer data no longer include a separate 'purpose code' that identifies a deck-sorted haul so 2020 data cannot be characterized in this manner. In addition to direct costs, deck sorting may reduce a vessel's daily productivity if it is able to complete fewer tows and if tows are shortened to increase viability. These costs could be compensated if lower DMRs reduce the likelihood that the sector or a company within the sector loses fishing opportunities or has to diverge from its optimal operating plan due to PSC levels that approach internal limits, standards set within the sector's Halibut Avoidance Plan, or the overall sector limit. These benefits would be of marginally greater value in years that can be described as a high-PSC environment, which the sector has avoided in recent years (partly as a result of deck sorting – see Figure 3-25 through Figure 3-27).

Figure 3-40 shows a strong correlation between the percentage of A80 catch that occurs on deck sorted hauls and the effective halibut mortality rate (the ratio of halibut PSC mortality to total halibut catch). Figure 3-41 shows that the sector has expanded deck sorting from a practice used in only the highest-PSC-rate target. The sector apparently now sees a net benefit from deck sorting even when the target tends to have a lower PSC rate, such as Atka mackerel or Pacific ocean perch. Figure 3-42 illustrates the marked change in the number of halibut assessed by viability category on A80 vessels beginning in 2015 with the ramped up deck sorting EFP. The investments made by the A80 sector and NMFS to improve fish handling and to collect viability information has resulted in better information about the release mortality of halibut bycatch, which has translated into lower DMRs for the sector (Table 3-7).

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[52] The EFP application can be seen at: https://meetings.npfmc.org/CommentReview/DownloadFile?p=924c31f1-0bdf-4625-a44d-c7f643b16024.pdf&fileName=D2%20Halibut%20Excluder%20EFP%20Application.pdf.

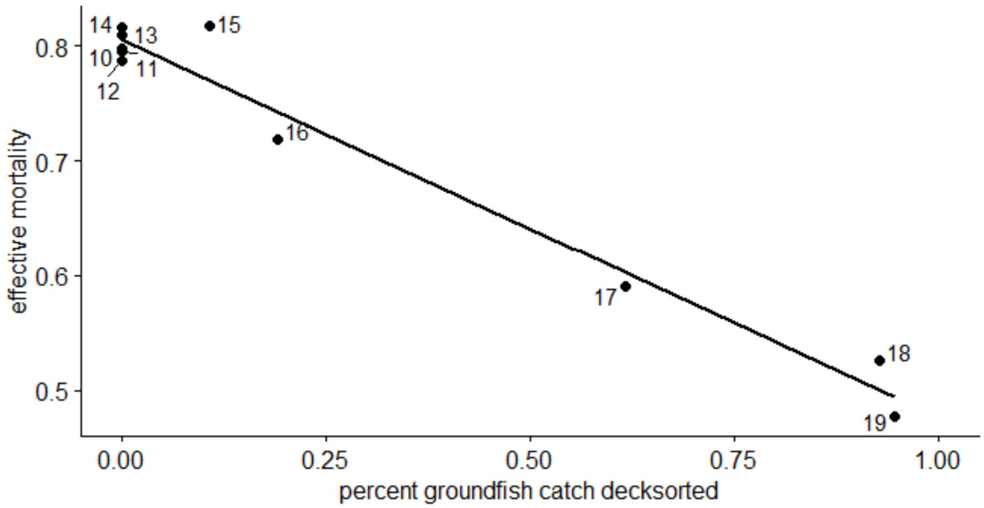

Figure 3-40 **Relationship between effective mortality rate (halibut mortality/catch) and percent of A80 groundfish catch deck sorted**

Figure 3-41 **Proportion of A80 catch deck sorted, by targets species (2014 through 2019)**

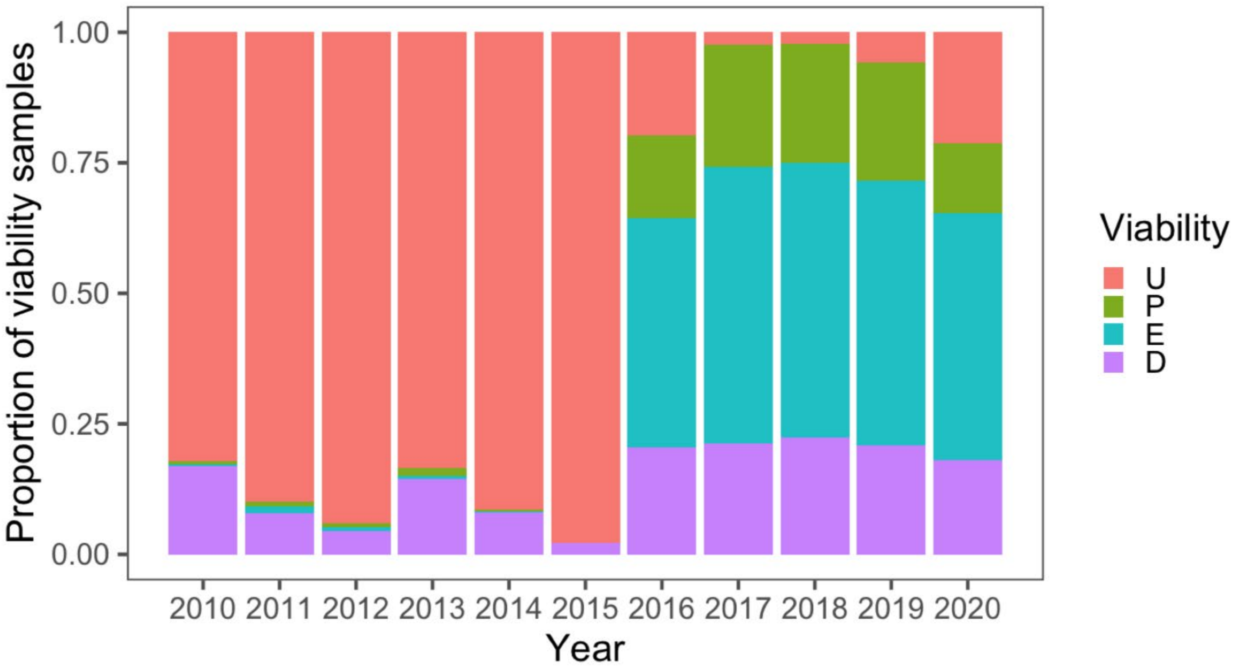

Figure 3-42 Observer estimates of Pacific halibut viabilities taken on A80 vessels, 2010 through August 2020. Viability codes (which affect DMR estimates) are: D=Dead, E=Excellent, P=Poor, U=Unknown.

3.4.5 Count of SBA small entities

The Regulatory Flexibility Act (RFA), first enacted in 1980 and amended by the Small Business Regulatory Enforcement Fairness Act of 1996 (5 U.S.C. 601-612), is designed to place the burden on the government to review all regulations to ensure that, while accomplishing their intended purposes, they do not unduly inhibit the ability of small entities to compete. Major goals of the RFA are 1) to increase agency awareness and understanding of the impact of their regulations on small business, 2) to require that agencies communicate and explain their findings to the public, and 3) to encourage agencies to use flexibility and to provide regulatory relief to small entities. The RFA emphasizes predicting significant adverse economic impacts on small entities as a group distinct from other entities, and on the consideration of alternatives that may minimize adverse economic impacts, while still achieving the stated objective of the action. When an agency publishes a proposed rule, it must either 'certify' that the action will not have a significant adverse economic impact on a substantial number of small entities and support that certification with the 'factual basis' upon which the decision is based, or it must prepare and make available for public review an Initial Regulatory Flexibility Analysis (IRFA). Under section 603 of the RFA, an IRFA "shall describe the impact of the proposed rule on small entities." Required elements of an IRFA are specified at 5 U.S.C., section 603(b).

One of the required elements in an IRFA is a description of and, where feasible, an estimate of the number of small entities to which the proposed rule will apply (including a profile of the industry divided into industry segments, if appropriate). This section identifies the number of small entities that would be directly regulated by an ABM action. As currently specified, the alternatives under consideration would only directly regulate the A80 sector, which is described in Section 3.3. Entities that fish for halibut either commercially under the IFQ Program or for subsistence and sport uses are important in the consideration of the ABM action and, as such, are described in this DEIS and the attached SIA but they are not directly regulated. Therefore, any documentation prepared under the RFA would not include directed halibut fishery participants. As the action alternatives are presently defined, the number and categories of small entities that could be directly regulated does not differ between alternatives.

Note that the preparation of a complete IRFA is not necessary for the Council to take action on this issue. NMFS Alaska Region prepares the IRFA for a proposed action in the Classification section of the proposed rule. Section 5.5 of this document identifies the general nature of the potential economic impacts on directly regulated entities, whether the impacts may be adverse or beneficial, and how impacts might be distributed among directly regulated entities.

The RFA recognizes and defines three kinds of small entities: 1) small businesses, 2) small non-profit organizations, and 3) small government jurisdictions. The analysts have preliminarily concluded that the considered action would only directly regulate the first type of small entity (small businesses – i.e. fish harvesting businesses). As noted above, the only BSAI groundfish sector that is regulated by a PSC limit is A80. Some A80 vessels harvest groundfish that were allocated to CDQ groups (3.3.2.1). Vessels harvesting CDQ allocations are distinct from the non-profit CDQ groups, themselves. Vessels that are owned by, or fishing on behalf of, CDQ groups are evaluated according to the same affiliation and income thresholds as for all other vessels. NMFS typically considers CDQ groups to be small entities due to their non-profit status. The CDQ groups that partner with A80 vessels or partially own vessels are not considered to be directly regulated but, nevertheless, are identified elsewhere in Section 3.3.4 of this document and in the attached SIA.

The following paragraphs provide the parts of the SBA definition of small businesses that are relevant to the directly regulated entities and for which the analysts possess the data necessary to make a small/non-small determination:

Section 601(3) of the RFA defines a 'small business' as having the same meaning as 'small business concern', which is defined under Section 3 of the Small Business Act (SBA). 'Small business' or 'small business concern' includes any firm that is independently owned and operated and not dominant in its field of operation. The SBA has further defined a "small business concern" as one "organized for profit, with a place of business located in the United States, and which operates primarily within the United States or which makes a significant contribution to the U.S. economy through payment of taxes or use of American products, materials or labor… A small business concern may be in the legal form of an individual proprietorship, partnership, limited liability company, corporation, joint venture, association, trust or cooperative, except that where the firm is a joint venture there can be no more than 49 percent participation by foreign business entities in the joint venture."

The thresholds applied to determine if an entity or group of entities is a small business under the RFA depend on the industry classification for the entity or entities. Businesses classified as primarily engaged in commercial fishing are considered small entities if they have combined annual gross receipts not in excess of $11.0 million for all affiliated operations worldwide (81 FR 4469; January 26, 2016). Businesses classified as primarily engaged in fish processing are considered small entities if they employ 750 or fewer persons on a full-time, part-time, temporary, or other basis, at all affiliated operations worldwide. Since at least 1993, NMFS has considered CPs – such as A80 vessels – to be predominantly engaged in fish harvesting rather than fish processing. Under this classification, the threshold of $11.0 million in annual gross receipts is appropriate. Because this action directly regulates only fish harvesting businesses, the employment threshold does not need to be considered in determining SBA classifications.

The SBA has established "principles of affiliation" to determine whether a business concern is "independently owned and operated." In general, business concerns are affiliates of each other when one concern controls or has the power to control the other, or when a third-party controls or has the power to control both. The SBA considers factors such as ownership, management, previous relationships with or ties to another concern, and contractual relationships, in determining whether affiliation exists. Individuals or firms that have identical or substantially identical business or economic interests, such as family members, persons with common investments, or firms that are economically dependent through contractual or other relationships, are treated as one party with such interests aggregated when measuring the size of the concern in question.

NMFS considers members of fishing cooperatives to be affiliated for purposes of applying thresholds for identifying small entities. In making this determination, NMFS considered SBA's "principles of affiliation" at 13 CFR 121.103. Specifically, in § 121.103(f), SBA refers to "[A]ffiliation based on identity of interest," which states "[A]ffiliation may arise among two or more persons with an identity of interest. Individuals or firms that have identical or substantially identical business or economic interests (such as family members, individuals or firms with common investments, or firms that are economically dependent through contractual or other relationships) may be treated as one party with such interests aggregated." If business entities are affiliated then the threshold for identifying small entities is applied to the group of affiliated entities rather than on an individual entity basis. The Alaska Seafood Cooperative – the lone A80 cooperative that operated during the year for which revenue data were examined by the analysts for this section (2019) – falls under this definition.

All directly regulated harvesting entities (i.e., A80 vessels) have participated in voluntary cooperatives since 2011. As a result of cooperative affiliation and aggregate gross revenues, no directly regulated entities are considered to be small entities under SBA guidelines. Data on A80 gross revenues are provided in Section 3.3.2.

4 Pacific Halibut

4.1 Life history, and distribution

Pacific halibut (*Hippoglossus stenolepsis*) is one of the largest species of flatfish in the world, with individuals growing up to eight feet in length and over 500 lb. The range of Pacific halibut that the IPHC manages covers the continental shelf from northern California to the Aleutian Islands and throughout the Bering Sea. Pacific halibut are also found along the western north Pacific continental shelf of Russia, Japan, and Korea.

The depth range for halibut is up to 250 fathoms (457 m) for most of the year and up to 500 fathoms (914 m) during the winter spawning months. During the winter (November through March), the eggs are released, move up in the water column, and are caught by ocean currents. Female halibut release a few thousand eggs to several million eggs, depending on the size of the fish. Eggs are fertilized externally by the males. Prevailing currents carry the eggs north and west. By the age of 6 months, young halibut settle to the bottom in shallow nearshore areas such as bays and inlets. Research has shown that the halibut then begin what can be called a journey back. This movement runs counter to the currents that carried them away from the spawning grounds and has been documented at over 1,000 miles for some fish. Most male halibut are sexually mature by about 8 years of age, while half of the females are mature by about age 11.6 (Stewart 2015). At this age, they are generally large enough to meet the minimum size limit for the commercial fishery of 32 inches.

Halibut feed on plankton during their first year of life. Young halibut (1 to 3 years old) feed on euphausiids (small shrimp-like crustaceans) and small fish. As halibut grow, fish make up a larger part of their diet. Larger halibut eat other fish, such as herring, sand lance, capelin, smelt, pollock, sablefish, cod, and rockfish. They also consume octopus, crabs, and clams.

Halibut also move seasonally between shallow waters and deep waters. Mature fish move to deeper offshore areas in the fall to spawn and return to nearshore feeding areas in early summer. It is not yet clear if fish return to the same areas to spawn or feed, year after year.

4.2 Stock assessment and management

As the Pacific halibut directed and non-directed fisheries have evolved, the methods to assess the stock and manage the fishery have also evolved over many decades. The stock assessment began with simple catch-per-unit-effort models, moved to yield-per-recruit models in the 1970s, surplus production models in the early 1980s, catch-at-age models in the 1980s and 1990s, and more recently integrated age-structured models (see Clark 2003 for a brief history of IPHC's first 80 years). Currently, the stock assessment for Pacific halibut uses four integrated age-structured models in an ensemble to account for parameter and structural uncertainty (Stewart & Martell 2015). The advice from the stock assessment ensemble is presented to the Commission as a risk-based decision table with different catch levels as columns and various performance metrics as rows.

As with all stock assessment models, the IPHC stock assessment ensemble is a simplification of reality that attempts to capture the trends in the stock, supply useful management advice, and characterize an appropriate level of uncertainty. The ensemble is composed of coastwide models, which means that the annual estimated biomass is a single value for the entire coast (U.S. and Canada) and migration between areas is not modeled. Natural mortality is estimated in some models and fixed for one sex in others. Each of the models use annual empirical weight-at-age observations to convert numbers-at-age to biomass. This allows the model to account for the observed large changes in historical weight-at-age. Steepness (a stock-recruit relationship parameter that relates to productivity/resilience of the stock) was fixed at 0.75

for all models. However, a dominant source of recruitment variability comes from treating the average recruitment as a function of environmental conditions where a regime (cool or warm) is determined from the Pacific Decadal Oscillation (PDO, Clark & Hare 2002).

Ensemble modeling provides a more robust assessment approach that acknowledges structural uncertainty and that, along with other recent improvements, has effectively stabilized management decision tables relative to catch recommendations and potential impacts on spawning biomass (in probabilistic terms). Prior to 2012 assessments for Pacific halibut had consistently overestimated spawning biomass causing a retrospective pattern of overly optimistic short-term forecasts (Stewart & Martell 2014). Figure 4-1 shows the estimates of fishing intensity (a measure of the harvesting rate over all sizes and sources) on the coastwide stock compared to the current interim SPR-based harvest policy of $F_{SPR=43\%}$. The fishing intensity is estimated to have been more than 1.2 times the current interim harvest policy fishing intensity in some years with considerable uncertainty. Over this period, the estimated stock status was mostly above 30% (i.e., higher than the threshold precautionary management action) and always above 20% (i.e., higher than the threshold for biological concern Figure 4-2). Weight-at-age was declining (even without fishing, a decline in spawning biomass and recommended catch levels are predicted over this period) but has since stabilized, and recent recruitment was below average. Large changes in the spawning biomass of Pacific halibut, which do not seem explicitly linked to fishing, have been observed over the more than 100 years of commercial fishing.

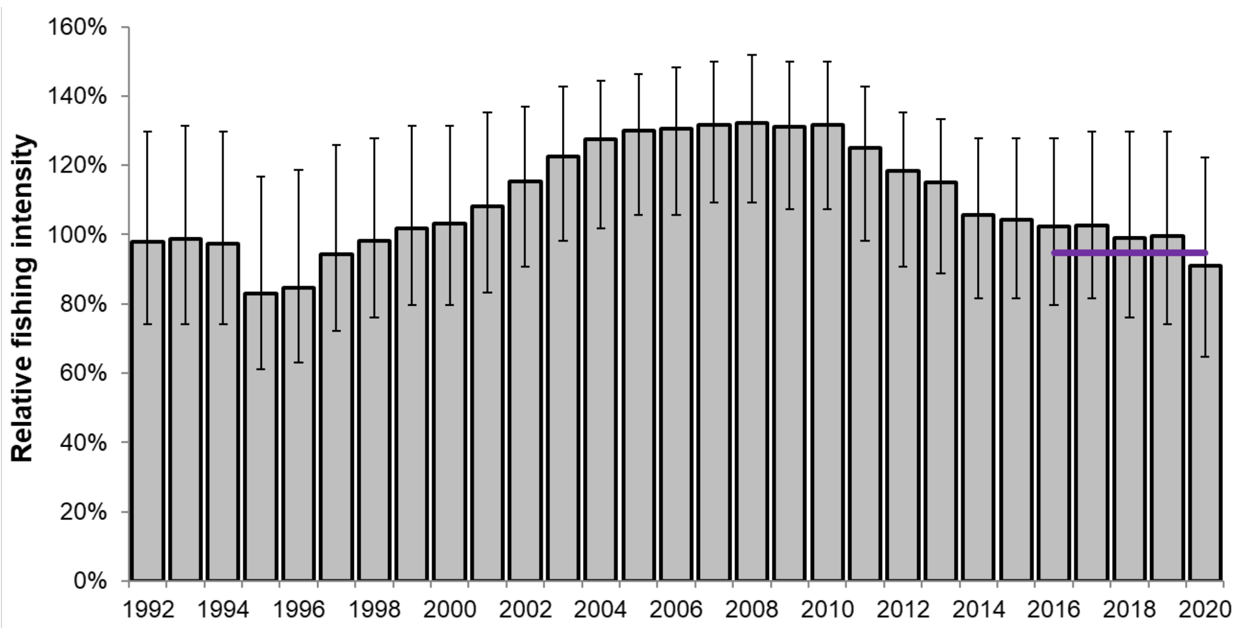

Figure 4-1. Time-series of coastwide fishing intensity (1992-2020; based on the Spawning Potential Ratio) relative to the IPHC current interim harvest policy SPR = 43%, as estimated retrospectively in the 2020 pacific halibut stock assessment. The previous IPHC interim SPR = 46% reference level is shown as the purple horizontal line. Vertical lines indicate approximate 95% credible intervals from the stock assessment ensemble.

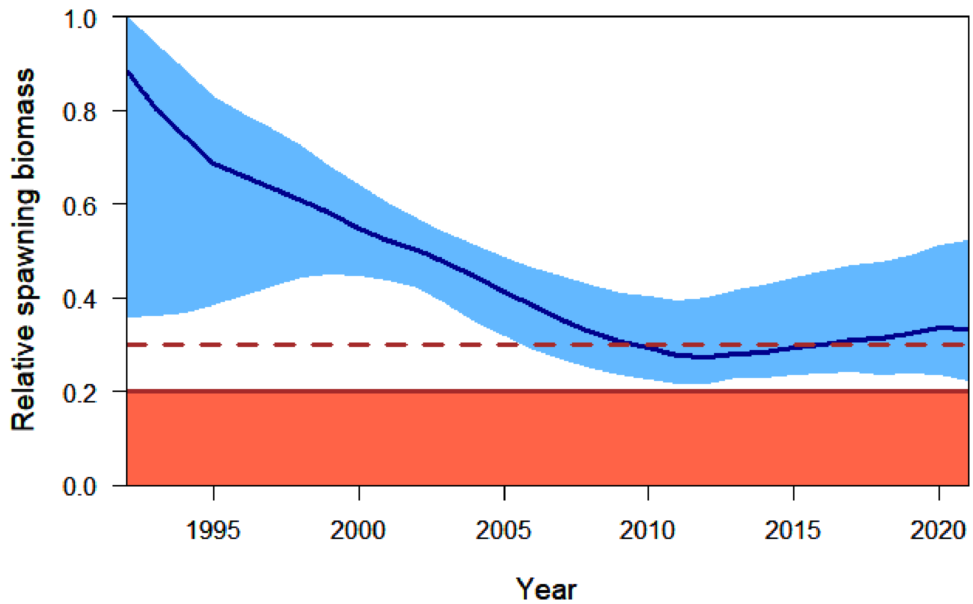

Figure 4-2 **Estimated time-series of relative spawning biomass (compared to the unfished condition in each year) based on the median (dark blue line) and approximate 95% credibility interval (blue shaded area). IPHC management procedure reference points ($SB_{30\%}$ and $SB_{20\%}$) are shown as dashed and solid lines respectively, with the region of biological concern (<$SB_{20\%}$) shaded in red**

The estimated spawning stock biomass has been stable since 2010 following a considerable decline since the late 1990s (Figure 4-3). In recent years, the spawning biomass has been predicted to slightly decrease, even at low fishing levels, due to a lack of incoming recruitment. Weight-at-age is also a contributing factor to this decline because the average weight-at-age of Pacific halibut has been declining over this same period.

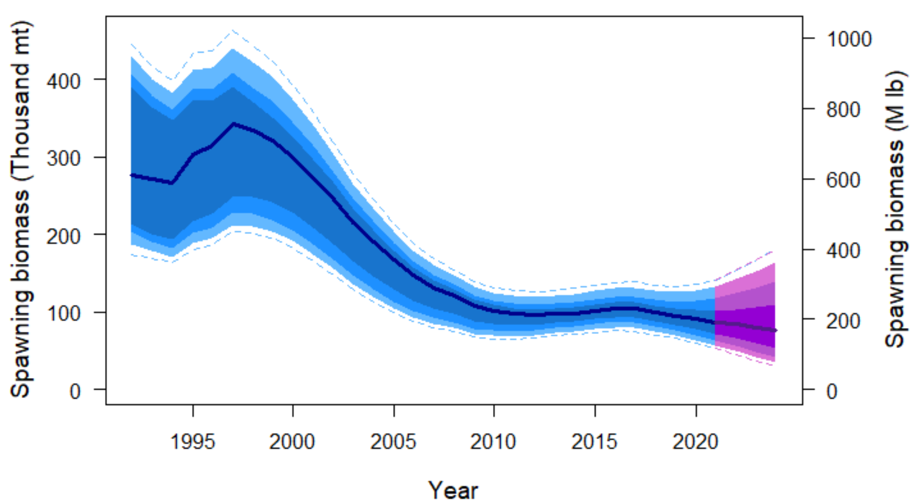

Figure 4-3. **Estimated spawning biomass from the 2020 stock assessment ensemble (from Stewart & Hicks 2021) with a three-year projection (purple) based on a fishing intensity of $F_{SPR=43\%}$ (TCEY=39.0 million pounds, ~17,690 t).**

4.3 Management of Pacific Halibut

4.3.1 IPHC and process for setting catch limits

In 2017, the previous IPHC harvest policy paradigm was replaced with an interim SPR-based (Spawning Potential Ratio) harvest strategy policy (Figure 4-4) while a management strategy evaluation (MSE) process is underway. This new paradigm sets a coastwide mortality limit (scale) and then distributes the mortality limits (distribution) across IPHC Regulatory Areas (Figure 1-3, Hicks & Stewart 2017). Previously, the IPHC Regulatory Area mortality limits were determined by multiplying the apportioned biomass (based on estimated biomass from survey catches) in each IPHC Regulatory Area by a harvest rate specific to each IPHC Regulatory Area. This new harvest strategy policy now considers mortality from all sources and sizes when setting a coastwide mortality limit but still uses estimates of stock distribution from the IPHC fishery independent setline survey (FISS) and relative harvest rates to distribute the mortality limits across IPHC Regulatory Areas. Currently, there are interim agreements through 2022 for IPHC Regulatory Areas 2A and 2B that define how the mortality limits are specifically determined in each of those areas.

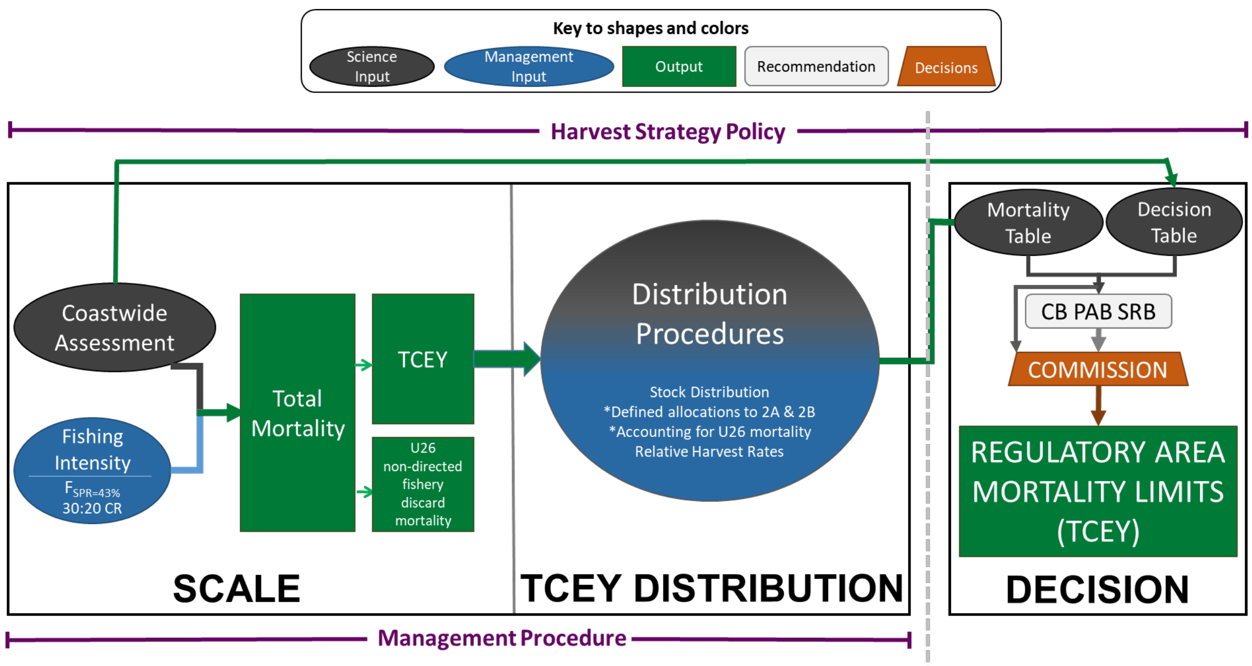

Figure 4-4. Illustration of the Commission interim IPHC harvest strategy policy (reflecting paragraph ID002 in IPHC CIRCULAR 2020-007) showing the coastwide scale and TCEY distribution components that comprise the management procedure. Items with an asterisk are three-year interim agreements to 2022. The decision component is the Commission decision-making procedure, which considers inputs from many sources.

The default level of fishing intensity ($F_{SPR=43\%}$) for this interim harvest policy is determined from MSE simulations investigating the coastwide scale portion of the harvest strategy policy (paragraph ID002 in IPHC CIRCULAR 2020-007). A control rule is also a part of the harvest policy where the fishing intensity is reduced when the stock status is estimated to be below 30% and set to zero when stock status is estimated to be below 20%. The control rule has never been invoked because the terminal year stock status has never been estimated by the stock assessment to be less than 30% since it was a part of the harvest policy, although the 2020 stock assessment estimates that stock status was below 30% in some historical years (REF NEW FIGURE ABOVE). A reduction in fishing intensity invoked by this control rule is expected to mainly affect the directed fisheries, although other agencies may consider action when the stock status of Pacific halibut is estimated to be at low levels.

The Total Mortality determined from F_{SPR} is split into two components: under 26" (U26) non-directed commercial fishing (i.e., U26 bycatch) mortality and all other mortality which is called the Total Constant Exploitation Yield (TCEY) and consists of mostly over 26" (O26) halibut. The TCEY is distributed among IPHC Regulatory Areas based on estimates of biomass from the FISS and relative harvest rates, where western areas (3B and all of Area 4) are harvested at a lower level (a factor of 0.75). The lower harvest rate in western areas is due to concerns about historical uncertainty, past observed declines in those regions, and likely different life-history characteristics and population dynamics. The westward areas also differ from the central and eastern regions in the levels of bycatch of juveniles (which can affect the overall productivity of the stock) and evidence that there is net emigration of exploitable halibut from these areas (Hare & Clark 2008, Hare 2011). All of these factors suggest that target harvest rates should be lower in the western IPHC Regulatory Areas.

Annually, a stock assessment is done using all of the available data for that year and a decision table (e.g., risk analysis) is presented at the IPHC Annual Meeting in January. Various advisory bodies as well as the public supply recommendations to the Commissioners. Decisions for Area-specific TCEY's are made considering all the input received; they may differ from the harvest policy output.

The IPHC formula for determining TCEY and allocating catch limits among regulatory areas has shifted over the past two years and is expected to shift again, as Commissioners evaluate the results of the IPHC's management strategy evaluation (described below). The management strategy evaluation evaluated 11 potential management strategies for allocating catch limits among areas and were presented to the Commission at the January 2021 Annual Meeting. These results will inform the Commission as they make decisions in the coming years to update the harvest policy in terms of both the scale of the coastwide TCEY and the methods for distributing TCEY among areas.

The specific formula used by the IPHC Commissioners to distribute catch limits among Regulatory Areas has been different for each of the past three years. In 2019, the US and Canadian Commissioners departed from the interim harvest policy at that time, written as follows in the Annual Meeting report from 2019, with further adjustments then made to the distribution of TCEY among Alaskan Regulatory Areas (IPHC AM095 Report 2019):

"69. The Commission ADOPTED: a) a coastwide target SPR of 47% for 2019; b) a share-based allocation for IPHC Regulatory Area 2B. The share will be defined based on a weighted average that assigns 30% weight to the current interim management procedure's target TCEY distribution and 70% on 2B's recent historical average share of 20%. This formula for defining IPHC Regulatory Areas 2B's annual allocation is intended to apply for a period of 2019 to 2022. For 2019, this equates to a share of 17.7%; and c) a fixed TCEY for IPHC Regulatory Area 2A of 1.65 mlbs is intended to apply for a period from 2019-2022, subject to any substantive conservation concerns."

In 2020, the formula used by Commissioners to set TCEY by Regulatory Area was again slightly different than the interim harvest policy at that time, as follows, with further adjustments then made to the distribution of TCEY among Alaskan Regulatory Areas (IPHC AM096 Report 2020):

"97. The Commission ADOPTED: a) a coastwide mortality limit (TCEY) of 36.6 million pounds; and b) a fixed TCEY for IPHC Regulatory Area 2A of 1.65 million pounds is intended to apply for a period from 2019-2022, subject to any substantive conservation concerns; and IPHC–2020–AM096–R c) a share-based allocation for IPHC Regulatory Area 2B. The share will be defined based on a weighted average that assigns 30% weight to the current interim management procedure's target TCEY distribution and 70% on 2B's recent historical average share of 20%. This formula for defining IPHC Regulatory Areas 2B's annual allocation is intended to apply for a period of 2019 to 2022. For 2020, this equates to a share of 18.2% before accounting for U26 ; and d) an accounting for some impacts of U26 non-directed discard mortality from US IPHC Regulatory Areas on available harvest in IPHC Regulatory Area 2B. The accounting increases the 2B TCEY by 50% of the estimated yield lost due to U26 non-directed discard mortality in Alaskan waters and is intended to apply for the period 2020-2022. For 2020 this

calculation equates to 0.21 million pounds and reduces all Alaskan IPHC Regulatory Area TCEYs to maintain a coastwide TCEY of 36.6 million pounds; and e) the use of a rolling three-year average for projecting non-directed fishery discard mortality by IPHC Regulatory Area; this is also intended to apply for a period of 2020 to 2022."

In 2021, the Commission set the coastwide limit at 39.0 Mlbs, which followed the current interim harvest policy coastwide fishing intensity level ($F_{SPR=43\%}$). The mortality limits for IPHC Regulatory Areas 2A and 2B followed the interim agreements and adjustments to the distribution of TCEY occurred among Alaskan Regulatory Areas (IPHC-2021-AM097-R).

Currently, a management strategy evaluation (MSE) framework is being done at IPHC to determine a level of fishing intensity and distribution procedure that meets the short- and long-term objectives of the directed fishery and managers. These include biological sustainability, optimizing yield, and stability in yield, with biological sustainability objectives as the top priority for evaluation. Recent MSE analyses have informed the change to a fishing intensity using SPR=43% and are being used to evaluate trade-offs in distributing the mortality limits between IPHC Regulatory Areas. A change in the distribution procedure may affect the treatment of bycatch in a specific IPHC Regulatory Area because the mortality limit in that area may change. For example, if a new distribution procedure resulted in fewer fish in 4CDE, that could put a strain on the directed and bycatch fisheries in that Area. Vice versa, an increase in mortality limits may provide more opportunity for the directed and bycatch fisheries. It is unlikely that a chosen distribution procedure would change greatly among Areas compared to current mortality limits, but even a small change could be significant for some sectors.

Bycatch mortality in IPHC MSE closed-loop simulations is simulated from an assumed relationship with simulated total biomass tuned to recent coastwide bycatch levels (one unit increase in total biomass results in 0.4% increase in bycatch mortality). This integrates over a wide range of possible bycatch scenarios to determine a management procedure that is robust to various levels of bycatch. In the future, allocation between directed and non-directed fisheries may be specifically investigated with involvement from other agencies and fishing sectors.

Another factor of interest in the management of Pacific halibut is the size limit for the directed commercial fishery (currently 32 inches; see Stewart et al 2020 for a recent investigation). A change in the size limit could increase efficiency of the commercial fleet but would result in a change in selectivity. A change in selectivity could result in a change to the target SPR that meets the defined goals and objectives, although in the likely range of potential selectivity, this change in SPR would be slight.

Changes to the IPHC harvest strategy policy to meet objectives as defined in the IPHC MSE process will benefit the management of the coastwide stock of Pacific halibut, distribute the TCEY using an agreed upon procedure, and provide opportunity to measure impacts from different fisheries. However, it does not solve the difficult issues of allocation between fisheries within IPHC Regulatory Areas. One can understand the components of the harvest policy and measure impacts of each fleet, but ultimately choosing a management strategy comes down to understanding and balancing the trade-offs between the goals and objectives of each fishery, which may be achieved in an MSE context if that is the goal of the evaluation. The IPHC MSE uses currently defined catch-sharing plans to distribute the mortality limits among fisheries within IPHC Regulatory Areas, which does not include ABM alternatives in the Bering Sea and Aleutian Islands. Given the generalized IPHC MSE framework, it is possible to use this framework to simulate and evaluate alternative procedures for allocating mortality between fisheries within IPHC Regulatory Areas.

Figure 4-5 illustrates the distribution of TCEY to the Area 4 subareas and the Area 4 Catch Sharing Plan (CSP) that is described in the following subsection. Areas 4C, 4D, and 4E are considered as a unit by IPHC when harvest policy analyses are conducted. The first step of distribution within Area 4 apportions TCEY to Areas 4A, 4B, and 4CDE. Predicted non-directed commercial discard mortality (e.g., A80 bycatch mortality) is accounted for at this point. Note that the IPHC's predicted bycatch mortality is not the same as the fixed A80 PSC limit, and in fact is typically less than that limit. The lower levels in Figure 4-5 address distribution within Area 4CDE. Note that the figure is incorporating a provision that is in place when the catch limit for that combined area is above a certain threshold. If that threshold is not met, the fishery CEY for those combined areas is distributed by the percentages shown with no adjustment applied.

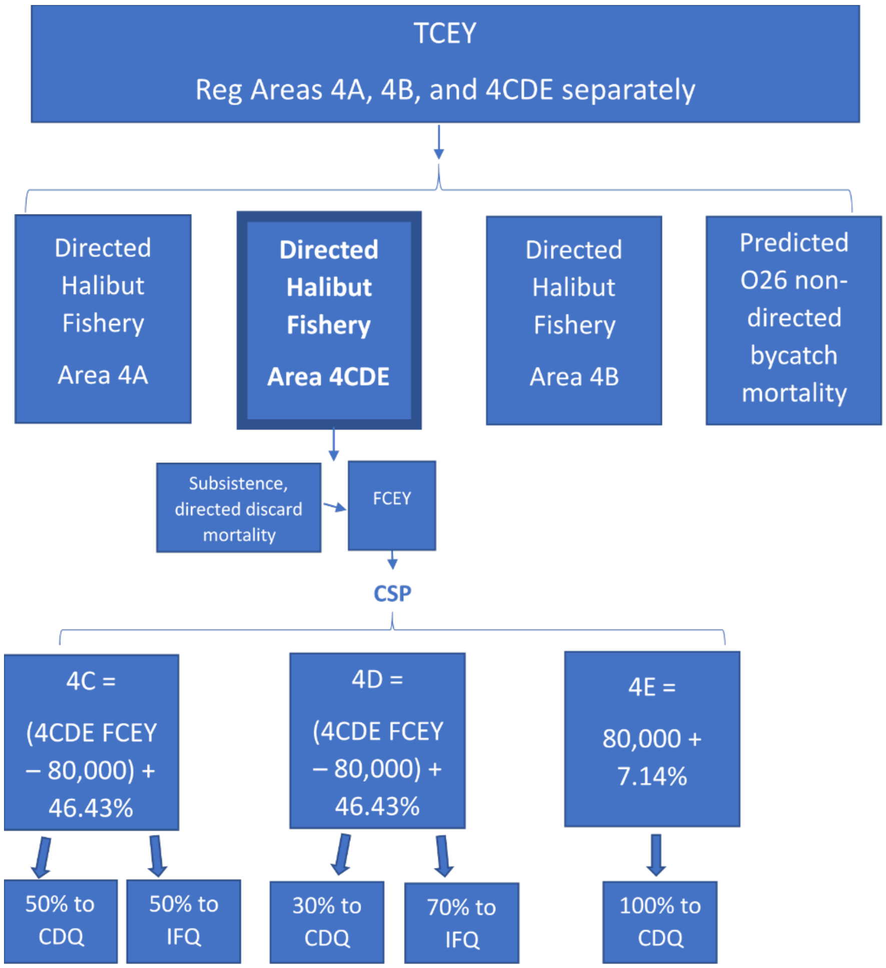

Figure 4-5. Distribution of TCEY to directed fishery users in IPHC Area 4 when the 4CDE catch limit is greater than 1,657,600 lbs.

Figure Notes: CSP: Area 4 Catch Sharing Plan; TCEY: Total Constant Exploitation Yield = Total mortality minus U26 bycatch mortality; FCEY in Area 4CDE = commercial catch limit (TCEY minus subsistence and O26 non-directed commercial discard mortality ("bycatch) and directed commercial discard mortality)

4.3.2 NPFMC Area 4 Catch Sharing Plan

The BSAI management area equates approximately to the IPHC's Area 4 regulatory areas, excepting a portion of Area 4A that overlaps the GOA management area. Area 4CDE and the Closed Area are considered to be a single unit in all IPHC apportionment and harvest policy analyses. Within each of the Area 4 regulatory areas (4A, 4B, and 4CDE), allocation of the IPHC catch limit to different sectors is under the jurisdiction of the Council and NMFS, not the IPHC.

The 4C, 4D, and 4E subareas were created to serve the needs of the Council's Area 4CDE catch sharing plan (CSP). Each year, the IPHC adopts the Council's CSP to determine the specific catch limits for these subareas. The percentage shares for these areas, as determined by the Council, are: Areas 4C and 4D each receive 46.43% of the IPHC's adopted catch limit for Area 4CDE and Area 4E receives the remaining

7.14%. If the total catch limit for Area 4CDE exceeds 1,657,600 lbs., Area 4E receives 80,000 pounds off the top of the total 4CDE catch limit *before* the percentages are applied.

Within Area 4CDE, the annual catch limit is further allocated among CDQ and IFQ fishing within subareas. The amounts allocated to CDQ by area are: Area 4C 50%, Area 4D 30% and Area 4E 100%. The CDQ component of the commercial halibut fishery is described in Section 4.4.1.1. There are also provisions within the CSP allowing Area 4C CDQ and IFQ to be harvested in Area 4D, and for allowing Area 4D CDQ fish to be harvested in Area 4E. The CDQ allocations are apportioned among the six CDQ groups that represent CDQ communities.

4.3.3 IPHC Closed Area

The IPHC has identified part of the Bering Sea shelf as a Closed Area, in which commercial fishing for halibut is prohibited. The IPHC considers the halibut resource in this area to be part of the Area 4CDE halibut stock unit.

The Closed Area was created by the IPHC in 1967 to protect a nursery area for juvenile halibut, in response to severe declines in halibut abundance. The current Closed Area is slightly smaller than the original definition due to reductions that occurred when Areas 4C and 4E were created. The Closed Area had historically accounted for a relatively small percentage (<10%) of the commercial halibut landings in the Bering Sea but was a source of significant halibut mortality from foreign vessel bottom trawling. The IPHC recommended the closure to both commercial halibut fishing, which was under IPHC jurisdiction, and to bottom trawling, which was not under Commission jurisdiction. However, through negotiations within the International North Pacific Fisheries Commission and bilateral agreements with foreign governments, the Closed Area was also closed to foreign bottom trawling. Throughout the late 1960s until the early 1970s, the Closed Area provided significant protection for juvenile halibut, with bycatch mortality dropping to an estimated low of 4.21 million lbs. in 1985. Coincidentally, halibut abundance improved dramatically, fueled in part by strong year classes of the mid-1970s.

With the Americanization of the Bering Sea trawl fisheries in the early 1980s, following promulgation of the U.S. Extended Economic Zone, the protection to juvenile halibut afforded by the Closed Area diminished. Bycatch mortality on halibut again increased substantially in the 1985 through 1991 period, reaching a peak of approximately 10.7 Mlbs. in 1992. Bottom trawling within the Closed Area accounts for a significant proportion of the halibut mortality in the Bering Sea. The Closed Area remains open to all fishing except commercial halibut fishing.

The IPHC requested a review of the Closed Area in 1998 (Trumble 1999). That review examined the purpose of the Closed Area and its value to halibut management. The summary of that review is reproduced below:

The closed area does not reduce halibut PSC mortality. Bycatch is managed by bycatch mortality limits through the NPFMC, with quota reductions and harvest rate reductions by the IPHC.

Ecosystem effects from the IPHC closed area have little benefit. The fishing by other gear types throughout the Bering Sea- Aleutian Island area, especially on the Bering Sea shelf, preclude an undisturbed ecosystem. A small no-trawl zone occurs on the eastern edge of the IPHC closed area. Evaluation of ecosystem stability in the Bering Sea must include the other fisheries, both in and out of the IPHC closed area and the no-trawl zone.

Of the issues favoring development of MPAs, only uncertainty of the stock assessment and concomitant management program apply to Pacific halibut. Stock assessment results in the Bering Sea are currently inadequate because of insufficient time series of catch and survey data (Sullivan and Parma 1998), and because exploitation rates are low. Question still remain on stock assessment issue in the Gulf of Alaska.

The IPHC requested another review of the Closed Area in 2012. The 2012 report noted that the area remained closed after 1989 as a hedge against uncertainty concerning assessment and management of halibut in the Bering Sea. Since 1998, the Commission has accumulated sufficient data and has been able to generate stock assessments for the Bering Sea with considerably greater confidence than was possible in 1998. Therefore, in 2012 the IPHC staff no longer saw a purpose for the Closed Area as a guard against uncertainty.

It also stated that halibut PSC was managed through PSC limits for various groundfish fisheries, with particular time and area specificity, and the IPHC Closed Area played no role in the management of bycatch. IPHC staff concluded that from a halibut assessment and management perspective, there was no continued purpose in maintaining the current Closed Area to the commercial halibut fishery in the eastern Bering Sea. In 2012, the IPHC took no action to open the Closed Area to the commercial halibut fishery. The IPHC treats Area 4CDE, including the Closed Area, as a single management unit. If the Closed Area was to open to the commercial halibut fishery, allocations within the new area would have to be incorporated in the Council's Area 4CDE halibut CSP.

The IPHC again reviewed the Closed Area in 2018 (IPHC-2018-AM094-PropA1) with the following outcome (IPHC-2018-AM094-R, paragraph 47).

> *The Commission DEFERRED regulatory proposal IPHC-2018-AM094-PropA1, which considered the intent, purpose and effectiveness of the IPHC Closed Area, as defined in IPHC Fishery Regulations (2017) Section 10, NOTING that the NPFMC is currently undertaking an Abundance-Based Management process aimed at limiting bycatch. The ABM process should be closely monitored and if considered necessary, the IPHC closed area proposal should be reconsidered at subsequent meetings of the Commission, but no later than in 2020.*

4.4 Directed halibut IFQ fishery description

Note to the reader: CFEC/ADF&G Fish Ticket information and COAR data are not yet available for 2020 at the time of preparation. As a result, tables and figures that report revenue or catch tables based on Fish Ticket information terminate in 2019.

This section provides a broad overview of commercial halibut IFQ fishery management, but the focus of the section is the fishery that occurs in IPHC Area 4 (IFQ and CDQ) and putting that area in the context of the halibut fishery on the Alaska statewide scale. Greater detail on the regulations that govern the fishery are most recently provided in the Council's IFQ Program 20-Year Review (NPFMC 2016[53]) and through resources accessible on the NMFS Alaska Region website.[54] Section 4.4.4 provides a brief synopsis of information on subsistence and recreational uses of halibut in Alaska, and directs the reader to a more detailed description in the SIA Appendix to this DEIS (Appendix 1, Sections 5.9, 5.10, and the subsections of Section 6 that are titled "Engagement in the Subsistence BSAI Halibut Fishery").

In December 1991, the Council chose an IFQ Program as the preferred management alternative for both halibut and sablefish fixed gear fisheries. The IFQ Program was approved as a regulatory amendment by the Secretary of Commerce in 1993 and implemented by NMFS in 1995 (58 FR 215). The IFQ Program was developed to address issues associated with the race-for-fish that had resulted from the open-access and effort control management of the halibut and sablefish fisheries. Specifically, the Council identified several problems that emerged in these fisheries due to the previous management regime, including

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[53] https://www.npfmc.org/wp-content/PDFdocuments/halibut/IFQProgramReview_417.pdf
[54] https://www.fisheries.noaa.gov/alaska/sustainable-fisheries/pacific-halibut-and-sablefish-individual-fishing-quota-ifq-program

increased harvesting capacity, decreased product quality, increased conflicts among fishermen, adverse effects on halibut and sablefish stocks, and unintended distributions of benefits and costs from the fisheries.

In the original Supplemental Environmental Impact Statement for the IFQ Program, the Council identified 10 policy objectives that it intended to address through elements of the IFQ Program. In selecting the elements of the IFQ Program the Council attempted to do the following:

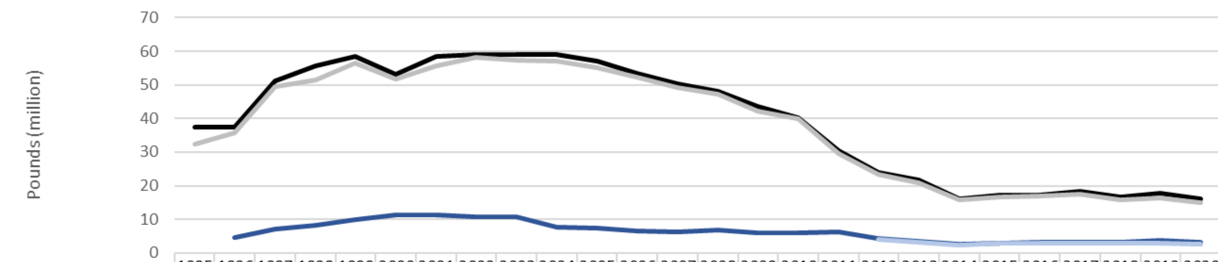
1) Address the problems that occurred with the open-access management regime.
   - The Council identified 10 specific problems: Allocation conflicts, gear conflicts, deadloss from lost gear, bycatch loss, discard mortality, excess harvesting capacity, product wholesomeness, safety, economic stability in the fisheries and communities, and rural coastal community development of a small boat fleet.
2) Link the initial quota share (QS) allocations to recent dependence on the halibut and sablefish fixed gear fisheries.
3) Broadly distribute QS to prevent excessively large QS from being given to some persons.
4) Maintain the diversity in the fleet with respect to vessel categories.
5) Maintain the existing business relationships among vessel owners, crews, and processors.
6) Assure that those directly involved in the fishery benefit from the IFQ Program by assuring that these two fisheries are dominated by owner/operator operations.
7) Limit the concentration of quota share ownership and IFQ usage that will occur over time.
8) Limit the adjustment cost to current participants including Alaskan coastal communities.
9) Increase the ability of rural coastal communities adjacent to the Bering Sea and Aleutian Islands to share in the wealth generated by the IFQ Program.
10) Achieve previously stated Council goals and objectives and meet MSA requirements.

A primary impact of implementing the IFQ Program was the elimination of the derby-style fishery that existed previously and the transition to longer seasons. The prolongation of the fishing season was made possible by the allocation of exclusive harvesting privileges through QS. Longer fishing seasons have allowed for better handling of fish, a shift in product form from frozen toward fresh halibut, the removal of unused fishing gear from grounds, and likely fewer gear conflicts. This document is focused on Area 4. Fresh markets have not developed equally in all parts of Alaska. The markets that purchase halibut caught in Area 4 predominantly rely on frozen product due to their remote location relative to consumers, yielding a lower ex-vessel value relative to the statewide average. Ex-vessel values may also be affected by the cost of operating processors and bringing products to market, which can be higher for halibut caught in Area 4 (noting that not all halibut caught in Area 4 are processed in communities adjacent to the BSAI). Information on ex-vessel values by area is provided in Section 4.4.1 (see Figure 4-8 through Figure 4-10) and information on the processing component of the halibut IFQ fishery is provided in Section 4.4.2.

In terms of how participants have fared under the IFQ program, the 20-Year Review found that many significant impacts were the result of the changing commercial halibut TAC levels in the time since implementation. Figure 4-6 shows total IFQ (non-CDQ) TAC and landings dating back to 1995 for all IPHC management areas in Alaska and for Area 4 in particular. Statewide, halibut TAC has generally declined since 2004. The Area 4 TAC and landings encompass Areas 4ABCD; Area 4E is not included because 100% of the available harvest in that area is allocated to the CDQ reserve. CDQ TAC and harvest data are provided in Section 4.4.1.2. Decreasing TACs may change how QS holders and hired masters participate in the IFQ fisheries. For example, since decreasing TAC results in QS holders having fewer IFQ pounds to harvest they may choose to consolidate QS onto fewer vessels by coordinating with other QS holders to fish on one vessel, they might sell their QS, they might lease IFQ or act as a hired master for eligible shareholders, or they might purchase additional QS to increase their annual harvest potential. Hired masters with fewer IFQ pounds on their vessel might choose to lease IFQ or bring onboard more

IFQ via individual QS holders who do not operate a vessel. The aggregation of QS holders onto fewer vessels eliminates some crew positions and other indirect economic activity that is associated with the operation of an active vessel. The number of unique vessels that have operated in Area 4/BSAI through 2019, based on Fish Tickets, is shown in Table 4-4.

The 20-Year Review notes that biologists have not found direct linkages between overall stock abundance and the IFQ Program (NPFMC 2016, Section 2.9), and that changes in the TACs are understood to be external to the IFQ Program itself. Section 4.2 of this document similarly notes that large changes in the spawning biomass of Pacific halibut, which do not seem explicitly linked to fishing, have been observed over the more than 100 years of commercial fishing.



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
TAC	37.4	37.4	51.1	55.7	58.4	53.1	58.5	59.0	59.0	58.9	57.0	53.3	50.2	48.0	43.5	40.3	30.4	24.0	21.8	16.0	17.1	17.1	18.3	16.6	17.7	16.1
Catch	32.3	35.6	49.4	51.4	56.4	51.8	55.8	58.1	57.4	57.2	55.2	52.2	49.3	47.3	42.3	39.9	29.6	23.3	20.8	15.8	16.7	16.8	17.6	15.9	16.5	15.0
Area 4 TAC		4.7	7.1	8.2	9.9	11.3	11.3	10.8	10.8	7.8	7.4	6.6	6.3	6.7	5.9	6.0	6.2	4.4	3.5	2.5	3.0	3.2	3.2	3.1	3.7	3.2
Area 4 Catch																		4.1	3.1	2.4	2.9	3.0	3.0	2.8	3.0	2.7

Figure 4-6 Commercial IFQ (non-CDQ) halibut TAC and catch (millions of pounds), statewide and Area 4ABCD.

Sources: 1995 through 2012 are taken from the annual NMFS IFQ Report to the Fleet, which do not include harvest amounts at the subarea level (https://www.fisheries.noaa.gov/resource/document/pacific-halibut-sablefish-ifq-report-report-fleet); 2013 through 2020 are taken from NMFS Annual IFQ Catch and Landings Reports (https://www.fisheries.noaa.gov/alaska/commercial-fishing/fisheries-catch-and-landings-reports).

All halibut QS has regulatory area designations that specify the area in which the IFQ derived from those shares may be harvested. Catch and value data by regulatory area and subareas within Area 4 are provided in Section 4.4.1.

There are four vessel classes in the halibut IFQ fishery (A through D). Class A shares are harvested on catcher/processors and there is no vessel length restriction. Class B, C, and D are designated by harvesting vessel length, where B class vessels are greater than 60’ LOA, C class vessels are greater than 35’ and less than 60’, and D class vessels are 35’ or less. Vessel class designations were intended to maintain the diversity of the IFQ fleets, and the Council intended for the Class D QS to be the most likely entry-level opportunity. In most cases, quota can be “fished down” on smaller-class vessels. In regards to Area 4, class D QS may be harvested on any vessel that is less than or equal to 60’ LOA in Areas 4B and 4C. Table 4-1 shows the percentages by which QS is distributed among vessel classes. The table shows that in Area 4 the plurality of QS units in each subarea are designated as class B. Class A shares (catcher/processors) account for a small percentage of potential harvest in each area, and no QS is allocated to class A in Area 4C. Area 4C has the highest proportion of QS that is designated class D but, as noted above, class D QS can be fished up on class C vessels in that area.

Table 4-1 Halibut quota share distribution by vessel category

Vessel Category	2C	3A	3B	4A	4B	4C	4D	4E	4ABCD Subtotal	Grand Total
A	2%	3%	3%	4%	6%	0%	8%		5%	3%
B	4%	37%	55%	59%	77%	40%	83%	All	65%	37%
C	79%	53%	39%	30%	15%	22%	9%	CDQ	21%	52%
D	15%	7%	3%	7%	3%	38%	0%		9%	8%

The overall management context of the IFQ Program for the 20-plus years since its implementation has largely been one of decreasing restrictions over time. For example, within the first year of the IFQ Program, the Council added the "fish down" provision allowing IFQ designated for larger vessel classes to be fished on smaller vessels and increased the allowable "sweep up" limit to allow larger amounts of IFQ to be swept up into QS blocks. Over the course of the IFQ Program, the Council has also allowed for some inter-area harvest of QS, increased the number of QS blocks that a shareholder may hold, and allowed for "fishing up" in some areas (e.g., the allowance to fish category D QS on C class vessels in 4B, 4C – mentioned above – and in 3B).

The main exception the general trend of decreasing restrictions has been with respect to the owner-operator characteristic of the fleet. The Council has repeatedly re-asserted its position on limiting hired master use for the harvest of catcher vessel IFQ and the acquisition of catcher vessel QS by non-individual entities in an effort to continue progress toward an owner-operator catcher vessel fleet. At the same time, however, the Council elected to authorize certain communities to be able to form community quota entities (CQEs) that can purchase halibut and sablefish QS and lease the resultant IFQ to their residents.

4.4.1 Catch, value, and harvest participation

IPHC Area 4 is comprised of five subareas (ABCDE) and generally covers the BSAI groundfish FMP area. A portion of Area 4A overlaps the GOA FMP area. This section is based on catch and processing data for all halibut IFQ and CDQ harvest that occurred in Area 4 ABCDE. IPHC management areas are depicted in Figure 1-3. To compare Area 4 to Alaska statewide commercial halibut catch, Table 4-2 shows IFQ landings in metric tons (round weight, or "CFEC whole pounds") for each area from 2010 through 2020. Values are shown in round weight tons to better put commercial harvest in the context of PSC limits for the groundfish fisheries and the units output from the Operating Model are referenced in the impact analysis. During that period, Area 4 accounted for 21% of statewide catch on average, ranging from 18% in 2010 to 24% in 2011. Area 4 accounted for 23% of catch in both 2019 and 2020.

The summary data below are based on ADF&G/CFEC Fish Ticket information, and values are reported at the ex-vessel level. Section 4.4.1.1, below, describes why the analysts have elected to present ex-vessel values for commercial halibut, but also provides what information is available to help a reader consider the relative scale of the fishery's value at the primary processing level (gross first wholesale value). The best available information on gross first wholesale value is applied alongside ex-vessel values in the impact analysis results tables that are presented in Section 5.5.

Table 4-3 shows total ex-vessel value by area in inflation-adjusted 2018 dollars (millions). Overall, Area 4 accounted for 18% of state-wide ex-vessel value from commercial halibut catch. On an annual basis, Area 4 accounted for 16% (2010, 2013, 2014) to 23% (2011) of total value. Area 4 accounted for 19% of total ex-vessel value in 2019. Figure 4-7 plots the gross ex-vessel value (2018$) of commercial halibut catch in Area 4 by subarea.

Table 4-2 Alaska commercial IFQ and CDQ halibut catch (t) by IPHC area, 2010 through 2020

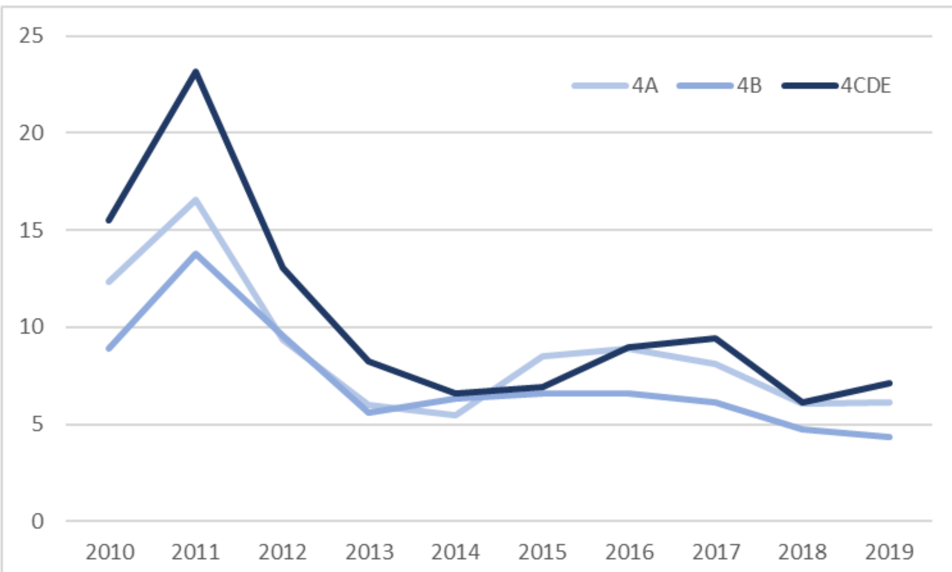
IPHC Area	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
2C	2,627	1,416	1,565	1,766	1,991	2,202	2,345	2,412	2,049	2,027	1,936
3	18,432	13,277	10,310	9,152	6,385	6,435	6,216	6,406	5,789	6,056	5,483
4	4,534	4,710	3,409	2,567	1,982	2,205	2,398	2,379	2,214	2,409	2,207
Total (t)	25,593	19,403	15,284	13,485	10,358	10,842	10,959	11,197	10,052	10,492	9,625
Total (M lbs.)	56.4	42.8	33.7	29.7	22.8	23.9	24.2	24.7	22.2	23.1	21.2

Source: CFEC Fish Ticket data provided by AKFIN Note: Conversion to mil of lbs. (M lbs.) provided for comparison to Figure 4-6.

Table 4-3 Alaska commercial IFQ and CDQ halibut ex-vessel value (million 2018$), 2010 through 2019

IPHC Area	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
2C	24.8	17.8	18.4	17.4	23.5	25.6	28.8	26.6	18.3	18.5
3	173.7	163.3	111.6	86.5	73.3	73.6	73.7	69.0	52.6	55.2
4	37.6	54.6	32.6	20.3	19.1	22.5	24.9	23.7	16.9	17.6
Total	236.1	235.6	162.6	124.2	115.9	121.8	127.4	119.3	87.8	91.3

Source: CFEC Fish Ticket data provided by AKFIN



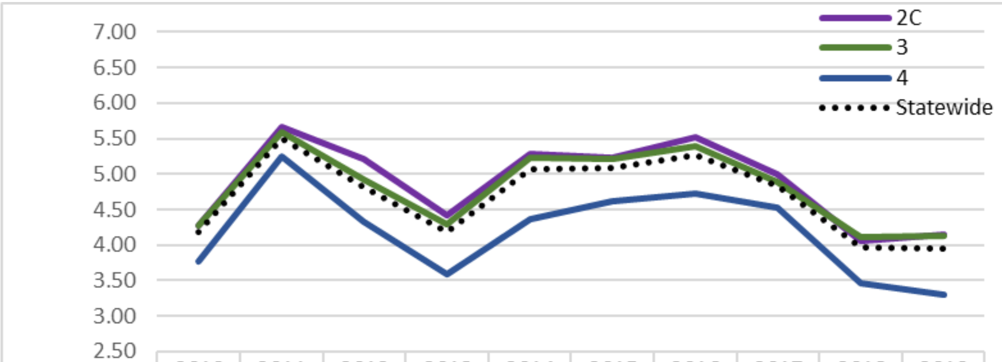
Source: CFEC Fish Ticket data provided by AKFIN

Figure 4-7 Alaska commercial IFQ and CDQ halibut ex-vessel value (million 2018$) within Area 4, 2010 through 2019

Figure 4-8 plots average annual halibut value per pound calculated based on the round weight totals shown in Table 4-2 and Table 4-3, adjusted to 2018 dollars to account for general inflation. Calculating value per pound based on round weights results in lower estimates that the reader is likely accustomed to seeing, as IPHC and RAM typically report on the halibut fishery in terms of IFQ pounds, i.e., head-and-gut net weight. Those values are reported in Source: NMFS – See "Annual ex-vessel and volume prices – Halibut" at https://www.fisheries.noaa.gov/alaska/sustainable-fisheries/alaska-fisheries-management-reports.
Note: Area 4ABCDE estimates for 2014 and 2015 omit Area 4C due to confidential data.

Figure 4-9 and Source: NMFS – see "Annual ex-vessel and volume prices – Halibut" at https://www.fisheries.noaa.gov/alaska/sustainable-fisheries/alaska-fisheries-management-reports
Note: Area 4C data in 2014 and 2015 is redacted as confidential.

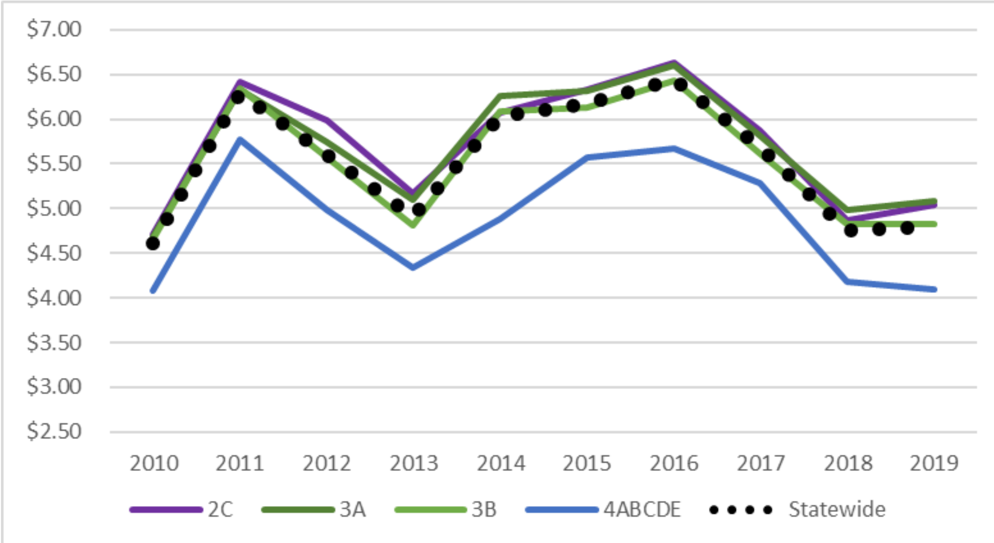
Figure 4-10. The purpose of Figure 4-8 is to show that, in real dollar terms, the unit value of the resource has been flat to decreasing over the analyzed period, and that unit value in Area 4 displays the same time trend as the rest of the state but at a lower level. This document does not fully analyze the reason that Area 4 catch produces lower value per pound relative to other areas. However, several factors that might be at play include higher plant operating costs at some of the smaller, remote plants in western Alaska that purchase halibut, as well as a general focus by processors in the BSAI region on the higher volume groundfish species for which processing facilities are specifically set up. Related to this point, the IFQ Program 20-Year Review includes an exploration of whether and to what extent the issuance of quota exclusively to the harvest sector reduced profit margins on halibut for the processing sector (see Section 2.4.2 in NPFMC 2016). Accepting the conclusion that the IFQ program tilted economic rents toward the harvest sector, it is reasonable to conclude that processors in western Alaska, which are either focused on high-volume groundfish species or have high operating costs, would have less demand for halibut and thus might offer a lower price than what is observed in areas such as 2C and 3A. In those areas, halibut is a primary focus and processors have both incentive and ability to market the product in ways that can generate a greater unit return.



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
2C	4.28	5.67	5.21	4.42	5.29	5.22	5.52	5.00	4.06	4.14
3	4.27	5.59	4.92	4.29	5.23	5.21	5.39	4.88	4.12	4.14
4	3.76	5.24	4.34	3.59	4.37	4.62	4.72	4.52	3.46	3.31
Statewide	4.18	5.51	4.82	4.18	5.08	5.09	5.27	4.83	3.96	3.95

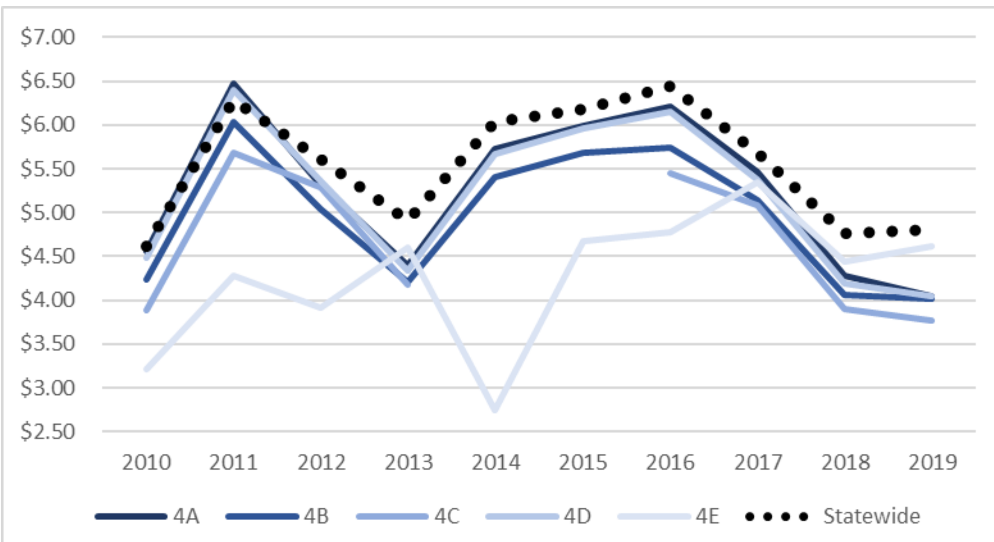
Figure 4-8 Average annual ex-vessel value per pound (2018$) by IPHC areas within Alaska, calculated from round weight catch. (Source: CFEC Fish Tickets provided by AKFIN)

Figure 4-9 and Figure 4-10 plot ex-vessel by area in nominal dollars (not inflation-adjusted) in terms of head-and-gut net weight. These values are taken from NMFS Alaska Region website and are the annual estimates with which the reader will be most familiar. Like the data shown above, these values are based on CFEC Fish Tickets for all commercial catch delivered by catcher vessels to inshore processors. The statewide estimate is a weighted average based on the volume and value of harvest taken across all Alaska IFQ areas. Figure 4-10 breaks out the subareas within Area 4, comparing them to the statewide average and to each other. Data for Area 4C is redacted in 2014 and 2015 due to confidentiality. Figure 4-10 highlights that average values are lower in Area 4.



Source: NMFS – See "Annual ex-vessel and volume prices – Halibut" at https://www.fisheries.noaa.gov/alaska/sustainable-fisheries/alaska-fisheries-management-reports.
Note: Area 4ABCDE estimates for 2014 and 2015 omit Area 4C due to confidential data.

Figure 4-9 Commercial halibut ex-vessel value/lb. (nominal dollars) by IPHC area, 2010 through 2019



Source: NMFS – see "Annual ex-vessel and volume prices – Halibut" at https://www.fisheries.noaa.gov/alaska/sustainable-fisheries/alaska-fisheries-management-reports
Note: Area 4C data in 2014 and 2015 is redacted as confidential.

Figure 4-10 Figure 4-10Area 4 subarea commercial halibut ex-vessel value compared to statewide value (nominal dollars), 2010 through 2019

Annual ex-vessel value estimates for 2020 at the state-wide level and in each area are not currently available. The analysts can state, however, that 2020 did not likely to reflect an upward movement in the ex-vessel value of Alaska halibut. In-season dock prices at the beginning of the season, reported voluntarily by quota brokers and in online trade-press, were around $3.25/lb. to $4.40/lb. depending on size and varying across locations (all reporting locations were in Areas 3A and 2C)[55]; it is appropriate to

[55] Alaska Fish Factor, published in Anchorage Daily News, March 24, 2020.

presume that prices are similar or lower in more westward areas). Summer prices represented a slight improvement but did not exceed the 2019 nominal ex-vessel values shown in Figure 4-9 (e.g., Homer dock price reported at $4.25 to $4.75/lb. on August 5, 2020[56]).

The 2020 market for U.S. halibut faced several headwinds; the extent to which these factors remain in effect into 2021 is not yet known but a price holding steady at recent historical levels would likely be viewed as a positive outcome. Though not vetted through the AKFIN process for ex-vessel price reporting, early 2021 prices in the 3A/2C region appear higher, between $5.25 and $5.75/lb. in March 2021 (Sitka, Petersburg, Whittier, and Homer).[57] It is likely that ex-vessel prices in Area 4 are slightly lower, but that information is not publicly available at the time of writing. Alaska halibut markets are currently facing at least three headwinds. First, domestic demand has been depressed by the ongoing global health crisis, especially in high-end fresh markets to supply the restaurant industry. Second, air services were stalled in the early months of 2020, impeding high-value fresh markets and adding to a backlog in frozen inventories. Third, Alaska halibut is facing increased competition from foreign imports that have penetrated U.S. retail markets in all regions at lower prices. The U.S. increased its purchase of farmed halibut from Norway in 2019 and 2020. Atlantic halibut from eastern Canada is increasingly entering U.S. markets and is being supplied fresh year-round. The U.S. is also importing an increasing volume of halibut caught in Russia and China. A news article published in May 2020 – citing industry analysts – notes that U.S. imports of Russian halibut were 140,000 lbs. in 2018 and up to approximately 2 million lbs. in 2019. Russian imports in just the first two months of 2020 were triple the annual total for 2018. Halibut caught in Russia and China are entering U.S. frozen markets via importation through Canada to circumvent tariffs on trade with those two countries and are marketed in the U.S. at lower prices than Alaska halibut. The relatively weak Russian currency is making that nation's product attractive to U.S. buyers and buyers in China whose reprocessed product may be destined for U.S. end-markets. In terms of U.S. halibut exports, Russia has not purchased U.S. seafood since 2014 and China imposes a reciprocal tariff of 25% that suppresses demand for many U.S. seafood products.

From 2010 through 2019, the number of CVs participating in Area 4 averaged 200 per year, ranging from 337 CVs in 2011 to 117 CVs in 2017 (Table 4-4). As noted in Table 4-1, the bulk of the harvest opportunity is in the class B category. The total number of vessels decreased substantially in 2015, with the largest drop-off occurring among class B vessels. In the average across years, 86.3% of active CVs were owned by individuals who listed their residence as Alaska average (equating to an average 180 CVs owned by Alaska residents). There were 568 unique CVs participating in the Area 4 halibut fishery; 523 of those were owned by Alaska residents, 41 were owned by Washington residents, 4 were owned by Oregon residents, and 8 were owned by residents of other states. Table 4-4 also shows the number of CPs and catcher-sellers (listed as CASO) that fished A class quota during the period. The average number of vessels that processed their own halibut catch in Area 4 was six. Note that all annual vessel counts shown in Table 4-4 include the unique number of vessels participating in IFQ, CDQ, or both; a vessel that fished both IFQ and CDQ halibut in a given year would not be double-counted.

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[56] Alaska Boats & Permits, Inc. www.alaskaboat.com
[57] Ibid., accessed March 2021.

Table 4-4 Number of vessels in the Area 4 halibut fishery by vessel class, 2010 through 2019

	Catcher Vessels				CP/CASO
	B	C	D	Total	A
2010	216	60	33	309	10
2011	243	62	32	337	4
2012	214	60	28	302	2
2013	227	52	25	304	3
2014	81	48	21	150	1
2015	44	53	22	119	3
2016	48	50	21	119	4
2017	48	50	19	117	8
2018	47	56	20	123	9
2019	49	53	20	122	12
Average	**122**	**54**	**24**	**200**	**6**
Median	**65**	**53**	**21.5**	**136.5**	**4**

Section 5.2 of the SIA Appendix provides information on engagement and reliance on the BSAI halibut fishery by community of vessel ownership address. For the Area 4 fishery, commercial halibut vessel ownership among states is heavily concentrated in Alaska. Within Alaska, ownership is distributed across numerous communities. The SIA identifies 25 Alaska communities with two or more vessels participating in the fishery annual (on average), another four communities with 1 or 2 vessels participating, and 21 communities with one or fewer vessels participating (on average). The SIA notes a recent downward trend in CV participation in recent years that spans multiple BSAI communities and regions, but is most notable in the communities associated within the Coastal Villages Region Fund (CVRF) CDQ group region.

Table 4-5 shows total catch (CFEC whole lbs.) of Area 4 halibut IFQ and CDQ by subarea from 2010 through 2019. On average, the Area 4 fishery generated 6.34 million whole lbs. per year. The greatest proportion of catch occurs in Areas 4A, 4B, and 4D. The annual catch trend peaked in 2011 but currently appears to be at a stable level around 5 million whole lbs. This trend conforms to the decline in statewide TACs that is shown in Figure 4-6.

Table 4-3 reported gross halibut ex-vessel revenue from the Area 4 fishery for 2010 through 2019 (2018$). Table 4-6 reports inflation-adjusted ex-vessel revenues (2018$) by Area 4 subarea. The annual average value was around $27 million across all areas and years. Ex-vessel value by subarea clearly tracks the relative amount of catch by subarea. By residence of vessel ownership, Alaska-owned vessels accounted for an average of 66% of gross revenue; Washington-owned vessels accounted for roughly 30%. For all CVs that participated in the fishery during the analyzed period, the Area 4 halibut fishery accounted for approximately 28% of total inflation-adjusted gross ex-vessel revenues from all fisheries, including other areas, species, and gear types that those vessels prosecuted.

Table 4-7 and Table 4-8 report shoreside halibut catch and gross ex-vessel revenues (2018$) by area and by vessel size category from 2010 through 2019.

Section 5.2 of the SIA Appendix identifies the communities of vessel ownership with combined average annual revenues greater than $1 million. The higher-grossing communities located in the BSAI region were St. Paul and Unalaska. The other communities of residence with high ex-vessel gross revenues were Anchorage/Wasilla, Homer, Juneau/Sitka, Kodiak, and the Seattle MSA.

Table 4-5 Total halibut catch (IFQ + CDQ) in Area 4 (CFEC whole lbs.), 2010 through 2019

	4A	4B	4C	4D	4E	4ABCDE Total
2010	3,204,111	2,483,204	1,013,835	2,748,241	546,103	**9,995,494**
2011	3,070,785	2,749,754	1,055,179	2,923,669	609,221	**10,408,608**
2012	2,101,072	2,308,241	750,826	1,906,104	443,665	**7,509,908**
2013	1,615,029	1,661,653	678,671	1,315,880	372,694	**5,643,927**
2014	1,193,289	1,486,806	525,847	930,241	202,313	**4,338,496**
2015	1,778,525	1,455,041	539,997	948,399	118,177	**4,840,139**
2016	1,822,804	1,487,477	552,943	1,257,131	159,559	**5,279,914**
2017	1,742,815	1,397,215	678,302	1,207,444	218,307	**5,244,083**
2018	1,621,429	1,382,072	660,910	1,094,895	126,693	**4,885,999**
2019	1,800,135	1,296,887	646,908	1,377,635	158,403	**5,279,968**
Average	**1,994,999**	**1,770,835**	**710,342**	**1,570,964**	**295,514**	**6,342,654**

Source: CFEC Fish Tickets provided by AKFIN

Table 4-6 Ex-vessel value (2018$) of all halibut catch (IFQ+CDQ), 2010 through 2019

	4A	4B	4C	4D	4E	4ABCDE Total
2010	12,618,162	9,060,223	3,695,186	10,675,677	1,577,994	**37,627,241**
2011	16,843,193	14,018,154	5,455,909	15,818,404	2,418,054	**54,553,713**
2012	9,276,352	9,616,738	3,597,548	8,490,769	1,576,836	**32,638,219**
2013	5,834,081	5,694,057	2,540,492	4,666,917	1,520,714	**20,319,188**
2014	5,483,180	6,401,491	2,333,494	4,233,100	476,385	**19,094,363**
2015	8,467,071	6,530,732	2,458,248	4,468,937	438,439	**22,363,428**
2016	8,905,273	6,714,714	2,603,693	6,059,222	626,207	**24,909,108**
2017	8,119,576	6,122,683	2,938,104	5,522,621	995,331	**23,698,315**
2018	5,775,440	4,681,520	2,150,498	3,839,246	469,578	**16,916,281**
2019	5,996,834	4,276,457	2,009,123	4,580,441	601,322	**17,464,178**
Average	**8,731,916**	**7,311,677**	**2,978,230**	**6,835,533**	**1,070,086**	**26,958,403**

Source: CFEC Fish Tickets provided by AKFIN

Table 4-7 Halibut catch (IFQ+CDQ) delivered to shore in Area 4 subareas by vessel class (CFEC whole pounds), 2010 through 2019

Area	Vessel Class	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total	Average
4A	B	250,874	267,875	157,398	143,409	94,398	117,743	210,650	161,540	143,483	120,216	1,667,586	166,759
	C	1,890,376	1,947,014	1,388,485	1,024,378	774,632	1,191,948	1,163,793	1,232,961	1,139,628	1,286,393	13,039,608	1,303,961
	D	991,508	816,417	525,231	429,786	269,619	435,450	383,757	327,217	320,561	376,556	4,876,102	487,610
4A Total		**3,132,758**	**3,031,306**	**2,071,114**	**1,597,573**	**1,138,649**	**1,745,141**	**1,758,200**	**1,721,718**	**1,603,672**	**1,783,165**	**19,583,296**	**1,958,330**
4B	B	23,246	17,731	42,175	60,179	40,258	52,989	48,826	9,235	0	0	294,639	29,464
	C	1,339,774	1,404,528	1,478,062	965,649	965,348	947,941	1,024,715	962,853	952,369	884,186	10,925,425	1,092,543
	D	1,013,114	1,252,522	788,004	635,509	481,200	454,111	413,936	425,127	429,703	412,701	6,305,927	630,593
4B Total		**2,376,134**	**2,674,781**	**2,308,241**	**1,661,337**	**1,486,806**	**1,455,041**	**1,487,477**	**1,397,215**	**1,382,072**	**1,296,887**	**17,525,991**	**1,752,599**
4C	B	752,767	697,594	558,021	536,571	419,798	380,408	423,541	483,156	443,531	438,462	5,133,849	513,385
	C	252,519	324,621	184,102	126,228	96,440	135,529	110,009	181,973	203,317	196,134	1,810,872	181,087
	D	C	C	C	C	C	24,060	15,954	C	C	C	107,671	10,767
4C Total		*	*	*	*	*	**539,997**	**549,504**	*	*	*	**7,052,392**	**713,702**
4D	B	73,801	40,769	70,696	48,263	50,635	14,009	32,866	35,707	48,182	95,852	510,780	51,078
	C	1,590,306	1,501,540	1,029,335	698,816	468,913	566,988	659,847	639,464	585,446	744,037	8,484,692	848,469
	D	932,821	1,268,083	707,466	513,306	379,017	333,369	529,413	493,641	425,619	493,324	6,076,059	607,606
4D Total		**2,596,928**	**2,810,392**	**1,807,497**	**1,260,385**	**898,565**	**914,366**	**1,222,126**	**1,168,812**	**1,059,247**	**1,333,213**	**15,071,531**	**1,507,153**
4E	B	499,916	553,919	411,157	344,075	181,869	67,920	85,320	94,464	58,533	75,046	2,372,219	237,222
	C	43,914	55,302	31,130	C	C	38,862	46,442	100,583	42,684	62,265	*	*
	D	C						C				C	C
4E Total		*	**609,221**	**442,287**	*	*	**106,782**	*	**195,047**	**101,217**	**137,311**	**2,839,751**	**283,975**

C = confidential; * denotes data not shown in order to maintain confidentiality.

Source: CFEC Fish Tickets provided by AKFIN

Table 4-8 Ex-vessel value (2018$) of all halibut catch (IFQ+CDQ) delivered to shore in Area 4 subareas by vessel class, 2010 through 2019

Area	Vessel Class	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total	Average
4A	B	977,995	1,462,095	703,824	502,842	429,191	544,599	1,013,410	723,415	492,140	387,489	7,237,000	723,700
	C	7,418,891	10,664,680	6,091,410	3,640,776	3,538,623	5,671,619	5,668,659	5,761,092	3,993,178	4,248,983	56,697,912	5,669,791
	D	3,948,269	4,503,281	2,346,520	1,629,423	1,269,422	2,096,474	1,919,226	1,542,938	1,228,945	1,303,316	21,787,812	2,178,781
4A Total		**12,345,155**	**16,630,056**	**9,141,754**	**5,773,040**	**5,237,235**	**8,312,692**	**8,601,295**	**8,027,445**	**5,714,263**	**5,939,788**	**85,722,724**	**8,572,272**
4B	B	65,045	66,038	146,502	189,463	156,273	224,107	196,252	34,854	0	0	1,078,534	107,853
	C	4,655,280	6,883,715	6,024,333	3,217,308	4,040,695	4,174,988	4,520,287	4,162,187	3,225,129	2,919,329	43,823,250	4,382,325
	D	3,965,258	6,664,069	3,445,904	2,286,252	2,204,523	2,131,637	1,998,175	1,925,643	1,456,391	1,357,127	27,434,978	2,743,498
4B Total		**8,685,583**	**13,613,822**	**9,616,738**	**5,693,023**	**6,401,491**	**6,530,732**	**6,714,714**	**6,122,683**	**4,681,520**	**4,276,457**	**72,336,762**	**7,233,676**
4C	B	2,715,937	3,552,121	2,694,102	2,013,546	1,862,668	1,726,300	1,987,156	2,078,499	1,439,490	1,355,307	21,425,126	2,142,513
	C	946,477	1,722,552	865,285	471,598	428,656	619,211	524,725	796,341	664,943	615,101	7,654,887	765,489
	D	C	C	C	C	C	112,738	75,801	C	C	C	486,916	48,692
4C Total		*	*	*	*	*	**2,458,248**	**2,587,681**	*	*	*	**29,566,929**	**2,956,693**
4D	B	227,333	169,138	345,149	151,471	211,242	53,061	143,467	159,995	204,152	384,586	2,049,594	204,959
	C	6,200,154	8,118,717	4,573,303	2,491,887	2,144,409	2,696,690	3,191,274	2,915,013	2,029,891	2,412,287	36,773,625	3,677,362
	D	3,663,785	6,920,055	3,130,537	1,823,789	1,732,701	1,560,441	2,556,233	2,278,595	1,482,009	1,633,290	26,781,435	2,678,144
4D Total		**10,091,272**	**15,207,909**	**8,048,989**	**4,467,148**	**4,088,352**	**4,310,192**	**5,890,974**	**5,353,603**	**3,716,052**	**4,430,162**	**65,604,654**	**6,560,465**
4E	B	1,424,443	2,158,818	1,417,203	1,430,315	395,465	230,132	300,941	440,787	181,037	260,389	8,239,529	823,953
	C	149,859	259,236	152,693	C	C	136,144	195,605	443,399	187,627	254,500	*	*
	D	C						C				C	C
4E Total		*	**2,418,054**	**1,569,896**	*	*	**366,276**	*	**884,186**	**368,664**	**514,889**	**10,174,885**	**1,017,488**

C = confidential; * denotes data not shown in order to maintain confidentiality.

Source: CFEC Fish Tickets provided by AKFIN

Table 4-9 reports the potential harvest for IFQ or CDQ participants in IPHC Areas 4BCDE from 2013 through 2020. Catch utilization is reported as a percentage from 2013 through 2020. The table reflects that the halibut resource has been near-fully utilized during the reported years, and that the harvest rate actually increased in 2020 relative to 2019. The concentration of CDQ harvest in Area 4D during 2020 may be the result of the unique operational challenges of 2020 resulting from the COVID-19 pandemic.

Table 4-9 Directed fishery halibut catch limits/allocations (lbs.) and utilization (%) in IPHC Areas 4CDE, 2013 through 2020

	Area	2013	2014	2015	2016	2017	2018	2019	2020
IFQ Catch Limit	**4C/4D**	1,030,800	715,920	715,920	880,320	902,400	880,200	1,092,000	919,200
		89%	*96%*	*96%*	*96%*	*96%*	*90%*	*82%*	*99%*
CDQ Allocation	**4C**	429,500	298,300	298,300	366,800	376,000	366,751	455,000	383,000
		*	*	*	*	*	*	*	*
	4D	309,240	178,980	178,980	220,080	225,600	220,050	273,000	229,800
		52%	*67%*	*65%*	*82%*	*99%*	*72%*	*97%*	*247%*
	4E	212,000	91,800	91,800	192,800	196,000	113,000	220,000	198,000
		132%	*166%*	*	*62%*	*	*	*	*
4CDE Total		1,981,540	1,285,000	1,285,000	1,660,000	1,700,000	1,580,001	2,040,000	1,730,000
%CDQ landed for 4BCDE		*86%*	*98%*	*90%*	*85%*	*94%*	*91%*	*83%*	*88%*

Notes: IFQ landings in Areas 4C and 4D are combined because 4C allocation may be fished in 4C or 4D. Harvest is debited from the account for the reported harvest area but the combined report is a better representation of activity in the two areas. CDQ allocation to 4D may be fished in 4D or 4E; harvest is debited from the account for the reported harvest area. CDQ allocation to 4C may be fished in 4C or 4D; harvest is debited from the account for the reported harvest area. Accounting for CDQ allocation that may be taken in more than one area could cause landings to appear overharvested in 4D or 4E, or underharvested in 4C or 4D.

Source: NMFS Alaska Region IFQ Catch & Landings Reports; data available from 2013. https://www.fisheries.noaa.gov/alaska/commercial-fishing/fisheries-catch-and-landings-reports-alaska#ifq-halibut/sablefish.

4.4.1.1 Consideration of ex-vessel versus first wholesale values for Area 4 halibut fisheries

Commercial halibut catch value is reported as ex-vessel revenues taken from ADF&G/CFEC Fish Tickets. The ex-vessel value represents the amount paid to fishermen by a primary processor for harvested seafood. Ex-vessel prices are the most appropriate value to represent halibut fishery revenue given the most common halibut supply chain in Alaska, particularly in IPHC Area 4, or the BSAI processing region. Most halibut is harvested by catcher vessels that deliver to shoreside processors: “Nearly all halibut is bled and gutted onboard, iced or chilled, and delivered to a shoreside plant for a small amount of additional processing, typically limited to heading or filleting. Less than one percent of annual first wholesale halibut production typically occurs aboard catcher/processor vessels. Alaska processors sell most halibut to Lower-48 seafood distributors that supply a specific region with a variety of products” (Fissel et al. 2021).

The Alaska Fisheries Science Center has recently begun reporting estimates of first wholesale production volume, value, and value per net-weight-pound (IFQ pound) of halibut in the “Economic SAFE” report; the most recent version covers 2015 through 2019 (Fissel et al. 2021). Table 4-10 excerpts first wholesale estimates for the head-and-gut product form from Table H7 of the Economic SAFE. That information is based data from Commercial Operators Annual Reports (COAR) that are reliant on the accuracy of processors’ reporting. Due to the dearth of COAR reporting on halibut products in the BSAI region, the Economic SAFE is only able to provide estimates at the statewide scale. These estimates may not be a reliably precise indicator of value-added production at the primary processing level in the BSAI/Area 4 region, or the Area 4CDE region in particular. As shown in Figure 4-8 through and Figure 4-10, ex-vessel values in Area 4 consistently trail the statewide average. Table 4-10 omits the Economic SAFE’s estimate of first wholesale values across “All Products”, which sums H&G estimates, fillet estimates, and “other products” estimates on an annual basis then divides by total reported revenues. More highly processed halibut product forms are less prevalent in the region of interest, so using All Products estimates would impute values from product forms that are not reported and may not be being produced in the area – at least not at the relative scale they are being produced statewide. Given that a substantial portion of Area 4 halibut are sold by primary processors in a head-on form, the values in Table 4-10 will be slightly overstated when those estimates were applied on a per-pound basis to Area 4 catch.

Table 4-10 First wholesale production volume (1000s of metric tons), value (nominal $millions), and price (nominal $/lb. net weight) in the commercial Pacific halibut fisheries off Alaska – head-and-gut product form – 2015 through 2019.

Year	Quantity	Value	Price
2015	5.38	92.07	7.77
2016	6.29	94.99	6.85
2017	5.64	91.86	7.39
2018	5.01	75.59	6.84
2019	5.07	71.12	6.37

Source: adapted from Table H7 in the 2020 Economic SAFE (AFSC 2021); data from COAR, provided by AKFIN

Upon the analysts’ request, AKFIN and AFSC investigated the possibility of estimating area-specific wholesale values in the region of interest but the effort was stymied by the small number of shoreside processors buying halibut as well as reporting issues (the latter – it is important to say – is not strictly a reflection on the reporting and recordkeeping of the processing plants themselves). AKFIN screened processors’ COAR data to exclude facility-years where the ratio of the volume of fish purchased and the volume of primary-processed product sold did not match within an acceptable range. Also, for specific halibut management areas – e.g., 4CDE – the small number of processors often makes the data confidential. The other issue that makes area-specific wholesale value difficult to use is that COAR data report “bought and sold” volumes on an annual basis, meaning that holdover inventory sold in the following year obscures the value-added supply chain and can cause a plant’s data to fail the AKFIN ratio “screen”. Such was the case for several facilities that the analysts know to be important local buyers of Area 4 halibut.

The high value of halibut relative to other white fish is widely acknowledged and is not diminished by the decision to describe the value chain only as far as the primary processing level. Research to fully describe the value chain and the broader economic impact of Alaska halibut fisheries – commercial and noncommercial – is currently in progress; an IPHC study of this question is referenced and described in Section 5.5 of this document. The analysts propose that the Area 4 commercial fishery value chain is distinct from other regions in important ways, and that ex-vessel values – with the additional context of first wholesale estimates – is the most appropriate metric. The reader can understand that secondarily processed halibut product forms, or even direct market sales to end-retail consumers, have a higher unit value. This does not need to be shown in table-form and likely should not be given the amount of information available on the extent to which those product forms are flowing out of the region of interest. It would not be appropriate to choose an end-retail value-per-pound, apply it to catch in Area 4, and consider that number to be net revenue (after fishing costs) as that would elide costs that accrue along the supply chain. Finally, the analysts do not provide a "what if" value estimate to represent how much Area 4 catch could be worth if it were directly marketed at retail prices because there are no data to gauge how much supply that type of market would demand from Area 4 considering its unique costs and processing capacity.

4.4.1.2 CDQ

When the IFQ Program was established, a portion of commercial halibut quotas in each Area 4 subarea (the CDQ reserve) was allocated to western Alaska communities via their CDQ groups. The structure of the CDQ program was initially developed as a component of BSAI pollock allocations ("inshore/offshore") and implemented under BSAI Groundfish FMP Amendment 18 (final rule published on June 3, 1992, 57 FR 23322). During that period, the Council was developing what would become the fixed-gear halibut and sablefish IFQ Program and was evaluating options for allocates of those species to CDQ communities.

Overall, the CDQ program is allocated a CDQ reserve equal to 20% of the Area 4B halibut TAC, 50% of the Area 4C TAC, 30% of the Area 4D TAC, 100% of the Area 4E TAC, and zero percent of the Area 4A TAC. The remainder in each area constitutes the IFQ fishery. Figure 4-11 shows how the CDQ reserve is allocated among the six CDQ groups. For example, APICDA receives the full 20% of the Area 4B TAC that goes to the CDQ program (100% of the CDQ reserve for the area), while the 30% of the Area 4D TAC that goes to the CDQ program is divided among four different CDQ groups.

In 2019, the total halibut TAC for Areas 4BCDE (IFQ + CDQ) is 3,250,000 lbs. Of that amount, 1,190,000 lbs. go to the CDQ reserve, or 36.6% of the total. APICDA received 310,250 lbs. in Areas 4B and 4C; BBEDC received 136,980 lbs. in Areas 4D and 4E; CBSFA received 386,750 lbs. in Area 4C; CVRF received 219,520 lbs. in Area 4D and 4E; NSEDC received 81,900 lbs. in Area 4D; and YDFDA received 54,600 lbs. in Area 4D. The total size of the CDQ reserve is determined annually based on the 4BCDE TAC, while the distribution percentages to CDQ and among groups have remained constant. The 2019 TAC of 3.25 million lbs. was greater than in previous years. The Area 4BCDE TAC was 2.63 million lbs. in 2018, 2.84 million lbs. in 2017, 2.80 million lbs. in 2016, 2.43 million lbs. in 2015, and 2.43 million lbs. in 2014. In 2013 the TAC for these areas was 3.38 million lbs.

The total 2019 CDQ reserve equated to roughly 540 t of halibut. For comparison, the total allocation of BSAI groundfish species to CDQ groups is 195,297 t.[58] The total allocated of crab species to the CDQ program in 2019 was roughly 4.2 million lbs. (1,905 t).

[58] https://www.fisheries.noaa.gov/webdam/download/90184482

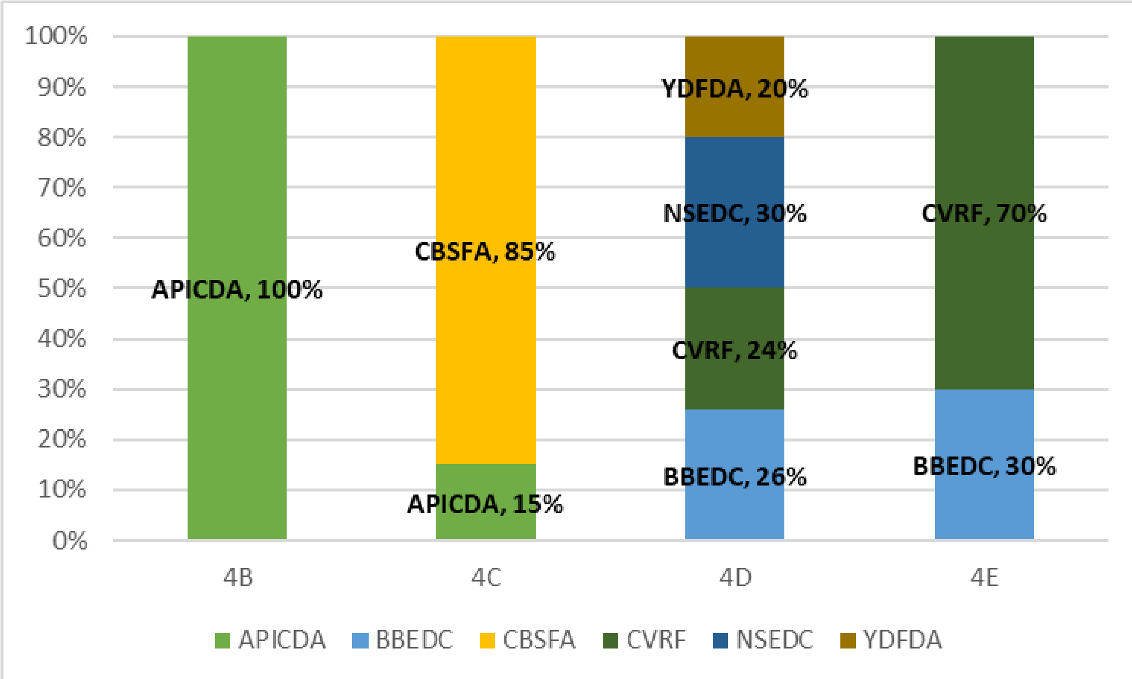

Figure 4-11 Allocation of CDQ reserve halibut by CDQ group in Areas 4BCDE

CDQ groups may use their allocation of the halibut catch limit to support nearshore small boat fisheries that provide economic opportunity and the social and cultural benefits inherent in active fishing participation to residents, or the groups can opt to lease the quota to fishing companies. CDQ groups might choose to lease the quota for a variety of reasons including, but not limited to (1) if the group's allocation is judged not large enough to support a viable or economically sustainable directed fishery, or (2) if the group judges that the social and economic benefit to their constituents would be greater by applying collected royalties to other community initiatives. Factors that influence consideration of the economic viability/sustainability of operating an in-region fishery include the size of a CDQ group's quota allocation, increases or decreases in resource abundance, and the difficulty or, under some arrangements, cost of providing or securing a processing market that is accessible to the fleet. Factors that influence consideration among different choices in providing other socioeconomic and cultural benefits to their constituents include the nature and complexity of that constituency, as some communities and individuals may not as directly benefit as others from in-region direct fishery engagement support initiatives. The complications that CDQ groups face when making this choice and the different structures they have chosen are discussed further in the Section 6 of the SIA Appendix.

Royalty revenues support CDQ projects that encourage fishery-based economic development and social development. These projects and programs include infrastructure (fishing and non-fishing), employment, training programs, equipment maintenance and repair facilities, bulk fuel procurement, seafood branding/marketing, and financial services to support small sale fishing operations that target nearshore species using small vessels. Until 2005, NMFS received information about royalty payments to CDQ groups by species harvested. Because submission of this information is no longer required, information about royalties collected from the leasing of halibut quota is not publicly available, and not all CDQ groups have chosen to present royalty information by species in their public reports.

CDQ groups have used earnings derived from investment in vessels and subsidiary companies to gain stakes in vessels, limited access privileges, and processing capacity across most BSAI fisheries (i.e., halibut, sablefish, crab, and groundfish). Investments by individual CDQ groups include ownership interest in the at-sea processing sector and in catcher vessels and are made with the expectation of financial gain or expanding equity in the fishing fleet. According to a 2016 report, at the time approximately 20% of vessels greater than 60' LOA fishing in the BSAI or GOA were owned in full or in part by a CDQ group.[59] Those vessels included pollock (AFA), Amendment 80, and freezer longline cod (HALCP) catcher/processors, among others. Investments in subsidiaries, such as limited liability corporations, allow CDQ groups to wholly or partially own vessels directly related to fisheries. These vessels provide revenue through the direct catch and sale of target species and, in some cases, vessel ownership increases a subsidiary's holdings of quota in fisheries such as BS pollock. In addition, investments in harvesting and processing capacity provide revenue through profit sharing, contractual agreements to harvest other CDQ groups' quota, and chartering commercial fishing vessels to government agencies conducting stock assessment surveys. Revenue from such investments has exceeded direct royalty income from leasing halibut and non-halibut quota since 2004 (NMFS 2018[60]). In years when data were available, direct income from investments accounted for 55% to 84% of CDQ groups' annual revenue. Until 2011, the six CDQ groups provided a joint report through the Western Alaska Community Development Association (WACDA) on assets and investments in CDQ communities. In 2011, the six CDQ groups held approximately $938 million in assets and they invested roughly $176 million in CDQ communities and fishery activities; that value was down from the reported peak of $251 million in regional investment reported for 2010. Similar information for more recent years is not publicly available.

In addition to fishery-related investments and support programs, MSA allows CDQ groups to make up to 20% of their annual investments in non-fishery related projects within the region.[61] Groups invest in capital projects such as village infrastructure, medical clinics, and environmental programs. Groups also expend funds on programs like vocational training, post-secondary education scholarships, and assistance for elders, to name only a few examples. Since the 2011 cessation of a combined report by WACDA, CDQ groups have highlighted the work completed in their member communities via public releases that vary in format and detail.

Table 4-11 summarizes CDQ allocations, harvest, and the number of vessel landing events (i.e. trips) in Areas 4BCDE from 2013 through 2020.[62] A vessel landing could include harvests by more than one CDQ permit holder. Harvest is reported in IFQ pounds (head-and-gut net weight). In some cases, Areas 4CDE may appear over or underharvested because 4D CDQ may also be harvested in 4E, and 4C CDQ may also be harvested in 4D. NMFS catch reports debit harvest from the area in which the catch actually occurred. Note that much of the area-level data is redacted as confidential due to the number of processing facilities that received CDQ halibut deliveries. For that reason, the summary tables that follow focus on CDQ activity at the Area 4 level.

During the 2013 through 2020 period, the combined CDQ reserve halibut allocation was highest in 2013 (1.2 million lbs.), then dropped to roughly 800,000 lbs. during 2014 and 2015 before rebounding to between 1.0 and 1.2 million lbs. from 2016 through 2020. CDQ harvest was at its highest point in 2013 (1.1 million lbs.), representing an 86% harvest rate of available CDQ quota across the four subareas in that year. Harvest rates in the other years have ranged from 83% in 2019 to 98% in 2014. It is apparent from the annual subtotals that include all of 4BCDE that the subareas where data are confidential actually accounted for the majority of total CDQ harvest and individual landing events in most years. This trend reversed in 2020, which may again be attributed to the operational impacts of fishing during the COVID-19 pandemic. The pounds harvested could include both direct catch by vessels from CDQ communities and catch of quotas that were contracted to other vessels fishing in these areas and generated royalties for the CDQ group.

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59 McDowell Group. (2016). Modernization of the North Pacific Fishing Fleet: Economic Opportunity Analysis. Available at: www.edc-seaking.org

60 https://www.fisheries.noaa.gov/resource/document/western-alaska-community-development-quota-program

61 MSA Section 305(i)(1)(E)(iii)

62 Data are based on NMFS Fisheries Catch and Landings Reports, which are available back to 2013 at: https://www.fisheries.noaa.gov/alaska/commercial-fishing/fisheries-catch-and-landings-reports

Table 4-11 CDQ halibut allocation, harvest, and landing events, 2013 through 2020 (Source: NMFS Catch & Landings Reports)

Year	Area	Vessel Landings	Allocation (lbs.)	Harvest (lbs.)	% Harvested	Year	Area	Vessel Landings	Allocation (lbs.)	Harvest (lbs.)	% Harvested
2013	4B	*	290,000	*	*	**2014**	4B	*	228,000	*	*
	4C	*	429,000	*	*		4C	*	298,300	*	*
	4D	165	309,240	160,877	52%		4D	176	178,980	120,075	67%
	4E	876	212,000	279,910	132%		4E	240	91,800	152,118	166%
	Subtotal	**1,462**	**1,240,740**	**1,066,864**	**86%**		**Subtotal**	**730**	**797,080**	**784,726**	**98%**
2015	4B	*	228,000	*	*	**2016**	4B	*	228,000	*	*
	4C	*	298,300	*	*		4C	*	366,800	*	*
	4D	98	178,980	116,847	65%		4D	122	220,080	180,790	82%
	4E	*	91,800	*	*		4E	122	192,800	119,821	62%
	Subtotal	**420**	**797,080**	**721,310**	**90%**		**Subtotal**	**558**	**1,007,680**	**851,869**	**85%**
2017	4B	*	228,000	*	*	**2018**	4B	*	210,000	*	*
	4C	*	376,000	*	*		4C	*	366,751	*	*
	4D	106	225,600	224,116	99%		4D	94	220,050	157,636	72%
	4E	*	196,000	*	*		4E	*	113,000	*	*
	Subtotal	**544**	**1,025,600**	**966,914**	**94%**		**Subtotal**	**493**	**909,801**	**828,334**	**91%**
2019	4B	*	242,000	*	*	**2020**	4B	*	220,000	*	*
	4C	*	455,000	*	*		4C	*	383,000	*	*
	4D	114	273,000	264,703	97%		4D	103	229,800	567,950	247%
	4E	*	220,000	*	*		4E	*	198,000	*	*
	Subtotal	**602**	**1,190,000**	**992,315**	**83%**		**Subtotal**	*****	**1,030,800**	*****	**88%**

* denotes confidential data

4.4.1.3 Cost recovery and other taxes and fees

MSA section 304(d) requires the collection of cost recovery fees for LAPP programs and the CDQ program. Cost recovery fees recover the actual costs directly related to the management, data collection, and enforcement of the programs. The fee can be up to, but not exceeding, 3.0% of the annual ex-vessel value of the fish harvested under the program (MSA 304(d)(2)(B)). The cost recovery fee for halibut IFQ was at the maximum level of 3.0% in 2020 and 2019, up from 2.8% in 2018, and 2.2% in 2017. The fee percentage is based on a calculation of management and enforcement costs in relation to the calculated total value of the fishery. Had the fee percentage not been capped, the 2020 assessment based on direct program costs divided by total fishery value would have been 4.28%. The 2020 combined IFQ fishery value that NMFS used, based on its standard pricing methodology, was $103.1 million, which is down from $150.0 million in 2019, $161.4 million in 2018, and $208.0 million in 2017.

Cost recovery has been collected from IFQ fishing since 2000. The final rule implementing cost recovery for the CDQ program was published on January 5, 2016 (81 FR 150). Because CDQ groups are allocated groundfish species as well as IFQ species, the total value calculation includes non-halibut species as well. For CDQ halibut in particular, NMFS calculates an annual standard price using the same Bering Sea port group prices calculated under the Observer Fee Program, which itself is based on the annual IFQ Registered Buyer Ex-Vessel Volume and Value Report. The CDQ halibut value estimate is combined with value estimates of other CDQ species to arrive at a total value and calculate the fee percentage. For 2020, the CDQ cost recovery fee percentage was 0.84%, up from 0.70% in 2019, 0.66% in 2018, and 0.55% in 2017. The total ex-vessel value of CDQ fisheries – which, again, are comprised mostly of non-halibut species – was $66.9 million in 2020, which was a decrease from $77.7 million in 2019, $86.1 million in 2018, and $81.7 million in 2017.[63]

The state and municipal taxes that apply to commercial halibut landings include the Fisheries Business Tax ("raw fish tax") that the State of Alaska collects from shore-based and floating processors (3% and

[63] https://www.fisheries.noaa.gov/resource/document/community-development-quota-cdq-cost-recovery-reports

5% of ex-vessel value, respectively). Revenues from this tax are shared between the State and the localities where the tax was first collected. Alaska also levies a Seafood Marketing Assessment of 0.5% on all seafood processed or first landed in Alaska and any unprocessed fishery products exported from the state. The state collects this tax from the processor or fisherman who exports the resource from Alaska. Processors or fishermen who produce less than $50,000 worth of seafood products during the year are exempt. Municipal fish taxes are also collected in 14 Alaska communities and four boroughs (Aleutians East, Bristol Bay, Kodiak Island, and Lake & Peninsula). Most municipal taxes are set at 2.0% but range from 1.5% to 3.5%.[64] Note that CPs (Category A halibut QS) do not pay taxes that are based on landings of raw fish. CPs would be responsible for the Alaska's Fishery Resource Landings Tax which is levied on fish processed outside the 3-mile limit but within the U.S. EEZ and is first landed in Alaska. That levy is currently set at 3% of the estimated unprocessed value of the resource and is also eligible for sharing with the municipalities or boroughs where the fishery resource was first landed.

Harvesting vessels and processors that are not part of the full observer coverage category – i.e., halibut CVs and the inshore processors who receive their landings – are also responsible for a joint payment of 1.6% of ex-vessel value that goes toward the administration of the North Pacific Observer Program's partial coverage category (including electronic monitoring).

4.4.1.4 Halibut discard mortality in the commercial halibut fishery

The commercial IFQ fishery, itself, incurs halibut bycatch mortality. The IPHC describes this as incidental mortality of halibut in the directed commercial fishery that do not become part of the landed catch. The three sources of discard mortality include (1) fish that are caught but discarded because they are below the legal size limit of 32 inches, (2) fish that are discarded for regulatory reasons (e.g., the vessel has exceeded the amount of IFQ pounds that are possessed onboard), and (3) fish that are estimated to die on lost or abandoned fishing gear.[65] Information on lost gear and regulatory discards is collected through logbook interviews and fishing logs mailed to IPHC. The ratio of U32 to O32 halibut is determined from the IPHC Setline Survey in all areas off Alaska. Different mortality rates are applied to each category: mortality for released halibut is 16% and mortality for halibut estimated to be caught on lost gear is 100%.

Table 4-12 shows commercial halibut discards in all Alaska IPHC areas from 2009 through 2020. In 2019, all areas except for 3B experienced an increase in discard mortality relative to the preceding years. In 2020, commercial discards declined markedly in Areas 2C, 3A/B, and 4A, but held constant with the 2019 upticks in Areas 4B and 4CDE. On average, Area 4 accounted for 15% of the annual commercial discards that occurred from 2009 through 2020 across all Alaska areas. For comparison, total state-wide commercial IFQ halibut bycatch mortality was equal to 5.6% of the commercial catch by volume from 2009 through 2020 (16.0 million lbs. compared to 285.9 million lbs.). For those years, that relationship was highest in 2010 (6.9%) and lowest in 2020 (3.4%).

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[64] The 2019 Alaska Taxable Report, Volume LIX (Jan. 2020) is available at https://www.commerce.alaska.gov/web/Portals/4/pub/OSA/Official%202019%20Alaska%20Taxable.pdf. There, the reader can refer to Table 1A ("Reported Tax Rates for Each Municipality") for local raw fish taxes rates and revenues in 2019. The 2019 Alaska Taxable Supplemental Report, Volume LIX (Jan. 2020) is available at https://www.commerce.alaska.gov/web/Portals/4/pub/OSA/Full%20Supplemental.pdf. The Supplement provides greater detail at the community level, including whether a community imposes a raw fish tax and how much tax revenue was generated under that tax in 2019.

[65] IPHC fishery statistics (2020) published for the January 2021 IPHC Annual Meeting; available at https://iphc.int/uploads/pdf/am/am097/iphc-2021-am097-05.pdf.

Table 4-12 Halibut discard mortality (net weight tons) in the Alaska commercial IFQ fishery and percent relative to total commercial halibut catch, by area , 2009 through 2020 (Source: IPHC)

Area	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average
2C	138	118	38	43	50	54	55	56	39	27	36	29	57
3A	533	658	422	269	235	201	236	171	157	129	160	85	271
3B	361	410	349	239	183	148	98	105	106	94	74	44	184
4A	71	63	65	43	32	16	36	24	30	31	47	38	41
4B	8	17	20	17	16	25	16	27	14	9	17	16	17
4CDE	41	43	87	34	25	24	24	29	13	12	34	36	33
Total	**1,152**	**1,308**	**980**	**645**	**542**	**468**	**464**	**414**	**360**	**302**	**368**	**248**	**604**
% Comm. Catch	**5.8%**	**6.9%**	**6.8%**	**5.7%**	**5.4%**	**6.2%**	**5.9%**	**5.2%**	**4.2%**	**4.0%**	**4.5%**	**3.4%**	**5.6%**

4.4.2 Processing component

Shore-based processors accounted for over 99% of the processing of the Area 4 halibut catch from 2010 through 2019. The average annual ex-vessel value of halibut processed shoreside was $24.8 million (2018$), though the total value was low in 2018 and 2019 compared to the period as a whole – $14.7 million and $15.5 million, respectively. The balance of the processing activity involved two catcher/processor vessels registered to Seattle-based companies that were primarily involved in the Pacific cod fishery (catch data confidential), one catcher/processor registered to Petersburg, AK (catch data confidential), one vessel that was classified by its self-reported processor code as a direct marketer catcher/processor (catch data confidential), and 19 operations defined in AKFIN data as catcher-sellers that marketed their own unprocessed catch (total 2010-2019 catch was less than 400,000 lbs. with a combined estimated ex-vessel value of roughly $1.3 million in inflation-adjusted 2018$). Almost two-thirds of the non-shore-based activity that occurred in Area 4 during the analyzed period took place in Areas 4A and 4B during 2010 and 2011.

The shore-based processors that received halibut during the analyzed period for which revenue data are available were located in 22 Alaska communities, but seven of those operations processed halibut in fewer than half of the studied years. As noted in Section 5.3 of the SIA Appendix, Area 4 halibut was processed every year in 11 Alaska communities. Within the BSAI area, those communities included Adak, Akutan, Unalaska/Dutch Harbor, St. Paul, Nome/Savoonga, and Twin Hills (Togiak area). Communities elsewhere included Anchorage, Homer, King Cove, Kodiak, Sand Point, and Seward. In 2019, Area 4 halibut was processed in 13 communities, eight of which are adjacent to the BSAI area. Six of the eight communities that processed Area 4 halibut in fewer than half of the years were located in communities that are affiliated with the CVRF CDQ group; those operations were active from 2010 through 2013 but not since. The other communities with inconsistent processing participation were Togiak (BBEDC CDQ region), where halibut processing has occurred in all covered years since 2016, and False Pass (APICDA CDQ region), where halibut processing occurred in 2010, 2011, 2014, and 2015.

The average number of Alaska shore-based processing facilities the received Area 4 halibut in a given year from 2010 through 2018 was 24.2, ranging from a high of 29 in 2011 to just 20 in 2016. Over the period, 37 unique facilities processed shoreside halibut deliveries from the Area 4 fishery. In the average year, just below half of the shore-based facilities that processed Area 4 halibut (average of 11.4 shore-based processors) were located in communities adjacent to GOA waters (i.e., Kodiak, Homer, King Cove, Sand Point, Seward, and Anchorage).

While facilities located adjacent to the BSAI accounted for roughly half of the Alaska processors that received Area 4 halibut, those facilities combined to account for 86% of the combined Alaska-landed ex-vessel value derived from the CV fishery during the analyzed period. By CDQ region, processors in the APICDA and CBSFA regions combined to account for 81%, NSEDC and BBEDC together accounted for

3%, CVRF accounted for 2%, while facilities in GOA communities accounted for 15%. Processed volume and value cannot be further disaggregated to the community level due to confidentiality restrictions.

The shore-based processors that received Area 4 halibut deliveries over this period processed a total average annual ex-vessel value (all species, coming from multiple areas and gear types) of around $560 million (2018$), meaning that Area 4 halibut accounted for roughly just 4.4% of the plants' total activity as measured by ex-vessel. Among this group of processors, as defined by regional location, the GOA facilities were the least dependent on Area 4 halibut (~1.5% of average annual ex-vessel value). When operating, the facilities in the CVRF region were almost entirely reliant on Area 4 halibut (>99%). Facilities in the APICDA/CBSFA regions (combined) generated roughly 16% of ex-vessel value from Area 4 halibut. Facilities in the NSEDC/BBEDC regions (combined) generated roughly 7% of ex-vessel value from Area 4 halibut. The total ex-vessel value of all processing by all plants in the communities where Area 4 halibut were processed had an average annual value of $733 million (2018$); the value of ex-vessel payments for Area 4 halibut equate to 3.4% of that total.

The 20-Year Review found that the IFQ Program fundamentally changed processing needs in the halibut IFQ fishery, shifting from a primarily frozen to a majority fresh market – though that shift was experienced mainly in geographies outside of Area 4 (NPFMC 2016). After the implementation of IFQs, most processors that were engaged in the halibut fishery increased diversification in non-IFQ species. Processors who were interviewed for the 20-Year Review noted that diversification included entering into other fisheries, increasing processing of species that they had previously been processing, focusing on value added products, and entering into custom processing arrangements. Processors adjacent to the BSAI/Area 4 that derive the majority of their revenue from high-volume groundfish fisheries and crab were less likely to modify halibut operations in a manner similar to what has been observed in some facilities that are relatively more engaged in the Areas 2C and 3A halibut fisheries.

The 20-Year Review also noted that IFQ Program implementation likely caused a shift in the relative bargaining power between harvesters and shore-based processors (Matulich and Clark, 2003; Fell and Haynie, 2011; 2013). Analysis of price margins between wholesale and ex-vessel prices indicates that halibut processor price margins have decreased over time as a result of the harvesting sector receiving 100% of the fishery's quota share (NPFMC 2016, Section 2.4.2.3). Processor representatives who were interviewed as part of the review process listed the top impacts of the IFQ program. Most of those impacts bear on bargaining power and the relative share of economic rents derived from the halibut fishery. They include: devaluation of capital investments; the creation of surplus capacity (freezing and ice-making capacity that was less needed after the elimination of the pre-IFQ derby fishery); changes in relationships between processors and fishermen; changes in landings patterns; diversification into other fisheries and different product types; and previously active processors going out of business (especially in rural communities without access to transportation services). Again, some of these generalized impacts are more reflective of the post-IFQ experience in GOA communities where processors were not already focused primarily on high-volume groundfish fisheries. Processors also noted that the total volume of IFQ landings has generally trended downwards in the years since program implementation (Figure 4-6).

Those shore-based processors that remain engaged in the Area 4 halibut fishery are, in many cases, processing halibut as a side-line, using halibut deliveries as a means to keep workers utilized during gaps in deliveries from other fisheries, engaging in custom processing for buyer-exporters, or partnering with CDQ groups to provide a market for a local small-vessel fleet. One of the IFQ Program's positive impacts that was noted by processor interviewees was steadier and longer employment for the processing workforce.

4.4.3 Halibut IFQ/CDQ crew

The IFQ Program 20-Year Review (NPFMC 2016) estimated average crew size for CVs fishing for halibut at two to four persons. The range captures the difference between vessel categories B, C, and D, which spans vessels over 60' LOA to open skiffs. While this vessel-based crew estimate is small relative to A80 groundfish CPs, it is similar to the Fish Ticket-based average annual median crew estimates for trawl and fixed gear CVs of four persons. A likely range for the number of individuals who work as crew each year in the Area 4 halibut CV fishery is between 420 to 840. This range is derived from the average crew size (2 to 4) and the average number of CVs fishing in the area annually during the 2010 through 2019 period (211; citing Table 12 within SIA Section 5.2). The true number of unique individuals who crew in the Area 4 IFQ fishery in a given year is not known due to incomplete data collection on crew size. The analysts presume that the true value is closer to the high end of the range because B and C class vessels are unlikely to operate with a crew of two persons. The true value is likely not at the extreme high end of the range because a simple multiplication of average crew size and average vessel count does not adjust for the unknown number of individuals who crew on multiple vessels in a given year. The 20-Year Review cites a 2001 study finding that typical IFQ CV crew size had decreased from a range of three to six individuals prior to IFQ implementation. The decrease was attributed to greater use of auto-baiters and the slower pace of the fishery (Hartley and Fina, 2001).

Specific data on crew compensation was identified as a data gap in the 20-Year Review and is also listed as a category of unavailable information in Section 4.5.4 of the SIA. As such, the analysts cannot estimate crew shares as a percentage of ex-vessel revenues or average crew earnings. The 20-Year Review relied on previous research as well as information gathered at an IFQ crew workshop held in conjunction with a Council meeting in April 2016 (Anchorage, AK). Implementation of the IFQ Program in 1995 is estimated to have decreased the total number of crew jobs by several thousand due to quota share consolidation, the exit of vessels from the fisheries, and quota share holders consolidating IFQ permits onto fewer vessels. The 20-Year Review concluded that the decline in the number of available crew jobs and an overall shift away from vessel owners' needs for manpower reduced the bargaining strength of crewmembers relative to vessel owners. Vessel operators that lease quota or fish as a hired master for an initial quota share recipient may also deduct quota fees from gross revenues, thus reducing crew compensation. For those crew who have remained in the fishery, average seasonal earnings are likely to have increased under the IFQ Program due to the longer season and more quota available to catch on the reduced number of vessels that remained in the fishery. The Review concluded that crewmembers who remained in the fishery likely have higher paying, more stable, and safer jobs. Since the most dramatic effects of IFQ consolidation occurred in the fishery several decades ago, the annual income of crewmembers who are currently active in the fishery is mostly driven by the amount of TAC available for harvest on their vessel and the effects of lease rates when the vessel is fishing quota that is not owned by the vessel operator or active crewmembers onboard.

The 20-Year Review includes a summary of discussions at the April 2016 IFQ crew workshop (NPFMC 2016, Section 2.4.1). That summary provides anecdotal references to how crew share percentages have changed over time and as a result of quota leasing arrangements. The workshop summary noted that prior to the IFQ Program crewmembers were making a 9% to 15% share of gross ex-vessel revenues. In most cases, operating costs were deducted from the gross before determining boat-, captain-, and crew-shares. The implementation of IFQs led to a wider variety of compensation modes based on whether the participant is an initial quota share recipient, acquired additional quota share, or largely operates as a hired skipper/lessee. For instance, some initial recipients deduct lease fees from gross revenues for initially allocated quota while others do not. For those that do not apply a lease fee, crew shares were reported to range from 8% to 20% of gross ex-vessel revenues. Operators who do apply a lease fee for initially allocated quota were said to set those fees between 15% and 30%, meaning that operating costs and other shares were dividing 70% to 85% of fishing revenues. Operators who purchased quota typically deduct a fee from the gross revenue, and the standard lease fee has grown over the life of the program to around 50%/50% or 60%/40% (with the greater percentage going to the quota owner). The workshop summary reports that operations with a mix of initially allocated and purchased quota share paid crew shares in the range of 6% to 15% of the gross ex-vessel revenue. Operators that were strictly hired skippers or lessees paid crew shares in the range of 3% to 8% of the gross. Operating costs that are related to boat expenses that did not exist before IFQs are also being deducted from gross revenue; for example, some individuals reported that auto-baiter costs were being accounted for in the boat share. In general, the Review found that crew shares as a percentage of gross ex-vessel revenues have decreased since IFQ implementation.

4.4.4 Subsistence and Sport Halibut Use in the BSAI

Subsistence and sport uses of halibut in BSAI communities a described in detail in the SIA Appendix. Impacts relative to subsistence and sport users are discussed in Section 5.6.2 of this DEIS. Within the SIA Appendix, subsistence use is described in SIA Section 5.4, and in the subsections to SIA Section 6 that address each CDQ region individually (subsections titled “Engagement in the Subsistence BSAI Halibut Fishery”). Sport uses of halibut in the BSAI are described in SIA Section 5.5.

The IPHC’s 2019 annual fishery statistics report (IPHC-2020-AM096-05 Rev_2) lists estimated subsistence and recreational mortality by IPHC Areas. Table 21 in Section 5.4.3 of the SIA lists subsistence estimates from 2010 through 2019 based on the IPHC’s reports. Within Area 4, 4E tends to take the largest amount. The 4E estimate for 2018 and 2019 (estimated biennially) was 25,160 lbs., compared to 13,237 lbs. in 4A, 5,152 lbs. in 4C, and 1,684 lbs. in 4B.

Halibut is one of the primary sources of wild food throughout the western Alaska CDQ regions. Some exceptions are interior remote areas and communities on St. Lawrence Island (part of the NSEDC CDQ region) that rely primarily on marine and terrestrial mammals. Even residents in the communities that do not directly harvest halibut for subsistence use the resource as they might receive it through gift or trade, or individuals might travel to harvest halibut in an area that is different from where they reside. CDQ groups have also supplied communities with halibut in circumstances of uncommon food shortage, such as failed marine mammal harvests or natural events that spoiled caches of other stored foods.

Sport uses include both unguided and commercially guided (charter) recreational halibut fishing. ADF&G only documents unguided recreational harvest in five of their management areas that geographically overlap the BSAI. Three of those management areas are in ADF&G’s Southcentral region and two are in the Arctic-Yukon-Kuskokwim region. Aside from the Alaska Peninsula/Aleutian Islands area (Area R), recreational catch of halibut is reported in very low numbers (estimated at fewer than 50 fish per year, and often zero fish per year). Charter operations are not numerous IPHC Area 4. A 2013 ADFG estimate found that charter operations in Area 3B and Area 4, combined, represented less than 0.4 percent of Alaska’s total charter/non-charter recreational yield. AFSC’s Alaska Community Profiles, with data available through 2014, found that the only charter operations were in Unalaska/Dutch Harbor. Fieldwork conducted in Unalaska by NPFMC staff and a contractor in July 2019 found that there are currently two part time charter operators and one ecotourism-focused business that reported having offered recreational fishing opportunities in the past.

5 Impacts analysis for groundfish and halibut stocks and fisheries (including direct, indirect, and cumulative)

5.1 Documents incorporated by reference in this analysis

This DEIS relies heavily on the information and evaluation contained in previous environmental analyses, and these documents are incorporated by reference. The documents listed below contain information about the fishery management areas, fisheries, marine resources, ecosystem, social, and economic elements of the groundfish fisheries. They also include comprehensive analysis of the effects of the fisheries on the human environment, and are referenced in the analysis of impacts throughout this chapter.

Alaska Groundfish Harvest Specifications Final Environmental Impact Statement (NMFS 2007).

This EIS provides decision makers and the public an evaluation of the environmental, social, and economic effects of alternative harvest strategies for the federally managed groundfish fisheries in the GOA and the Bering Sea and Aleutian Islands management areas and is referenced here for an understanding of the groundfish fishery. The EIS examines alternative harvest strategies that comply with Federal regulations, the Fishery Management Plan for Groundfish of the GOA, the BSAI FMP, and the MSA. These strategies are applied using the best available scientific information to derive the TAC estimates for the groundfish fisheries. The EIS evaluates the effects of different alternatives on target species, non-specified species, forage species, prohibited species, marine mammals, seabirds, essential fish habitat, ecosystem relationships, and economic aspects of the groundfish fisheries. This document is available from:

http://alaskafisheries.noaa.gov/analyses/specs/eis/default.htm.

Stock Assessment and Fishery Evaluation (SAFE) Report for the Groundfish Resources of the BSAI (NPFMC 2020).

Annual SAFE reports review recent research and provide estimates of the biomass of each species and other biological parameters. The SAFE report includes the acceptable biological catch (ABC) specifications used by NMFS in the annual harvest specifications. The SAFE report also summarizes available information on the ecosystems and the economic condition of the groundfish fisheries off Alaska. This document is available from:

http://www.afsc.noaa.gov/refm/stocks/assessments.htm.

Final Programmatic Supplemental Environmental Impact Statement (PSEIS) on the Alaska Groundfish Fisheries (NMFS 2004).

The PSEIS evaluates the Alaska groundfish fisheries management program as a whole and includes analysis of alternative management strategies for the GOA and BSAI groundfish fisheries. The EIS is a comprehensive evaluation of the status of the environmental components and the effects of these components on target species, non-specified species, forage species, prohibited species, marine mammals, seabirds, essential fish habitat, ecosystem relationships, and economic aspects of the groundfish fisheries. This document is available from:

http://alaskafisheries.noaa.gov/sustainablefisheries/seis/intro.htm.

5.2 Methodology for assessing halibut: the closed-loop simulation model for Pacific halibut

This section describes the simulation model used in the analysis for Pacific halibut and what impacts on halibut are derived from it for purposes of this DEIS.

5.2.1 SSC review of model in October 2020

The SSC has iteratively reviewed this model over several meetings. The most recent review was in October 2020 with the previous set of alternatives. For that previous DEIS draft[66] a closed-loop simulation framework was used to compare the Pacific halibut stock trends and PSC limits across the previous (October 2020) set of alternatives. SSC minutes from October noted where model improvements were made to address the main SSC requests from the 2019 SSC review of the model and commended the analysts on thoroughly addressing those previous requests and resulting model improvements. This included (as before) model validation based on the IPHC coastwide assessment and available survey.

During the October meeting, the analysts discovered the distribution of catch among areas was mis-specified (and noted as a "conversion error" which was inaccurate). This error affected the 2019 directed halibut fishery catch estimates from which relative values were computed and plotted (i.e., the future projections were presented as ratios over the 2019 value). This error affected the presentation of the directed Pacific halibut fishery catch. However, correcting the catch distribution to better reflect reality resulted in very minor differences in overall results and no differences in contrasting alternatives, this was demonstrated in side-by-side comparisons presented to the SSC in October.

As noted, the revised results presented were unaffected by this error. Furthermore, the impact analysis on groundfish, comparison across alternatives in figures and tables, ranking of alternatives according to the performance metrics, modeled values and trends in time of simulated halibut catch in absolute terms, spawning and total biomass, indices, PSC limits and usage and the SIA were all unchanged when the error was corrected. Nonetheless the SSC indicated that there was insufficient time provided to evaluate the side-by-side comparison to ensure that directed fishery catch projections resulting from the model were unaffected by the change. The error affected the presentation of a critical component—that of the directed Pacific halibut fishery. However, this was simply a matter of results being presented relative to incorrect 2019 values. The other aspects of the model and interpretations remain valid.

Some concerns were also raised regarding the corrected model output for use in computing performance metrics. These were separate issues as some performance metrics were highly complex and showed behaviors that were difficult to interpret. Due to the Council's shift from an MSE based framework for this analysis to a more traditional analysis of impacts, the need to assess impacts according to such complex performance metrics was reduced. In this draft, impacts and decisions are framed in the context of balancing across the MSA National Standards. Given the Council's direction, the analysts used model results to infer the impacts given the new, reduced set of PSC limits. This provides the best available information to indicate likely patterns of survey indices used to set future PSC limits derived from the look up tables in Alternatives 2 through 4. We also demonstrate that past model results can effectively evaluate the sensitivity of these PSC limits on SSB.

Therefore, we maintain that some of the previous analysis and configurations provide results that can apply to the current alternative set. The simulation model implemented the same demographic parameters as in the IPHC Coastwide assessment model and accounts for the directed fisheries in the BSAI and elsewhere. That is, since the current set has an upper PSC limit of only 2,007 t, examining the status quo and "No PSC" runs provide an indication of both the resulting range of survey index values and impacts

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[66] October 2020 initial review preliminary ABM DEIS

to Pacific halibut SSB. As shown in Chapter 5, the differences between the model runs with no PSC and PSC equal to the current limit were minor for both the BSAI Pacific halibut SSB and the two indices.

5.2.2 Description of the closed loop simulation model

A description of the closed loop model is summarized below.

The steps of a closed-loop simulation are as follows: (i) simulating the true biology of the natural system (referred to as the operating model, OM), (ii) sampling from the true population, (iii) calculating the measures of stock status (assessment), (iv) calculating recommended fishing restrictions using management alternatives, and (v) applying updated restrictions to the fishery, which allows the dynamics of the true population to be updated. Here, we provide a short overview of the closed-loop simulation model. Additional details of the model are then described in the subsections that follow.

The OM consisted of a two-area, age- and sex-structured model of Pacific halibut population dynamics with the BSAI modeled as one area and the remaining components of the range of the halibut stock comprising the "other" area (this includes the GOA, British Columbia, and US West Coast). Recruitment is assumed to occur at the coastwide level and the proportion of new recruits that settle in the BSAI is time-varying and temporally autocorrelated. The OM allows adult movement between the two areas, based on a model validation exercise (described below) and values estimated in Webster et al. (2013). Weight-at-age was set equal to values used in the most recent (2020) IPHC assessment models. The model included five fishing fleets: the directed halibut fishery in the BSAI, the directed halibut fishery outside of the BSAI, the BSAI trawl PSC fishery, the BSAI hook-and-line (HAL) PSC fishery, and the bycatch fishery in the other area. Though BSAI trawl PSC is modeled as a single fleet when applying population dynamics, PSC limits and mortality are separated for the A80 and non-A80 components of trawl PSC when applying the Alternatives and for reporting purposes. Many values for halibut population dynamics were fixed based on results from the most recent IPHC coastwide long assessment model.

The Eastern Bering Sea Shelf trawl survey (BTS) and the IPHC's Fishery Independent Setline Survey (FISS) were modeled as a function of halibut total biomass, survey selectivity, and observation error. These two survey indices served as the basis for calculating PSC limits according to each PSC management alternative.

The IPHC's process for setting coastwide catch limits for the directed fishery (called Total Constant Exploitation Yield, or TCEY) was simulated by using the true spawning biomass from the population dynamics model and applying assessment error. In a sensitivity analysis, a lag on assessment error was incorporated to recognize that the current year's assessment results may be correlated with those of the previous year. More recently the IPHC has used an SPR-based harvest strategy which may contribute to the uncertainty of using spawning biomass as a proxy for the TCEY.

The coastwide catch limits were then calculated in two ways such that there are two base case runs of the model comprising bookends of the IPHC's decision-making process:

(1) a linear relationship between historical IPHC estimates of spawning biomass and total mortality of halibut in the following historical year. This approach assumes that the process of decision-making at the IPHC in the future will resemble that of the past. In contrast to the model configuration presented in 2019, this year's linear relationship between historical IPHC spawning biomass and the total mortality in the following historical year used fewer years of earlier observations (2011 onward instead of 2007 onward). This led to a shallower slope, or less drastic changes in predicted total mortality in the following year, as was recommended by the SSC. Removing all but the most recent period, as also suggested, led to a completely unresponsive relationship between spawning biomass and total mortality in the following year, which is likely not true. Additionally, there has been little change in the coastwide spawning biomass in recent

years, thus there is not a lot of contrast to measure how well spawning biomass may correlate with the TCEY.

(2) The linear relationship described in (1) was used when coastwide relative spawning biomass was greater than 30% of unfished biomass, and a 30:20 harvest control rule was implemented without variability when coastwide relative spawning biomass (with assessment error) was below 30% of unfished biomass.

The model allocated a proportion of the coastwide catch limit (TCEY) to the BSAI in each year, according to the proportion of all-sizes FISS survey biomass in the BSAI in the previous year. However, distribution of the TCEY determined in the current interim IPHC harvest strategy further reduces the TCEY in IPHC Regulatory Areas 3B, 4A, 4B, and 4CDE to account for a strategy to harvest at a rate in the western areas that is three-quarters the rate in eastern areas. The previous year's O26 PSC mortality was used as a proxy for expected O26 PSC in coming year in the BSAI and in the other area and was subtracted from the area-specific TCEY to determine directed fishery catch limits in the following year in both areas. As is the case in the current management system, the PSC in the BSAI may exceed the TCEY allocated to the BSAI in any given year. Bycatch limits in the other area are fixed to their 2019 value throughout the simulation.

The relationship between PSC use and limit was modeled stochastically according to the historical distribution of this relationship for each sector. A sensitivity analysis was conducted that assumed that as the PSC limit decreased, the proportion of the limit comprising the use would become higher.

The simulations were conducted for 100 future years and 500 simulations, each with a unique set of random deviations defining the process and observation errors modeled.

The model was first run for 26 historical years to verify that population dynamics, survey indices, distribution of survey biomass by area, and catches by fleet were able to mimic our historical data and assessment-based perceptions of stock dynamics. This process is detailed in Appendix 3, entitled "Model Validation," and prompted the inclusion of several key features of the OM prior to conducting forward simulations. In summary, time-varying recruitment allocation among areas, an influence of the Pacific Decadal Oscillation (PDO) on unfished recruitment, the ability of the model to simulate fluctuating weight-at-age over time, and the chosen mean recruitment allocation and adult movement parameters were included or adjusted to best match both the coastwide stock dynamics estimated by the most recent Pacific halibut stock assessment and to match BSAI dynamics from a BSAI-only assessment submodel, as well as the proportion of FISS survey biomass that has been observed in the BSAI over the past 25 years.

The simulation model uses two areas to model the population and fishery dynamics. The BSAI area incorporates three IPHC Regulatory Areas for which the IPHC sets TCEYs (4A, 4B, and 4CDE), and each of those areas has unique trade-offs between directed halibut mortality limits and PSC usage. Therefore, drawing model inferences on the area-specific directed fishery effects are limited. Also, summing over the three IPHC Regulatory Areas may dampen the effects on directed fisheries in certain areas, such as 4CDE.

5.3 Impacts of PSC on halibut: indices of abundance, SSB and PSC implications for overall catch mortality

Figure 5-1 shows SSB model results for Alternative 1 (status quo) compared to zero PSC. Results for Alternative 1 show an initial decline in SSB, followed by an increase in the SSB shortly thereafter and oscillations that mostly remain above the simulated SSB from the initial decline. This initial decline is common across all alternatives and occurs because the 2019 numbers-at-age for young fish from the 2019 IPHC coastwide long assessment model were estimated to be relatively low in recent years. This model is meant to approximate the general behavior of halibut population dynamics and should not be used to forecast the spawning biomass of halibut in future years, but rather to compare the SSB across alternatives under a variety of spawning biomass values. However, overly optimistic projections of SSB may show little to no difference between alternatives, and pessimistic projections (e.g., the low-recruitment sensitivity analyses presented in October 2020) had slightly more contrast.

With PSC limits at zero, results were nearly identical to that from the status quo alternative (Alternative 1; Figure 5-1). Previous work showed that when PSC values were unrealistically large (with BSAI PSC limits set to 10,000 t) the average spawning biomass in the BSAI declined over all simulation years to very low levels (~2k t). The spawning biomass in the other area experienced a substantial, but less dramatic decline than in the BSAI, from ~100k t to ~ 50k t over the 100-year simulation period (See October 2020 DEIS).

The simulation model also provides the ability to compare the impact of status quo PSC limits and that of zero PSC. As with spawning biomass, results were strikingly similar for the index values relative to the no appreciable change between status quo PSC and no PSC (Figure 5-2 and Figure 5-3). The proportion of time that index values across the simulation fall into different states of the surveys as defined by the Alternatives are shown in Table 2-13 and Figure 2-7 and not repeated here.

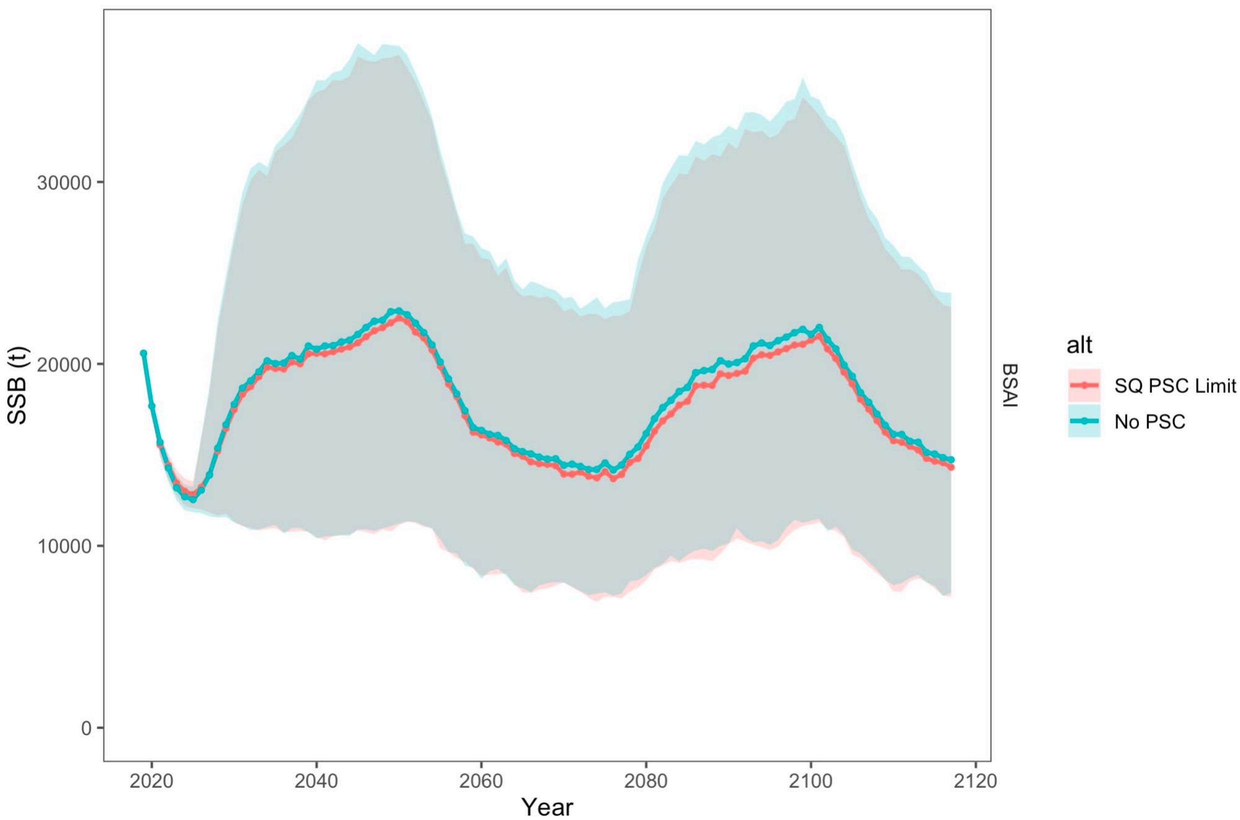

Figure 5-1 Projected Pacific halibut SSB for the BSAI region under status quo (SQ) and zero (no) PSC Pacific halibut mortality. Solid lines are median values and 90 out of 100 model realizations fall within the shaded areas.

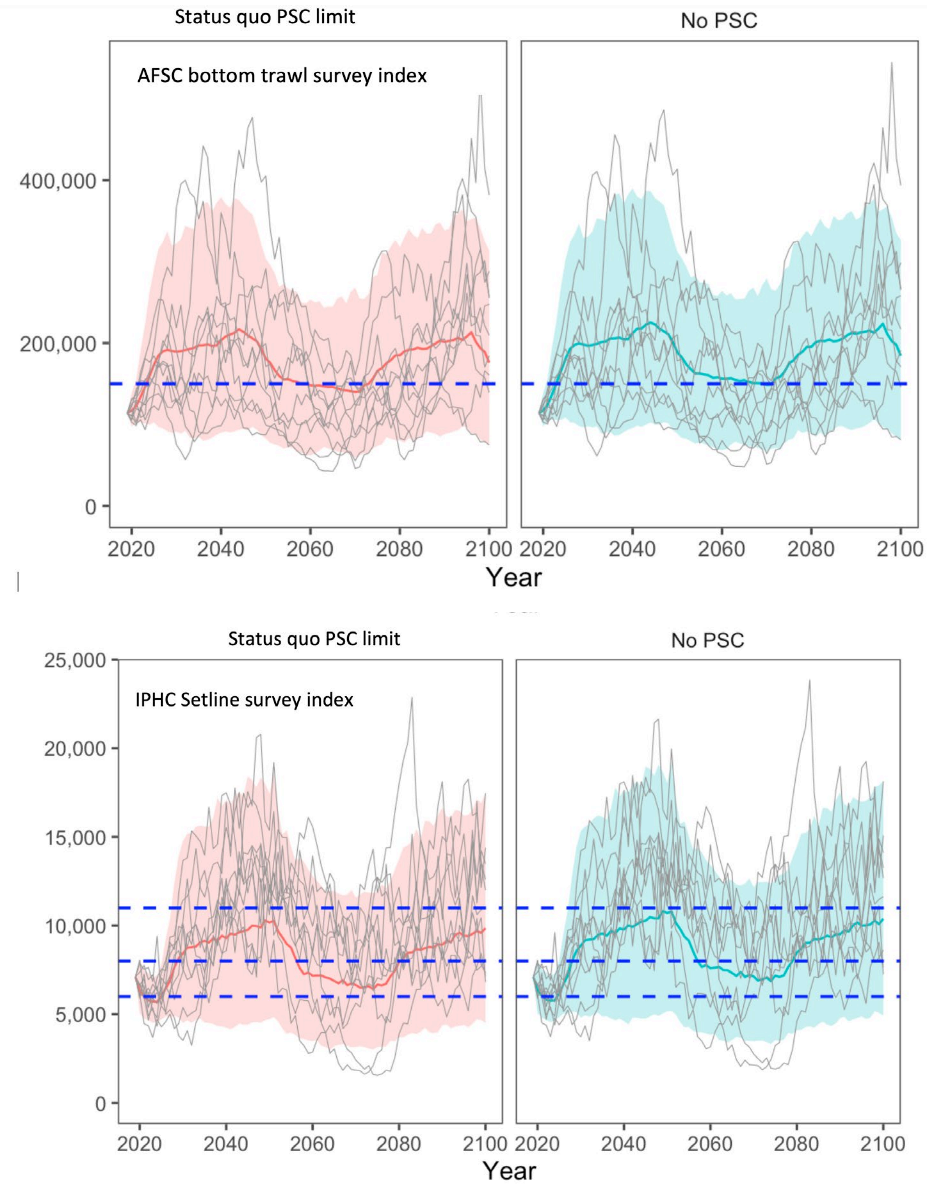

Figure 5-2 **Projected Pacific halibut AFSC bottom trawl survey index (top row) and IPHC setline survey index (bottom row) in the BSAI for status quo PSC limits (left panels) and zero PSC (right panels). Dashed lines represent the thresholds between survey 'states' under Alternatives 2,3, and 4.**

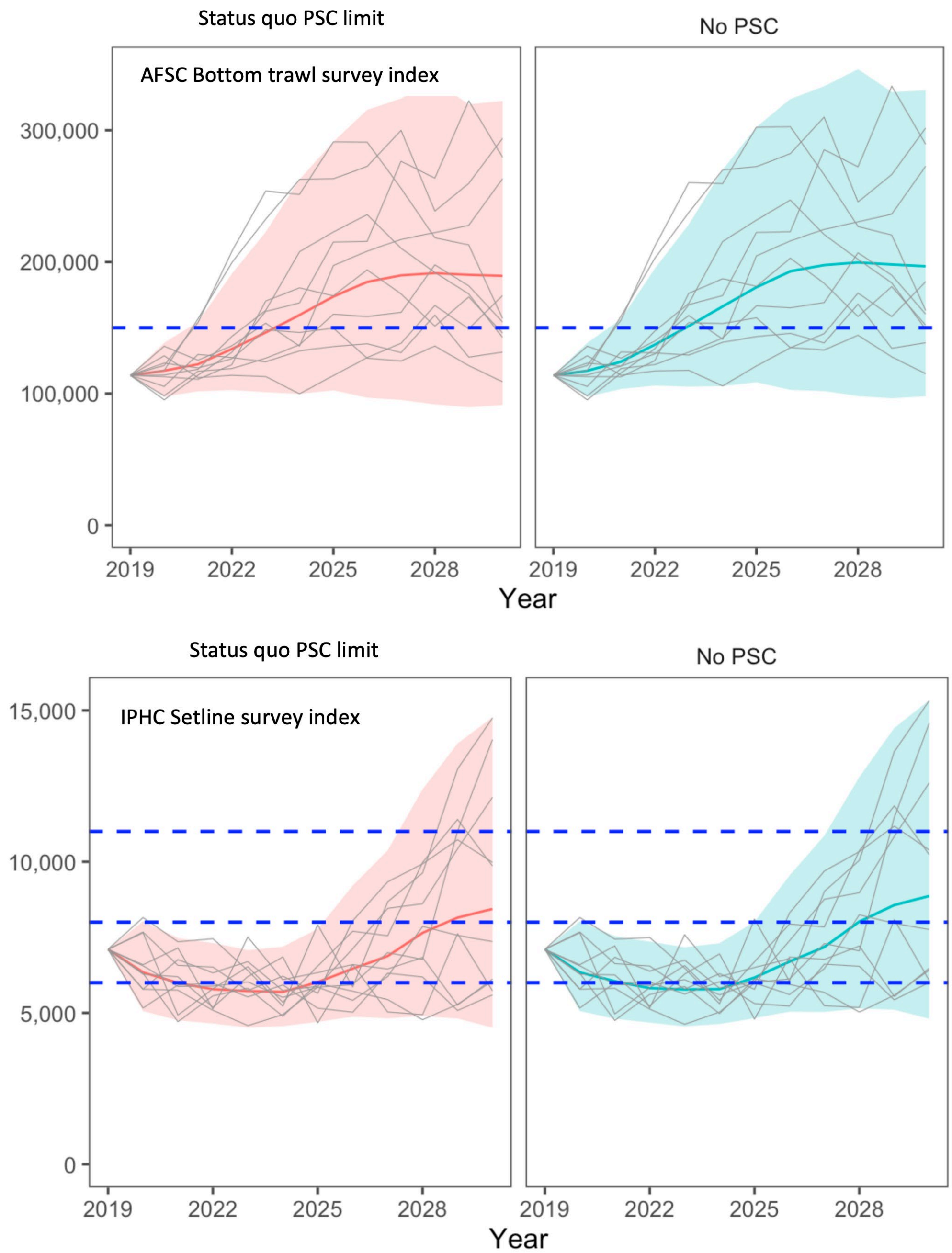

Figure 5-3 As for Figure 5-2 but showing just the initial years of the simulation (2020-2030)

As noted above, and also in the previous analysis for a broader range of PSC limits, SSB is largely insensitive to the alternatives under consideration.

Previous analyses showed that PSC limits and PSC use were inversely correlated with directed halibut fishery catches, as expected, based on how they are calculated in the management processes for the two agencies. Changes in PSC limits in general are larger proportionally than changes in directed halibut fishery catch limits. This occurs because the directed halibut fishery catch limits are determined by subtracting the previous year's O26 PSC use from the TCEY (as TCEY is a catch limit for O26 fish), and a majority of the PSC use is comprised of U26 fish (although in 2020, 25% of the PSC usage in 4ABCDE and 35% in 4CDE was U26). For example, median relative decreases in PSC use and PSC limits compared to Alternative 1 are considerably greater in absolute value than median relative increases in directed halibut fishery catch and limits. Therefore, an increase in the directed halibut fishery catch is mostly a result of reducing the O26 component of the PSC limit, but an increase in PSC usage is partly composed of U26 halibut and has less effect on the directed halibut fishery catch limit in these simulations. Furthermore, a large change in the BTS index may occur with an unusually large or small recruitment pulse, but the change in the expected spawning biomass and O26 PSC use that is used to calculate the directed halibut fishery catches and limits each year may change in an opposite direction until the cohort responsible for the recruitment pulse becomes part of the O26 and spawning components. Simply stated, differences in the sizes of Pacific halibut targeted by the directed fishery and those taken as PSC are often out of phase due to variability in year class strengths.

A sensitivity test using a scenario with low recruitment (where numbers-at-age for ages up to age 6 are set to zero initially, then low PDO throughout the simulation) was presented in October 2020 (See Appendix 2 to October DEIS[67]) and was meant to explore whether differences in alternatives and model implementation of the 30:20 control rule for TCEY determination would exist under more extreme circumstances. No difference in results for this sensitivity test were found between the scenarios with and without a 30:20 control rule for TCEY determination. This is likely due to the definition of dynamic unfished spawning biomass adopted by the IPHC recently, where both unfished and fished spawning biomass will both decline as a series of low recruitment cohorts grow to contribute to the spawning biomass. The impact of the 30:20 control rule is most likely affected by the amount of assessment error, lags in data, and implementation variability.

In summary, these simulation model results show that, in percentage terms, differences in PSC limits (and usage) projected by the model relative to Alternative 1 (status quo) were greater than for related impacts on spawning biomass (SSB) because the model simulates a high percentage of U26 in the PSC usage. This indicates that a range of PSC as considered in the current alternative set would likely have little impact on halibut spawning biomass. These results were insensitive to assumptions about implementation of a 30:20 harvest control rule for TCEY determination for the base case scenario. The stock only falls below 30% of unfished SSB when the TCEY or PSC limits are high.

A number of factors in these simulations may influence the lack of an effect on halibut spawning biomass. The simulations suggest that the SSB will increase after an initial decline with or without trawl mortality, thus the dynamics of the population model are predicting an increasing SSB regardless of PSC usage. Migration and recruitment from areas outside of GOA may drive this. Also, weight-at-age has a great influence on SSB and is considered to be below average at the start of these simulations. It is worth noting that with the recent IPHC SPR-based harvest policy which accounts for mortality of all sizes and from all sources, the coastwide TCEY balances the PSC usage with the directed fishery coastwide mortality. This balance likely contributes to there being minor long-term effects on the coastwide halibut spawning biomass.

5.4 Groundfish stocks

The extent to which changes in PSC limits and subsequent usage will affect groundfish stocks are anticipated to be minor and similar across all the alternatives. This is because the groundfish assessments are carried out each year, along with the fisheries being 100% covered by scientific observers, monitoring the groundfish stocks closely and modifying catch limits accordingly. The extent that new restrictions on Pacific halibut PSC change the spatial and temporal distribution of groundfish fisheries is difficult to predict. Limited evaluations of spatial bycatch patterns shown in Chapter 3 suggest variability across years. The extent that this variability was due to changes in PSC limits since 2015 is unknown. However, the patterns suggest that the areas fished remained relatively similar during the analyzed period,

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[67] October 2020 DEIS

suggesting that the directed groundfish fisheries will operate in similar areas and have access to similar species groups and groundfish size compositions. Changes in the general groundfish conservation status and management seem unlikely to be caused by changes in the determination of Pacific halibut PSC limits.

5.5 Revenue impact estimation

This section provides an analysis of the relationship between halibut PSC limits and direct revenues generated by the Amendment 80 sector. This section also gauges the relative indirect effect of the considered alternatives on directed halibut fishery catch in the BSAI region. Revenue estimates in this section are reported in gross first wholesale value for A80 and ex-vessel value for BSAI commercial halibut. To demonstrate the best defensible direct comparison between the fisheries, as requested in previous reviews, total halibut revenues also reported in terms of estimated wholesale values. This is not a straightforward calculation due to limited data sources, as described in Section 4.4.1.1. The analysts do not attempt to present an analogous conversion of A80 wholesale revenue to ex-vessel value. Section 3.3.2.1 described the analysts position on why ex-vessel values are not an appropriate unit to characterize revenues for a catcher/processor fishery. In short, there is no actual ex-vessel transaction price generated from the sale of raw fish by an A80 harvester to a primary processor. Also, the variety of species that make up A80 fishery catch – and their different value-added profiles and recovery rates – reduce the accuracy of any proxy ex-vessel value estimate that is based on a common conversion factor (multiplier).

The revenue estimates reported in this section do not represent the full scope of the economic impacts associated with the proposed action alternatives. This document does not incorporate generally understood but poorly quantified economic multipliers that would allow for an estimate of the total economic contributions of the A80 fishery or the directed halibut fishery in terms of output, income, employment or other economic measures. The broad, downstream economic impacts of commercial fishing can be understood and appreciated without drawing an equivalency between metrics or existing studies that have fundamentally different scopes. Previous studies have estimated economic multipliers for the A80 fishery and quantified economic contributions across multiple geographic regions.[68] More current models are being developed by both the Alaska Fisheries Science Center (Seung, et al. 2020) and the International Pacific Halibut Commission (Hutniczak 2020) to estimate economic multipliers that are specific to Alaska fisheries. These models employ a similar methodology, extending an input-output (IO) model to a multi-regional social accounting matrix (MRSAM) that links across industries to estimate the total economic impacts of an economic shock – in this case, increased or reduced harvesting revenues.

The AFSC model (Seung, et al. 2020) is a 10-region social accounting matrix that estimates impacts across six southwest Alaska boroughs and census areas (Aleutians West Census Area, Aleutians East Borough, Lake and Peninsula Borough, Bristol Bay Borough, Dillingham Census Area, and Kodiak Island Borough) as well as the rest of the State of Alaska, the West Coast (Washington, Oregon and California), the rest of the U.S., and a "region" representing at-sea catcher-processors and motherships operating in Southwest Alaska-region waters (Western Bering Sea, Aleutian Islands and Gulf of Alaska).

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[68] For example, Waters et al. (2014) estimated that the "A80 H&G sector's $281 million of first wholesale revenues produced in 2008 generated approximately $1 billion of total output and accounted for an estimated 6,800 total jobs in Alaska, the West Coast and the rest of the US (including the H&G sector's estimated 2,200 total employees)." The paper also estimated the impacts of a reduction in revenues from 2008 to 2009 of $41 million, or 14.5%, resulted in resulted in an estimated reduction of $150 million in total output, distributed as $72 million in Alaska, $26 million in the west coast and $52 million in the rest of the US. This change in total output generated estimated reductions of $82 million in total value added, $41 million in total labor income, $50 million in total household income, $12 million in total state and local government revenue, and about 1,000 total jobs in the three regions. The analysts of this document would surmise that the multipliers cited in the study, based on 2008 and 2009 data, likely underestimate the economic impact of the A80 sector in its current form as the fleet has increased its efficiency and productivity through vessel modernization and full cooperative participation since that time.

This is an update of a previous 3-region model (Seung and Miller 2018) that will more accurately represent impacts on smaller, fishing-dependent areas such as boroughs and census areas or fishing communities. In order to characterize impacts at a community scale, researchers conducted primary data collections in the form of surveys and key informant interviews to collect specific information on employment, revenues and expenditures (intermediate inputs) by participating vessels and processors. The SSC reviewed the previous 3-region version of the MRSAM model during its February 2020 meeting and noted that the authors no longer considered the 3-region model appropriate for use in Council analyses. The SSC requested the opportunity to review the 10-region version of the model before it is used in any analyses of Council actions. Review of the 10-region model is tentatively scheduled for February 2022, thus is it not available at this time.

The IPHC adopted a similar methodology to develop a MRSAM model, the Pacific Halibut Multiregional Economic Impact Assessment (PHMEIA). The PHMEIA will describe economic interdependencies between sectors and regions with the specific purpose of assessing the economic contribution of the Pacific halibut resource to the economy of the United States and Canada (Hutniczak, 2020). The PHMEIA models impacts across six regions: Alaska, the West Coast (WA, OR and CA), British Columbia, the rest of the US, the Rest of Canada and the Rest of the world. Preliminary results were presented at the 2021 IPHC Annual Meeting.[69] However, the principal investigator notes that: "…the current version of the model is based solely on secondary data sources. As such, the results are conditional on the adopted assumptions for the components for which data were not available. In order to improve the accuracy of the assessment, the IPHC intends to incorporate into the model primary economic data collected directly from members of Pacific halibut dependent sectors… The subsequent revisions of the model incorporating IPHC-collected data will bring improved estimates on the Pacific halibut sectors' economic impact." (Hutniczak, 2020).

The IPHC is currently conducting primary data collection in the form of surveys to commercial harvesters, processors, and charter business owners. The addition of primary data from the survey results is expected to substantially improve the accuracy of the model, particularly regarding modeling the linkages and variations between regions (B. Hutniczak, personal communication, March 1, 2021). Additionally, the in-progress PHMEIA model estimates economic impacts based on region wide shocks which may be less informative to the relative impacts of action alternatives that are specific to Area 4CDE.

Given the preliminary state of both the AFSC (10-region SAM) and IPHC (PHMEIA) models, and pending SSC review that was requested, these models are not used to estimate regional economic impacts for this analysis.

5.5.1 Analytical approach for Amendment 80 impacts

The analysts used a resampling approach to estimate a range of potential annual revenue totals for the A80 groundfish fishery under various PSC limits. The underlying data used for this analysis are NMFS observer data and NMFS Catch Accounting data that include date, groundfish target, metric tons of groundfish catch, wholesale value in 2018 dollars, and halibut PSC in metric tons for each haul by A80

[69] "The preliminary results suggest that the region-wide Pacific halibut commercial fishery's total estimated impact in 2018 amounts to USD 281 mil. (CAD 364 mil.) in GDP, USD 176 mil. (CAD 228 mil.) in labor income (including estimated USD 21.5 mil. (CAD 27.9 mil.) in wages in the Pacific halibut fishing sector), 4,453 in jobs, and USD 179 mil. (CAD 232 mil.) in household income, and over USD 666 mil. (CAD 863 mil.) in output. This is about 5.1 times the fishery output value of USD 129 mil. (CAD 168 mil.) recorded for 2018 (DFO, 2020; NOAA, 2020a). The estimate is the total economic impact, the sum of the direct, indirect, and induced effects from changes to the Pacific halibut fishing sector, as well as indirect and induced effects associated with forward-linked industries (e.g., the Pacific halibut processing sector) … These results are based on **the current version of the model incorporating only secondary data sources**. As such, **the results are conditional on the adopted assumptions for the components for which data were not available and are subject to change"** (Hutniczak, 2020).

vessels from 2010 through 2019 (see Table 5-1 for annual summaries of data). In 2015, as part of an Exempted Fishing Permit, deck sorted halibut were reported through logbooks rather than the observer data, therefore 2015 data at the haul level are not comparable to other years and are excluded from this analysis. In this section, when a time period of data is referred to as 2010-2019 it is actually 2010-2014 and 2016-2019.

Table 5-1 Annual totals of the underlying haul-by-haul data used for the revenue estimation. *2020 data are preliminary and revenue data are not yet available.

Year	Groundfish catch (mt)	Wholesale value ($ 2018)	PSC (mt)	Hauls
2010	305,241	323,870,339	2,254	12,507
2011	302,157	385,153,549	1,810	11,163
2012	307,406	397,530,330	1,944	10,892
2013	306,775	307,582,132	2,166	11,338
2014	308,022	316,928,372	2,178	11,702
2015	Not used due to reporting structure			
2016	298,449	306,505,259	1,412	14,167
2017	278,771	359,357,539	1,167	13,821
2018	290,173	379,443,654	1,343	15,908
2019	288,302	335,260,125	1,458	16,574
2020*	290,382	Not available	1,097	14,430

For hauls prior to 2015 or from 2016-2019 where deck sorting was not utilized, haul-level PSC is estimated by applying the appropriate DMR to the observed incidental catch of halibut in the factory (See Section 3.2.2.1 for description of halibut DMR estimation methods and Table 3-7 for DMRs). For hauls where decksorting occurred, halibut PSC is calculated as the sum of the estimates of the mortality observed on deck and in the factory. For the deck mortality estimate, the observer identifies the viability of the halibut in a simple random sample and applies a weighted average DMR based on the weight of halibut at each viability level.[70] For factory halibut mortality, the weight of halibut in an observer's species composition samples in the factory are extrapolated to the entire haul. In 2015 through 2017, a standard DMR of 90% was applied to the halibut recovered in the factory. Beginning in 2018, a DMR is applied to the halibut recovered in the factory based on DMRs published in harvest specification tables in the Federal Register (Table 3-7).

The haul-level wholesale value is calculated by multiplying a round wholesale value to the weight of catch by species as reported in Catch Accounting. The round wholesale value is estimated by matching the price reported in COAR Production by product type, species and processor to the weekly production reports (WPR). If a match at the processor, species and product type is not achieved then an algorithm matches at different levels of aggregation of products and species from the same processor. If products are still not priced then the algorithm will look for matches across other processors and further aggregate products and species. The WPR include the product weight and round weight, allowing the COAR price to be converted to a round wholesale value in the WPR that is then applied to the Catch Accounting weight.

From the haul-by-haul data, the analysts randomly sampled hauls without replacement and summed the combined wholesale value, groundfish catch, and halibut PSC until either the total halibut PSC reached the PSC limit or the total groundfish catch reached a predetermined limit (representing a hypothetical groundfish catch limit that is in the range of recent TAC and catch history). The total wholesale value summed across hauls when the PSC limit or groundfish catch limit is reached is the estimated annual revenue for the A80 fleet under that specific PSC limit. Under this random sampling method, hauls are selected at random regardless of when they occurred throughout the year. In scenarios when the annual

[70] The conditional mortality probabilities for halibut sorted on deck are 20% for "Excellent," 55% for "Poor," and 90% for "Dead"

effort is reduced, it is reduced proportional to the temporal distribution of the underlying data. This resampling was repeated 500 times creating 500 different combinations of resampled hauls, or “years,” under each PSC limit. Nine PSC limits are used in these resampling scenarios ranging from 960 mt to 2,007 mt, corresponding to limits that are specified in the lookup table for each alternative (Table 5-2).

Table 5-2 PSC limits used in revenue estimates and the associated Alternatives and look-up table states

PSC limit	960	1047	1222	1309	1396	1483	1571	1745	2007
Alternative(s)	4	4	3	3	2,3,4	2	2	1,2,3,4	3

PSC limits and use varied over the last 10 years (Figure 5-4). To capture this underlying variation in the fishery, analysts subset the haul data into three datasets drawing from different time periods that represent (1) high PSC use years (2010-2014), (2) all years (2010-2019, excluding 2015), and (3) low PSC use years (2016-2019). Analysts conducted the resampling analyses on each dataset separately. For each time period, analysts varied the groundfish catch limits to reflect maximum groundfish catch in the three most recent years (290,000 mt) and maximum groundfish catch throughout the decade (310,000 mt). This results in a total of ten “scenarios” that represent the range of possible outcomes for each of the nine PSC limits (five time periods or “datasets” x two catch limits).

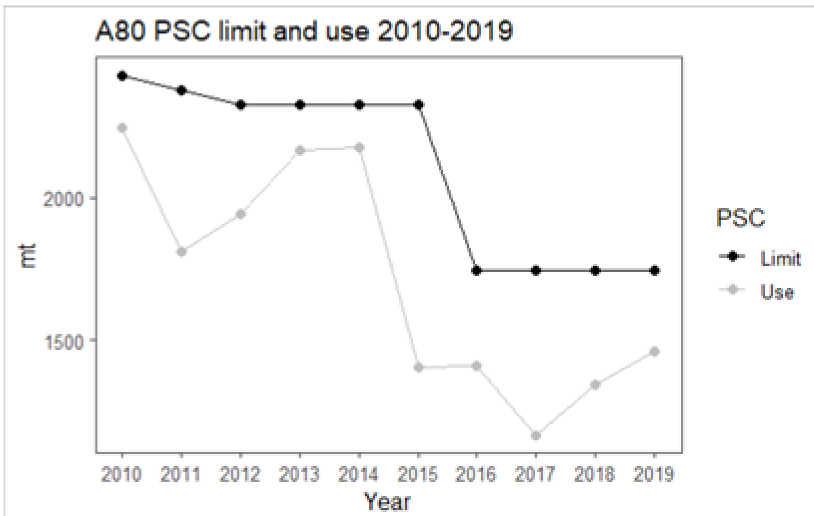

Figure 5-4 PSC limits and PSC use (metric tons) for the A80 sector, 2010 through 2019

The analysts did not predetermine a relationship between PSC use and the PSC limit to estimate revenue impacts. Rather, hauls were resampled until either the total PSC mortality reached the PSC limit (from the look-up tables) or the total groundfish catch reached the groundfish limit (290k or 310k metric tons). This approach functions as an implicit assumption that 100% of PSC use is possible, although 100% PSC use is not met in scenarios where the groundfish limit is met before 100% of the PSC limit is reached. Figure 5-5 shows the relationship between PSC use and the PSC limit (top panel) and groundfish catch and the groundfish catch limit (bottom panel) in the different scenarios for a PSC limit of 1,745 (status quo). The top panel shows the distribution of PSC use in all scenarios. The PSC limit of 1,745 is represented by the red vertical line. When the grey bar stacks up against the red bar, 100% of the PSC limit was caught and the PSC limit was constraining. This is evident in the high PSC use scenario (2010-2014 data) under either groundfish limit (290k and 310k) and for 2010-2019 data with a 310k groundfish limit. The 2010-2019 data with a 290k groundfish limit is constrained by the PSC limit in some runs, but not all. The lower panel shows the distribution of groundfish catch with the red line representing the groundfish limit.

The groundfish limit is constraining in the scenarios where the PSC limit was not constraining (the opposite of the top panel).

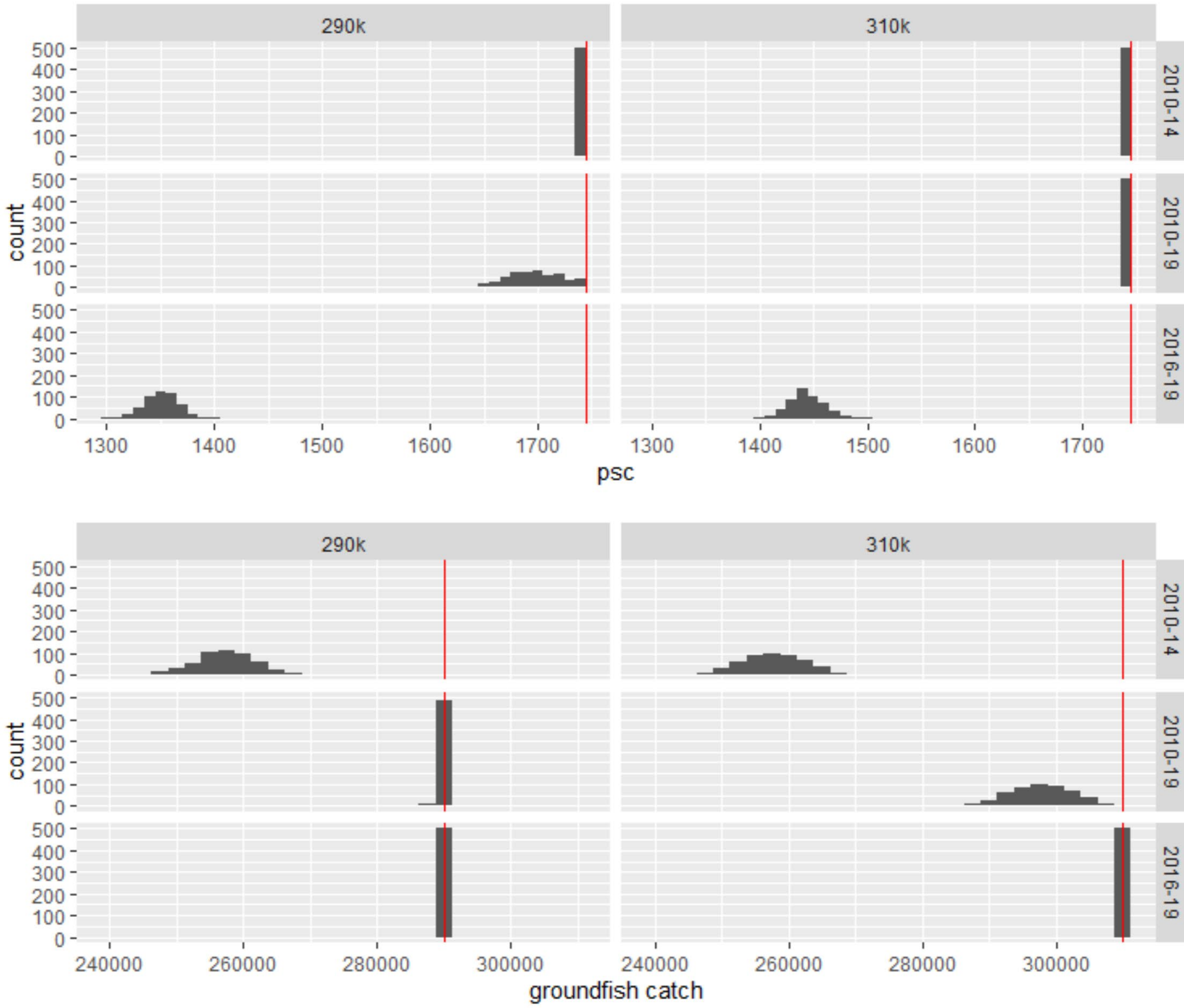

Figure 5-5 **Distribution of PSC use (top panel) and groundfish catch (bottom panel) under each imposed groundfish catch limit (290k and 310k) for simulations of the status quo 1,745 t PSC limit. PSC limit and groundfish limits are indicated by the vertical red lines.**

5.5.1.1 Additional analysis subsequent to October 2020 review

The following analyses were not part of the DEIS reviewed by the Council in October 2020. First, two additional year combinations were added to this analysis to more fully estimate the possible range of outcomes: data from 2017-2018 were combined to capture the years where PSC was low and revenue was high. This provides an upper bound example from the "best case" in the data. Data from 2013-14 were combined to capture the years where PSC was high and revenue was low to provide a lower bound example from the "worst case" in the data. These new year-combinations are only estimated using the random sampling method. Second, a stratified resampling approach was added to the document in response to SSC comments. This method stratifies the data by the month in which the haul occurred and resamples a number of hauls equal to the maximum hauls that occurred in that month during the years of the dataset (see Figure 5-6 for haul by month). Annual total revenues, groundfish, and PSC are summed over hauls in the order of the month in which they occur (starting with January), until the PSC limit or groundfish catch threshold is reached.

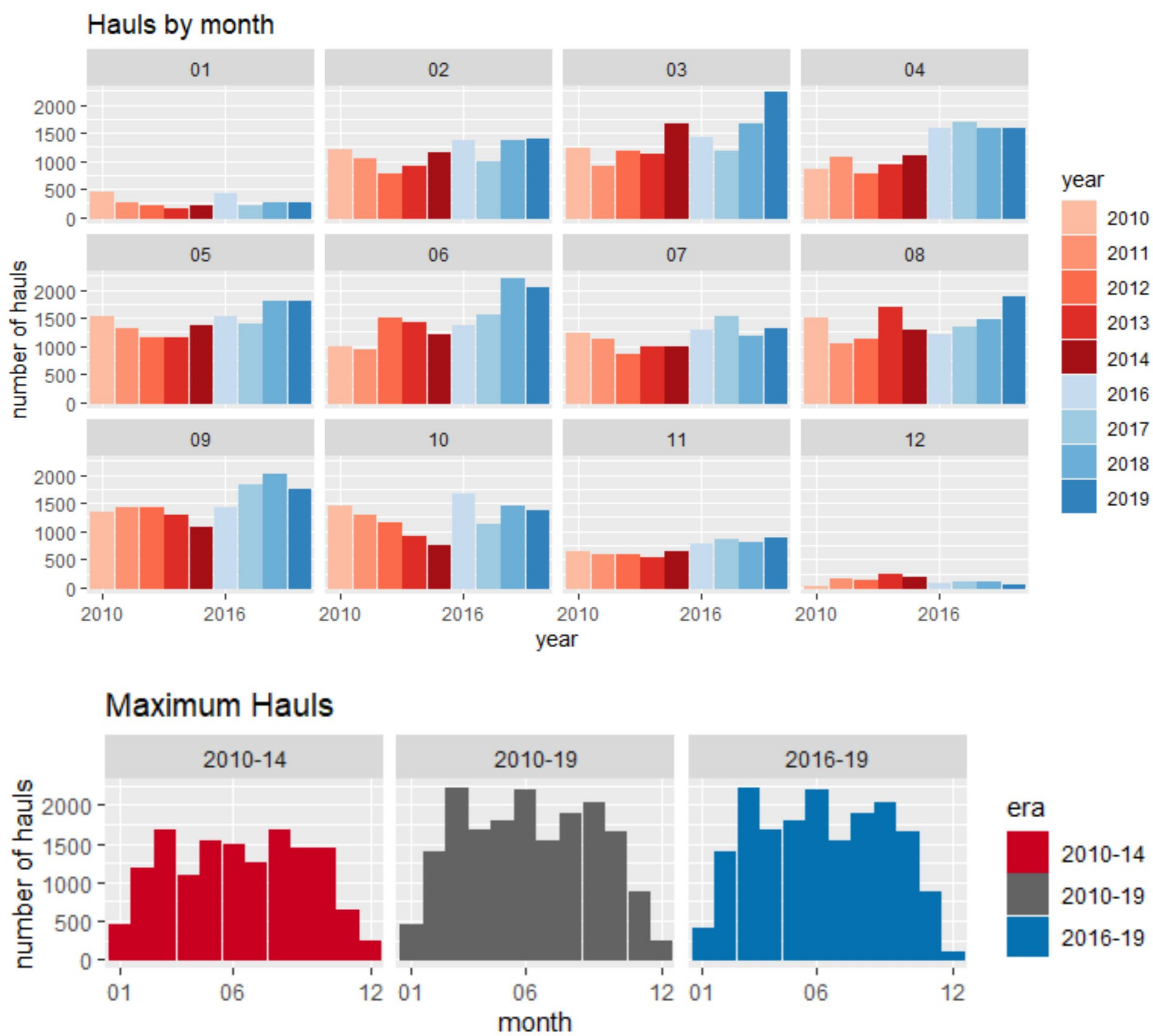

Figure 5-6 **Number of hauls per month by year from 2010 through 2019 (top panel) and maximum hauls by month in grouped datasets from underlying data used for the groundfish revenue analysis (bottom panel)**

Under the stratified sampling method, the represented effort is curtailed from the end of the year (backwards in time) for scenarios where effort is reduced by a PSC constraint. This means that hauls occurring earlier in the year are represented in the resampled data at the same effort levels as in the underlying data; later hauls are sampled at a reduced effort rate, if at all. Figure 5-7 shows the cumulative groundfish catch and PSC throughout each year, with vertical lines representing the new PSC limits and horizontal lines representing the imposed groundfish limits. In the stratified sampling scenario, the general effect is that hauls are only sampled if they occur below the groundfish threshold and to the left of the PSC limit.

In reality it is not likely that, under new PSC limits, fishing effort in terms of hauls would continue in the same frequency by month throughout the year as in previous years until constrained by the new limits. However, the stratified approach is included to demonstrate a “business-as-usual” scenario that can be used as an informative benchmark to compare to the results from the random resampling method.

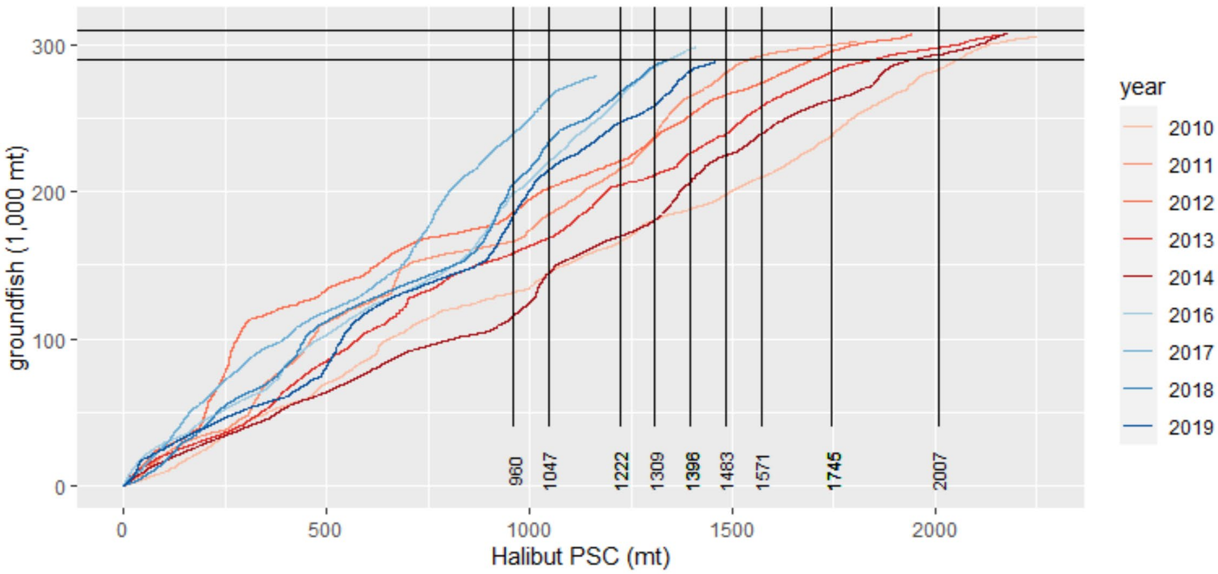

Figure 5-7 Cumulative groundfish catch and halibut PSC for 2010 through 2019. Black horizontal lines represent groundfish limits of 290k and 310k metric tons; vertical lines represent PSC limits in the Alternatives (look-up tables)

Figure 5-8 shows the distribution of hauls by week in the underlying data compared to those of the resampled runs for the scenarios representing the lower and upper bounds under the random approach in the middle panel, and compared to the stratified approach in the bottom panel. The distribution is displayed in kernel density estimates, which can be thought of as a smoothed-out histogram; higher "bumps" correspond to more observations within the fishery data (color) or the simulated results (black). The lower bound is represented by the scenario with a PSC limit of 960 t (the look-up limit under a Very Low setline survey and a Low trawl survey in Alternative 4), a groundfish catch limit of 290,000 t (the lower of the two groundfish catch thresholds) and data from 2010-2014 (the higher PSC-use years). The upper bound is represented by the scenario with a PSC limit of 2,007 t (the look-up limit when both surveys are in a High state in Alternative 3), a groundfish catch limit of 310,000 t (the larger of the two thresholds) and data from 2016-2019 (the lower PSC-use years). The random resampled data generally follow similar temporal effort distributions as those in the underlying data and there is no substantial difference in distribution between the lower and upper bound scenarios. In the stratified approach it is clear that the early season effort is sampled and the later season effort is not – particularly in the lower bound scenario – although end of the year effort is still slightly curtailed in the upper scenario.

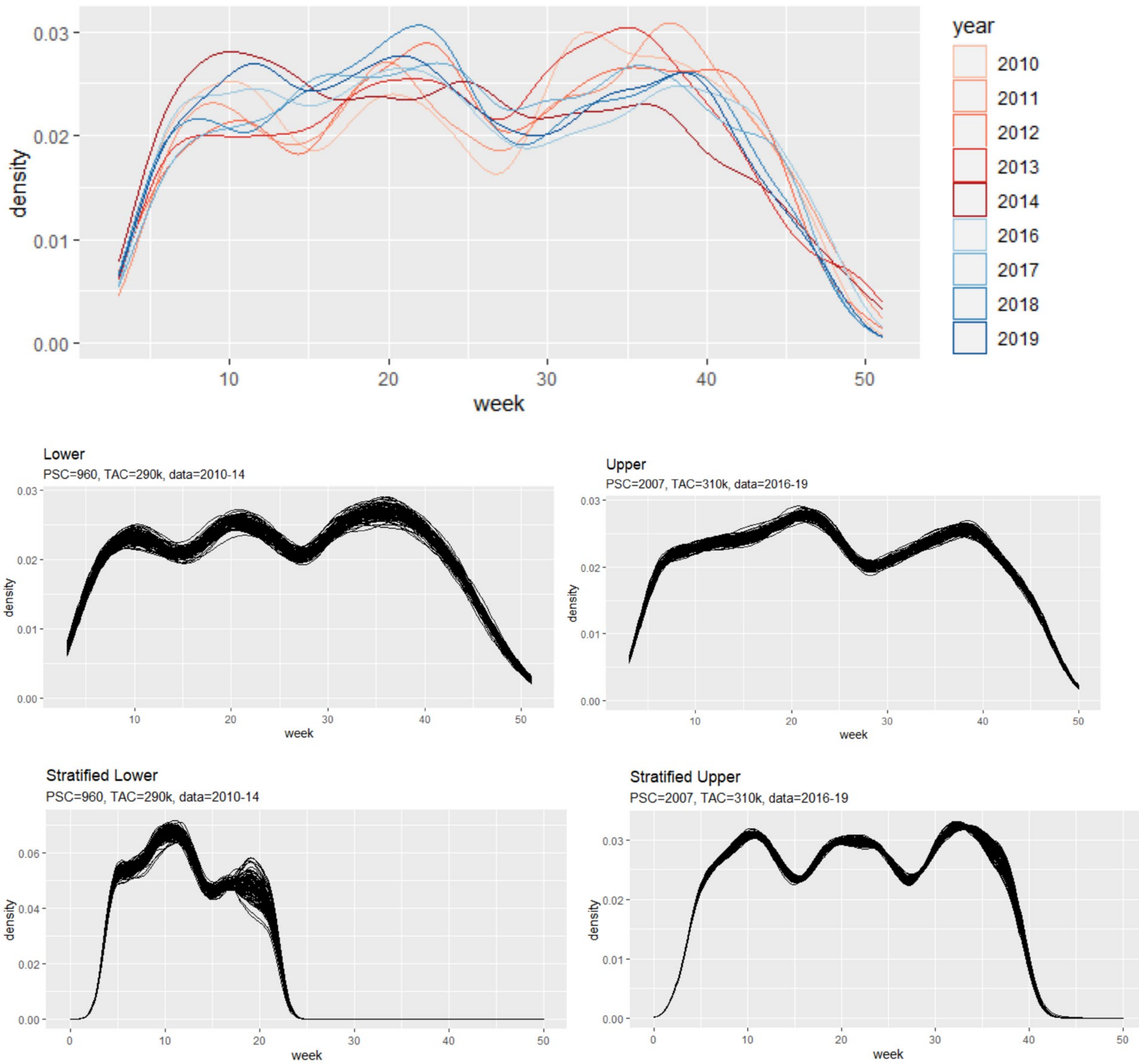

Figure 5-8 **Distributions of hauls by week. Top panel = underlying data; middle panels = random sampled runs of lower and upper scenarios; bottom panels = stratified resampled runs of lower and upper scenarios**

5.5.2 Amendment 80 sector revenue estimate results

The revenue estimates reported in this section should be read for comparison across alternatives. These results are not stand-alone predictions of future A80 revenues under each PSC limit. Harvesters are expected to make strategic choices that are different from the randomized or stratified selection of hauls used in this analysis. The analysts estimated annual revenue, PSC use, and groundfish catch under a variety of scenarios for each of nine PSC limits identified in the alternatives. These estimates are meant to illustrate the potential impact of different variables on revenue – for example, how changing the groundfish catch limit by 20 metric tons or changing sector-level PSC use might affect estimated sector-level revenue. The range of estimates under each dataset (years sampled) should be considered when comparing alternatives. The different datasets (2010-14, 2010-19, 2016-19, 2013-14 and 2017-18) represent different levels of PSC use. The relevance of the estimates resulting from each of these datasets depends on numerous variables including, but not limited to, environmental conditions (i.e., aggregation of halibut and overlap with target species) and fleet behavior (i.e., prevalence of halibut avoidance strategies such as deck sorting). It is important for the reader to keep in mind that results are aggregated at the A80 sector level; the distribution of impacts across companies and vessels will certainly differ based on many factors, most notably a company's species allocation portfolio and whether it is relatively more dependent on species that tend to carry a higher halibut PSC rate. Background information on the A80 sector that frames the consideration of internal distributional impacts is provided in Section 3.3.

The results are summarized in the following tables and figures. The specific effects of each variable and sampling method as well as a discussion of the results across alternative and assumptions of the analytical approach are included in the subsections that follow.

Table 5-3 through Table 5-5, below, display the average estimated PSC use, revenue, and groundfish catch limit organized by the PSC limits that appear in the alternatives (look-up tables). Unsurprisingly, lower PSC limits tend to result in reduced groundfish catch and revenue. Reductions in sector revenues are exacerbated under the high-use datasets (2010-2014, 2013-2014) and minimized in the low-use datasets (2016-19, 2017-18). Output estimates under higher PSC limits are more likely constrained by the groundfish catch limit (as demonstrated by blue shading in the tables) while those under lower PSC limits are more likely constrained by the PSC limit (demonstrated by green shading in the tables).

Figure 5-9 displays estimated revenue by PSC limit for each dataset under both the random and stratified sampling methods and under both considered groundfish limits. Annual totals from the underlying data are indicated by the black text for comparison purposes (10, 11, … 19). Proposed PSC limits are listed on the x-axis for reference. Figure 5-10 displays the estimated revenue across all PSC limits in each alternative, by dataset groundfish limit and sampling method.

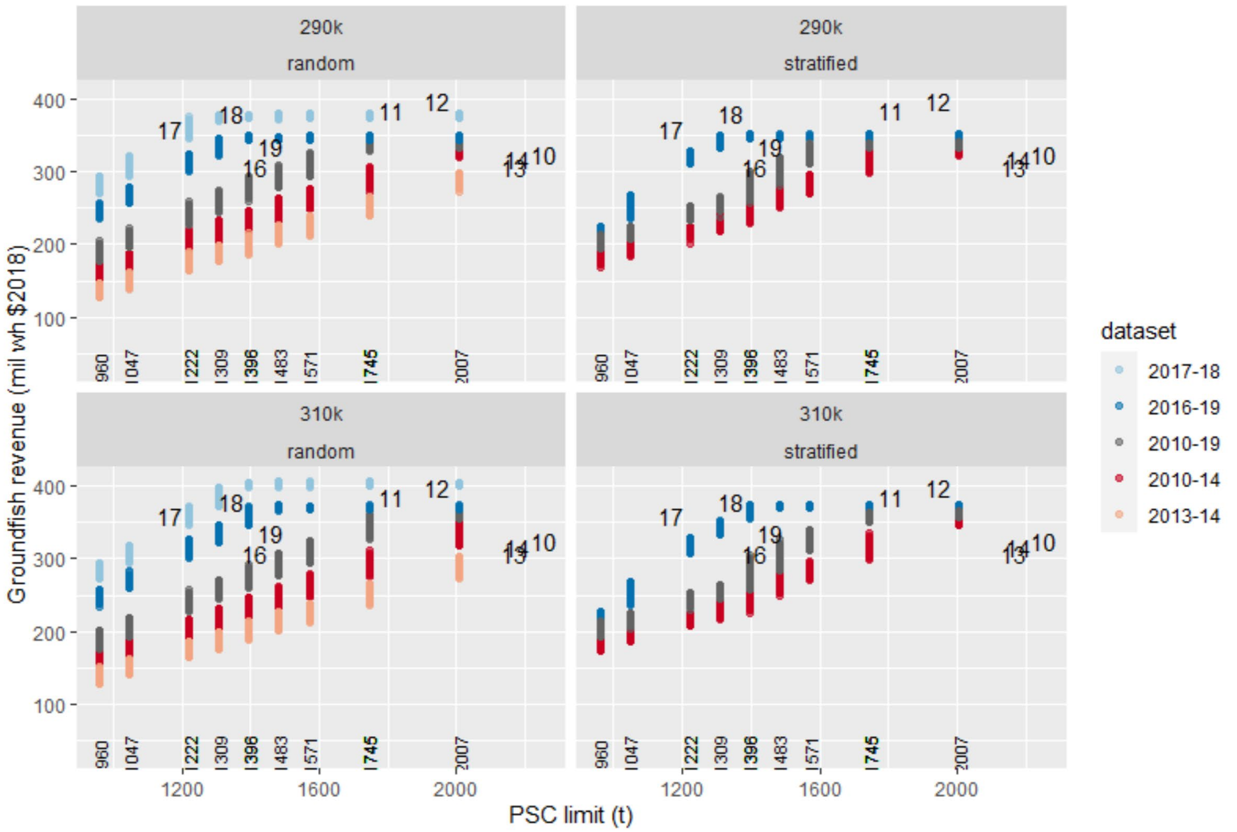

Figure 5-9 Estimated revenue by PSC limit for each dataset under both the random and stratified sampling method and both groundfish catch thresholds. Yearly totals from the underlying data are indicated by the black text (10-19) for comparison purposes. Proposed PSC limits are listed on the x-axis for reference.

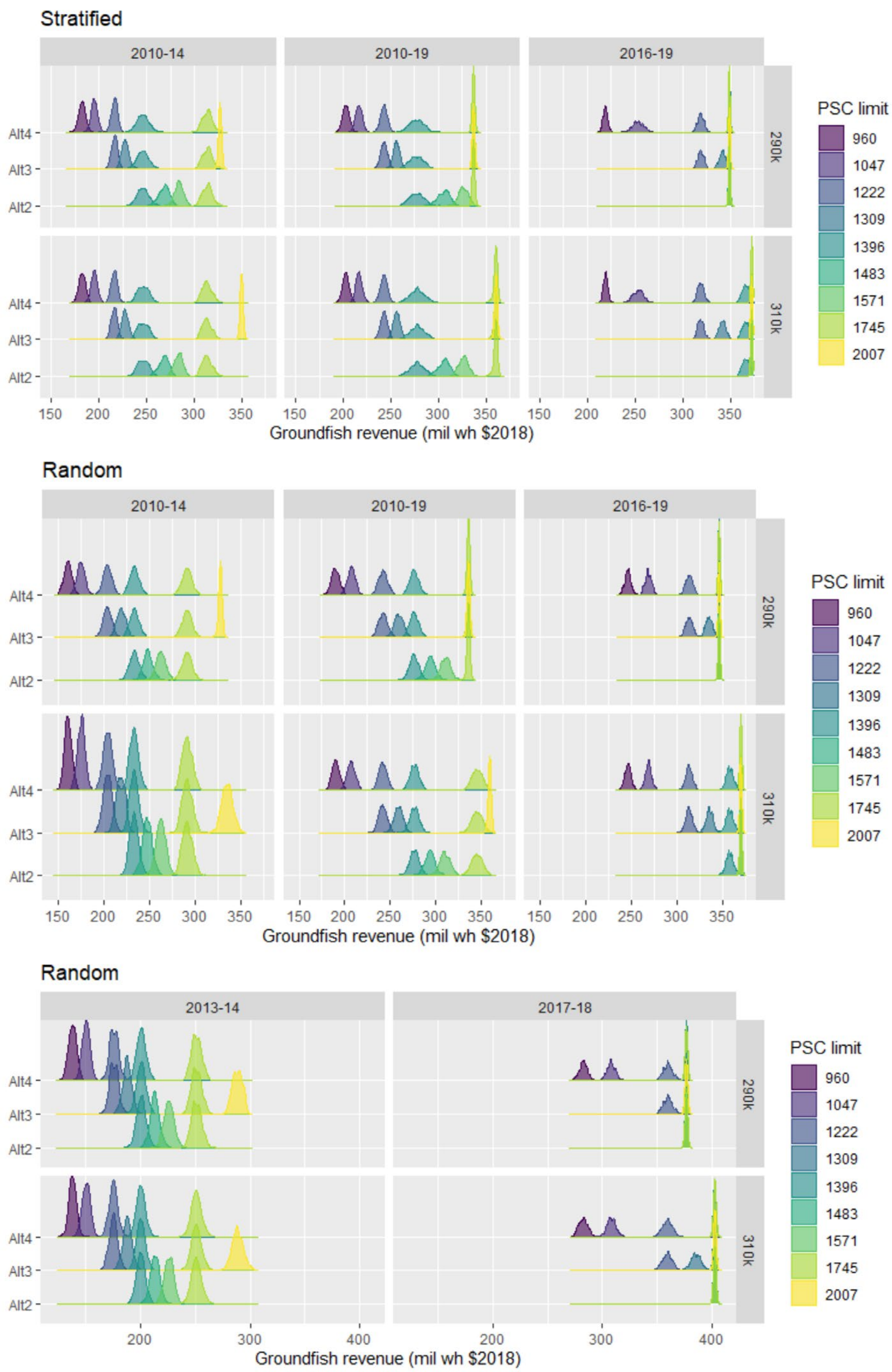

Figure 5-10 Estimated Amendment 80 sector gross wholesale revenue (2018$) associated with PSC limits specified in the look-up tables by Alternative. Top panel uses stratified sampling method; middle and bottom panels use the random sampling method. Dataset is listed across top and groundfish limit is listed on the right of each panel.

Table 5-3 Average estimated groundfish catch (1,000 t) by PSC limit and Alternative using different estimation methods. Green shading indicates the results were constrained by the PSC limit, blue shading indicates the results were constrained by the groundfish limit (290,000 or 310,000 t).

Estimation method	PSC limit	960		1047		1222		1309		1396		1483		1571		1745		2007	
	Alternative(s)	4		4		3		3		2,3,4		2		2		1,2,3,4		3	
	GF limit (1,000 t)	290	310	290	310	290	310	290	310	290	310	290	310	290	310	290	310	290	310
Random	2010-14	141.87	142.08	154.64	154.84	180.30	180.60	193.62	193.18	206.31	206.06	219.45	218.93	232.20	232.01	257.39	257.73	289.83	296.41
	2010-19	163.68	164.03	178.98	178.64	208.84	208.68	223.74	223.47	238.37	238.53	253.43	253.17	268.16	267.55	289.89	297.92	289.98	309.98
	2016-19	206.15	206.20	225.00	225.06	262.45	262.51	280.97	281.14	289.99	299.95	289.98	309.98	289.99	309.99	289.99	309.99	289.99	309.99
	2013-14	135.87	135.96	148.12	148.27	173.09	172.68	185.01	185.05	197.65	197.23	209.83	209.77	222.39	222.41	247.19	247.13	283.86	283.97
	2017-18	217.60	217.53	237.19	237.22	277.07	276.67	289.96	296.63	289.99	309.97	289.99	309.99	289.99	309.99	289.99	309.99	289.99	309.99
Stratified	2010-14	167.26	167.25	179.74	179.73	199.56	199.38	209.93	209.99	223.89	224.00	240.13	239.85	252.87	252.54	278.24	278.01	289.98	309.98
	2010-19	179.03	178.93	191.50	191.57	214.87	214.88	226.38	226.65	243.07	243.71	264.26	264.35	281.00	281.28	289.98	309.59	289.98	309.98
	2016-19	184.07	184.22	210.79	210.86	264.14	264.04	283.60	283.57	289.99	304.60	289.99	309.98	289.99	309.98	289.99	309.99	289.99	309.98

Table 5-4 Average estimated PSC use (t) by PSC limit and Alternative using different estimation methods. Green shading indicates the results were constrained by the PSC limit, blue shading indicates the results were constrained by the groundfish limit (290,000 or 310,000 t).

Estimation method	PSC limit	960		1047		1222		1309		1396		1483		1571		1745		2007	
	Alternative(s)	4		4		3		3		2,3,4		2		2		1,2,3,4		3	
	GF limit (1,000 t)	290	310	290	310	290	310	290	310	290	310	290	310	290	310	290	310	290	310
Random	2010-14	960	960	1,047	1,047	1,222	1,222	1,309	1,309	1,396	1,396	1,483	1,483	1,571	1,571	1,745	1,745	1,960	2,007
	2010-19	960	960	1,047	1,047	1,222	1,222	1,309	1,309	1,396	1,396	1,483	1,483	1,571	1,571	1,698	1,745	1,699	1,817
	2016-19	960	960	1,047	1,047	1,222	1,222	1,309	1,309	1,350	1,396	1,349	1,443	1,350	1,443	1,350	1,443	1,350	1,443
	2013-14	960	960	1,047	1,047	1,222	1,222	1,309	1,309	1,396	1,396	1,483	1,483	1,571	1,571	1,745	1,745	2,006	2,007
	2017-18	960	960	1,047	1,047	1,222	1,222	1,280	1,309	1,279	1,367	1,280	1,368	1,278	1,368	1,281	1,368	1,280	1,368
Stratified	2010-14	959	959	1,047	1,047	1,222	1,222	1,309	1,309	1,396	1,396	1,483	1,483	1,571	1,571	1,745	1,745	1,808	1,911
	2010-19	960	959	1,047	1,047	1,222	1,222	1,309	1,309	1,396	1,396	1,483	1,483	1,571	1,571	1,620	1,719	1,619	1,721
	2016-19	960	960	1,047	1,047	1,222	1,222	1,309	1,309	1,337	1,396	1,338	1,419	1,338	1,420	1,337	1,421	1,337	1,419

Table 5-5 Estimated revenue (million wholesale $2018) by PSC limit and Alternative using different estimation methods. Green shading indicates the results were constrained by the PSC limit, blue shading indicates the results were constrained by the groundfish limit (290,000 or 3310,000 t).

Estimation	PSC limit	960		1047		1222		1309		1396		1483		1571		1745		2007	
	Alternative(s)	4		4		3		3		2,3,4		2		2		1,2,3,4		3	
	GF limit (1,000 mt)	290	310	290	310	290	310	290	310	290	310	290	310	290	310	290	310	290	310
Random	2010-14	160.582	160.815	174.982	175.215	204.050	204.313	219.181	218.550	233.493	233.235	248.384	247.668	262.813	262.705	291.338	291.603	327.968	335.497
	2010-19	189.686	190.121	207.396	206.935	241.993	241.715	259.314	258.923	276.215	276.468	293.723	293.380	310.690	310.046	335.887	345.264	335.937	359.123
	2016-19	246.206	246.385	268.807	268.887	313.489	313.519	335.524	335.829	346.417	358.232	346.366	370.300	346.425	370.269	346.417	370.311	346.454	370.271
	2013-14	137.994	138.184	150.453	150.591	175.812	175.384	187.950	187.992	200.795	200.295	213.141	213.202	225.934	225.979	251.137	251.123	288.273	288.545
	2017-18	282.581	282.479	307.928	308.073	359.795	359.146	376.517	385.223	376.582	402.458	376.509	402.584	376.623	402.591	376.558	402.546	376.604	402.554
Stratified	2010-14	182.258	182.272	195.088	195.065	216.307	216.059	227.666	227.668	246.072	246.276	268.338	267.997	283.966	283.479	313.799	313.520	327.054	349.666
	2010-19	202.931	202.828	216.382	216.445	242.752	242.719	255.780	256.090	277.083	277.964	305.385	305.515	326.047	326.307	336.782	360.053	336.793	360.511
	2016-19	218.741	218.978	253.143	253.251	319.090	318.907	341.704	341.720	349.070	366.178	349.027	372.528	349.165	372.536	349.034	372.499	349.147	372.479

Table 5-6 **Estimated status quo revenues (millions wholesale $2018) and percent difference from status quo by Alternative and PSC limit based on survey states. Percent differences are calculated across the rows (comparing estimates using same methods and datasets)**

Estimation method	EBS Trawl Survey				Low		High		Low		High		Low		High		Low		High	
	Setline survey				Very Low		Very Low		Low		Low		Medium		Medium		High		High	
	PSC limit	1745			1396		1483		1396		1483		1483		1571		1571		1745	
	GF limit (1,000 t)	290	310		290	310	290	310	290	310	290	310	290	310	290	310	290	310	290	310
Random	2010-14	291.338	291.603	Alternative 2	-20%	-20%	-15%	-15%	-20%	-20%	-15%	-15%	-15%	-15%	-10%	-10%	-10%	-10%	0%	0%
Random	2010-19	335.887	345.264	Alternative 2	-18%	20%	-13%	-15%	-18%	-20%	-13%	-15%	-13%	-15%	-8%	-10%	-8%	-10%	0%	0%
Random	2016-19	346.417	370.311	Alternative 2	0%	-3%	0%	0%	0%	-3%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Random	2013-14	251.137	251.123	Alternative 2	-20%	-20%	-15%	-15%	-20%	-20%	-15%	-15%	-15%	-15%	-10%	-10%	-10%	-10%	0%	0%
Random	2017-18	376.558	402.546	Alternative 2	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Strat.	2010-14	313.799	313.520	Alternative 2	-22%	-21%	-14%	-15%	-22%	-21%	-14%	-15%	-14%	-15%	-10%	-10%	-10%	-10%	0%	0%
Strat.	2010-19	336.782	360.053	Alternative 2	-18%	-23%	-9%	-15%	-18%	-23%	-9%	-15%	-9%	-15%	-3%	-9%	-3%	-9%	0%	0%
Strat.	2016-19	349.034	372.499	Alternative 2	0%	-2%	0%	0%	0%	-2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	PSC limit	1745			1222		1309		1309		1396		1396		1745		1745		2007	
	GF limit (1,000 t)	290	310		290	310	290	310	290	310	290	310	290	310	290	310	290	310	290	310
Random	2010-14	291.338	291.603	Alternative 3	-30%	-30%	-25%	-25%	-25%	-25%	-20%	-20%	-20%	-20%	0%	0%	0%	0%	13%	15%
Random	2010-19	335.887	345.264	Alternative 3	-28%	-30%	-23%	-25%	-23%	-25%	-18%	-20%	-18%	-20%	0%	0%	0%	0%	0%	4%
Random	2016-19	346.417	370.311	Alternative 3	-10%	-15%	-3%	-9%	-3%	-9%	0%	-3%	0%	-3%	0%	0%	0%	0%	0%	0%
Random	2013-14	251.137	251.123	Alternative 3	-30%	-30%	-25%	-25%	-25%	-25%	-20%	-20%	-20%	-20%	0%	0%	0%	0%	15%	15%
Random	2017-18	376.558	402.546	Alternative 3	-4%	-11%	0%	-4%	0%	-4%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Strat.	2010-14	313.799	313.520	Alternative 3	-31%	-31%	-27%	-27%	-27%	-27%	-22%	-21%	-22%	-21%	0%	0%	0%	0%	4%	12%
Strat.	2010-19	336.782	360.053	Alternative 3	-28%	-33%	-24%	-29%	-24%	-29%	-18%	-23%	-18%	-23%	0%	0%	0%	0%	0%	0%
Strat.	2016-19	349.034	372.499	Alternative 3	-9%	-14%	-2%	-8%	-2%	-8%	0%	-2%	0%	-2%	0%	0%	0%	0%	0%	0%
	PSC limit	1745			960		1047		1047		1222		1222		1396		1396		1745	
	GF limit (1,000 t)	290	310		290	310	290	310	290	310	290	310	290	310	290	310	290	310	290	310
Random	2010-14	291.338	291.603	Alternative 4	-45%	-45%	-40%	-40%	-40%	-40%	-30%	-30%	-30%	-30%	-20%	-20%	-20%	-20%	0%	0%
Random	2010-19	335.887	345.264	Alternative 4	-44%	-45%	-38%	-40%	-38%	-40%	-28%	-30%	-28%	-30%	-18%	-20%	-18%	-20%	0%	0%
Random	2016-19	346.417	370.311	Alternative 4	-29%	-33%	-22%	-27%	-22%	-27%	-10%	-15%	-10%	-15%	0%	-3%	0%	-3%	0%	0%
Random	2013-14	251.137	251.123	Alternative 4	-45%	-45%	-40%	-40%	-40%	-40%	-30%	-30%	-30%	-30%	-20%	-20%	-20%	-20%	0%	0%
Random	2017-18	376.558	402.546	Alternative 4	-25%	-30%	-18%	-23%	-18%	-23%	-4%	-11%	-4%	-11%	0%	0%	0%	0%	0%	0%
Strat.	2010-14	313.799	313.520	Alternative 4	-42%	-42%	-38%	-38%	-38%	-38%	-31%	-31%	-31%	-31%	-22%	-21%	-22%	-21%	0%	0%
Strat.	2010-19	336.782	360.053	Alternative 4	-40%	-44%	-36%	-40%	-36%	-40%	-28%	-33%	-28%	-33%	-18%	-23%	-18%	-23%	0%	0%
Strat.	2016-19	349.034	372.499	Alternative 4	-37%	-41%	-27%	-32%	-27%	-32%	-9%	-14%	-9%	-14%	0%	-2%	0%	-2%	0%	0%

5.5.2.1 Effect of sampling method, groundfish limits, and dataset selection

The sampling method (random or stratified) has minimal impact on revenue results. One would expect a difference between these sampling methods if the distribution of revenue, groundfish, or PSC varied substantially by month. For example, if the fleet captured a majority of its revenue early in the season then a stratified approach would lead to higher revenue estimates than a random sampling approach since the early season revenue would be included in the resampling at the same effort levels. To compare results based on sampling method, contrast the dark red, grey, and dark blue datasets between the left and right panels in Figure 5-9 or compare the top two panels in Figure 5-10. Comparison of average estimates can also be made by comparing rows with the same dataset across each sampling method in Table 5-3 and Table 5-4. There is slight variation in estimates for the earlier, higher PSC-use dataset (2010-14). Stratified sampling results in higher revenue estimates than random sampling, although this is muted at the highest PSC limit. This may be due to some years in which the early rate of groundfish catch was relatively steep, and in all years from 2010 through 2014 catch tends to taper off towards the end of the year (Figure 5-8). For the later, lower PSC-use dataset (2016-19), there is slight variation between sampling methods with stratified sampling resulting in lower revenue estimates at lower PSC limits. However, these differences do not persist at higher PSC limits when the entire dataset is more likely to be sampled regardless of the sampling method.

The lack of substantial variation in estimates by sampling methods indicates that results from both the stratified and random sampling method likely represent a lower bound of possible revenue estimates (and an upper bound of revenue impacts). This is not unexpected, as any changes in fleet behavior to adapt to changing PSC limits are likely to be more efficient than a proportional reduction in effort throughout a fishing year as estimated by the random sampling method, or a repeat of previous effort that is prematurely truncated as estimated by the stratified sampling method.

The impact of the groundfish limit can be seen by comparing the upper and lower panels in Figure 5-9, as well as the upper and lower strips within each panel in Figure 5-10 or the columns listed "290" and "310" in Table 5-3 through Table 5-5. Regardless of dataset or estimation method, there is no discernable difference in revenue estimates by groundfish limit until the PSC limit is large enough for the groundfish limit to become constraining. The PSC limit at which this occurs depends upon the dataset, occurring earliest at a PSC limit of 1309 for the lowest PSC use dataset (2017-18) and never becoming constraining for the highest PSC use dataset (2013-14). Scenarios where the groundfish limit is constraining are shaded in blue in Table 5-3 through Table 5-5. In these scenarios the higher groundfish limit of 310,000 t results in larger estimated revenue.

The choice of which dataset to use in the revenue analysis has the largest impact of any other variations between the scenarios. Changing the sampling method between random or stratified or changing the groundfish limit between 290,000 t and 310,000 t have smaller impacts on total revenue estimates. This is unsurprising since there is large variation in the rate of PSC use and revenue generated between years, and because the range of datasets were selected to demonstrate these differences. Datasets including more recent years generate higher revenues at all PSC limits. The differences in estimated revenues from higher PSC use and lower PSC use datasets are larger at lower PSC limits and become less substantial at higher PSC limits.

5.5.2.2 Comparison across alternatives

Figure 5-10 displays the estimated A80 wholesale revenues by the PSC limits associated with each alternative. Alternative 1 is not shown but can be determined by comparing the results under the 1,745 PSC limit (shown in the lightest green/yellow color) to the other Alternatives. The range of potential revenue outcomes for each alternative is related to the range of the PSC limits associated with each alternative. Alternative 2 has the narrowest range of PSC limits (1,396-1,745) and thus the narrowest range of revenue estimates. Alternative 3 includes a wider range of PSC limits (1,222-2,007) than

Alternative 2, and is the only alternative that includes a potential increased limit from status quo (2,007), shown by the yellow ridge. Alternative 4 includes the two lowest potential PSC limits peaks at the status quo limit (960-1,745).

The PSC limit applied in each alternative is based on the combinations of the survey states as defined in the look-up tables. Table 5-6 displays the percent change in estimated revenue from status quo by the PSC limit associated with each alternative under equivalent survey states. These percent-differences are calculated across rows, so they are compared to the status quo revenue estimates using the same methodology and dataset as shown in the Alternative 1 column (in blue and green shading). The purple shading indicates reductions from status quo and yellow shading indicates increases from status quo; darker shading corresponds to larger changes.

The likelihood of falling into one of the cells in Table 5-6 is based on multiple factors. The first, most direct, factor is determined by the survey indices and the applicable PSC limit as determined by the alternatives (look-up tables). The second factor determining which cell represents the most likely outcome is which dataset was used to create the estimate. The lowest bound is represented by the 2013-14 dataset and the highest by the 2017-18 dataset. Given reductions in PSC limits and operational changes such as increased deck sorting, it is most likely that future PSC use will be similar to what has been seen in the years since 2015 – i.e., estimates using 2016-19 or 2017-18 data are most likely.

Currently, both the setline and the trawl surveys are in the Low categories, which correspond to PSC limits that represent immediate reductions from the status quo PSC limit of 1,745 t. Revenue estimates under the resulting PSC limits using the 2016-19 dataset range from no change to a reduction of 3% under Alternative 2, reductions of 3% to 9% under Alternative 3, and reductions of 22% to 32% under Alternative 4.

The probabilities for future survey states are shown in Section 2.4, Figure 2-7 and Table 2-13. In the short-term (through 2030) these estimates result in a 17% probability of staying in a Low/Low state. There is the highest probability, 25%, of being in a Low/Very Low combination of survey states resulting in the lowest PSC limit under each alternative, with revenue reductions of 0% to 3% under Alternative 2, 10% to 15% under Alternative 3, and 29% to 41% under Alternative 4 (using 2016-19 dataset estimates). It is almost just as likely, a 22% probability, to be in a High trawl survey state and a Low setline survey state, which would result in an increase to the next highest PSC limit for each alternative. In that event, revenue changes range from no change under Alternative 2, 0% to -3% under Alternative 3, and -9% to -15% under Alternative 4 (using 2016-19 dataset estimates). Estimates over longer time horizons show the possibility of improved survey states based on the modeling analysis.

5.5.2.3 Discussion

This section discusses some of the assumptions and limitations of the resampling approach and resulting revenue estimates. One advantage of the resampling approach is that it is based on actual fishery data. The analysts are not creating any individual hauls that have not occurred during actual fishing. A limitation of this approach is that estimates only reflect the environmental conditions and fishing behavior that occurred during the past 10 years. As a result, this approach does not estimate outcomes under a changed environmental or management regime, nor does it incorporate fishing adaptations or behavioral changes that may occur in the future.

Under the random sampling method, there is no specified order to the combination of hauls so any haul is equally likely to be selected regardless of when it occurred. This does not impose any external structure on a fishing year; however, when effort is reduced it is equally likely to be reduced from any portion of the fishing year based on the basic effort distribution in the underlying data. Under the stratified method, effort reductions truncate the fishing year starting with the end of the calendar. While both of the sampling methods may accurately reflect fishing in that harvesters have a limited amount of control over the species composition in each haul, neither method captures behavioral adjustments such as changes in targeting, fishing location, or other halibut avoidance strategies that might be employed depending on the emphasis being placed on PSC at the time. As such, the resulting estimates likely represent an upper bound for impacts, in that adaptive behaviors could mitigate the impact of PSC limit reductions more than random or stratified random sampling methods reflect. The extent to which this is true is unknown; a key unanswered question is how close the A80 sector is to the point of diminishing returns in halibut PSC mitigation. Some of the factors that inform this question are discussed in Sections 3.3.3 (Operations and Annual Planning) and 3.4.4 (Bycatch Mortality Reduction Strategies). Those section also note that A80 companies are not homogeneous in the extent to which a marginal PSC limit reduction could affect expected groundfish revenues.

The random resampling of actual hauls might also underestimate the range of uncertainty in annual revenue estimates since results based on historical haul data tend to center around the mean. While this may represent the most likely outcome because hauls are selected based on their prevalence in the underlying distribution, it is less likely to include the most extreme examples such as a year in which the fleet has difficulty avoiding halibut – despite efforts – and accumulates PSC at a more rapid rate. This method is unlikely to select rare “lightning strike” events that could result in adverse impacts for the Amendment 80 fleet simply because they are rare. This is particularly the case for this analysis because the distribution of the underlying data is skewed with many hauls capturing a small amount of PSC and very few hauls capturing relatively large amounts of PSC.

To incorporate a larger range of uncertainty in the results, the analysts separated the data into relatively high PSC-use years (2010-2014) and low PSC-use years (2016-2019) as well as selecting additional year combinations to bookend the results. Those combinations were 2013-2014 to capture the years where PSC was high and revenue was low and 2017-2018 to capture when PSC was low and revenue was high. Given recent mortality patterns and substantial changes in fleet operation, including widespread adoption of deck sorting, it seems unlikely that future years will be similar to those prior to 2015. Overall, the analysts presume that results from more recent years are likely to be better representative of future outcomes. Grouping datasets captures more uncertainty but results still cluster around the means of the grouped years and thus they do not capture the full range of potential outcomes – particularly in a scenario when halibut abundance and PSC limits are low but halibut encounters are high, which could have more negative consequences to the fleet.

The assumption that 100% PSC use is possible may contribute to less uncertainty in the revenue estimates for scenarios where the PSC limit is constraining. This assumption may also lead to relatively higher PSC use estimates than are likely, given that the fleet has not used 100% of the PSC limit in any of the past 10 years (Figure 5-4). This is not an uncommon challenge in PSC limit analyses and the Council has historically understood that in this case the analysts are presenting an estimate of the maximum adverse impact. The analysts considered other options for defining the relationship between PSC use and the limit. It makes sense to consider all types of relationships between the PSC limit and use – random, constant, or scaled (i.e. higher use-rate at a lower limit). Ultimately, for purposes of presentation, the analysts concluded that the results are most easily understood by showing 100% use as a maximum-impact and allowing the reader to adjust downward based on what is qualitatively understood. The implementation of a groundfish limit in this analysis also mutes the cases in which 100% of the PSC limit is attained. In most scenarios, at higher PSC limits, the groundfish limit is constraining before the PSC limit is met. It is possible that expected PSC use should be higher, all else equal, if halibut are more abundant in the BSAI, but this document has discussed the multiple, complex determinants of PSC encounter and mortality at several points (e.g., Sections 3.3.3 and 3.4).

Another reason not to take the 100% use assumption at face-value is that the marginal change in the constraint posed by a metric ton of PSC limit reduction (or increase) is not linear and is not experienced the same across A80 companies, per their groundfish quota portfolios. The analysts expect that an A80 operator’s behavior would be modified to a similar extent if expected use relative to the PSC limit is, say, 85%, 95%, or 100%. In other words, it is not the analysts’ impression that A80 companies create fishing plans to push their PSC use to the limit, given the substantial risk; this is borne out in the historical data shown in Figure 5-4. If an A80 company – or the sector as a whole – feels that it is making substantial investment and giving maximum practicable effort to minimize halibut mortality when PSC use is a fraction of the limit then it is possible that additional efforts might yield less PSC reduction or have no effect. For example, A80 PSC limit use was 63% in 2020 (1,097 t use vs. 1,745 t limit). It is difficult for the analysts to draw a *direct* line between a reduced hard cap (either through the alternatives or the options) and lower use. Given the variability in annual halibut encounter and mortality, similar efforts – all else equal – could yield more or less halibut PSC in a different year. The relatively loose nature of the relationship between the PSC limit and mortality on an annual basis – especially given the efforts to avoid PSC that are currently being employed – make it difficult to quantify what "incentive" a given percent reduction in the limit would provide. This is not to say that a marginal reduction in the PSC limit or a rollover/flexibility option would carry no incentive; rather, that the incentive partially lies in how the Council is framing the limit and the options.

The analysts also note that PSC use is a function of many factors, some of which are outside of the fleet's direct control. For example, changing environmental conditions could disperse groundfish or cause them to move out of well-known, fishable areas. This could cause the fleet to tow more hours for the same amount of catch, increasing gross costs as well as the possibility of high-bycatch events. A changing environment might also change the extent to which groundfish and halibut are comingled, also changing the probability of bycatch. The extent of these changes is presently unknown, meaning that at this time they can be thought of as risk factors that may affect the fleet's ability to maintain harvest levels under a lower PSC limit in a practicable manner.

Finally, it is important to note that these estimates represent gross revenues and do not attempt to estimate the costs associated with changing fishing operations to avoid halibut that are described in Section 3.4.4. Estimates are fleet-wide and, thus, potential distributional impacts within the sector based on operational differences and fishing portfolios are considered qualitatively. A key figure for that consideration is Figure 3-15 in Section 3.3.1, which compares the quota share portfolios by species group across the presently active A80 companies.

5.5.3 Impacts on BSAI halibut commercial catch

The analysts used the relationships between the PSC limits in the alternatives and projected BSAI directed halibut catch limits, as estimated in the closed-loop simulation model in the October 2020 DEIS, to calculate potential changes in directed halibut catch resulting from the PSC limits changes that could occur under the alternatives.

Median estimated PSC limits (as reported in Table 6-8 in the October 2020 DEIS) are compared to median estimated BSAI directed catch limits (as reported in Table 6-14 in the errata Revised Section 6.4.4) for 2021 through 2030. This comparison is made across alternatives. The analysts calculated a range of ratios for the difference in PSC (in million net pounds) to the difference in BSAI directed halibut limits (in million net pounds):

$(PSC_{\text{status quo}} – PSC_{\text{Alternative}})$ / (BSAI directed halibut catch $\text{limit}_{\text{status quo}}$ – BSAI directed halibut catch $\text{limit}_{\text{Alternative}}$).

The estimated PSC limits used to calculate the ratio ranged from 849 t to 2,325 t, representing a larger range than the current proposed alternatives that spans 960 t to 2,007 t. The BSAI halibut catch limits ranged from 4.44 million to 7.52 million pounds. Analysts use the minimum, median, and maximum values of the calculated ratios to estimate a range of potential changes to the BSAI directed halibut catch limit associated with each PSC limit in the current range of alternatives. These ratios range from a directed catch limit change of 0.094 to 0.609 net pounds per net pound of PSC limit reduction. Table 5-7 displays the resulting range of potential changes in net pounds of BSAI directed halibut catch limits from each PSC limit in the look-up tables.

The values in Table 5-7 should be considered with some important caveats, and may not precisely represent realized outcomes for Area 4 fisheries for several reasons.[71] BSAI directed catch differs from Area 4 directed catch by definition (as explained in Section 5.2). In the model, "BSAI" is an approximation of IPHC Area 4 due to the fact that part of Area 4A overlaps the GOA FMP area. Additionally, these ratios are based on the median projections from model simulations, so they do not capture the full range of the PSC-to-catch relationships that were simulated. In other words, reporting ranges and the median values may differ from a single simulation realization.

Table 5-7 Change from status quo (SQ) BSAI directed catch limits (million net pounds) resulting from proposed PSC limits (t). The bottom three rows display change from status quo directed BSAI catch limits resulting from the PSC listed at top, calculated using the minimum, median and maximum ratios.

PSC Limit (t)			960	1047	1222	1309	1396	1483	1571	1745	2007
Difference from SQ PSC limit (t)			-785	-698	-523	-436	-349	-262	-174	0	262
Difference from SQ PSC limit (mil. net pounds)			-1.298	-1.154	-0.865	-0.721	-0.577	-0.433	-0.288	0	0.433
Change in directed catch limit (million net pounds)	Min. ratio	0.094	0.122	0.109	0.082	0.068	0.054	0.041	0.027	0	-0.041
	Median ratio	0.327	0.424	0.377	0.283	0.236	0.189	0.142	0.094	0	-0.142
	Max. ratio	0.609	0.790	0.703	0.526	0.439	0.351	0.264	0.175	0	-0.264

The calculation of the ratios may have asymmetric effects that are not fully captured by reporting a range. For example, a PSC limit of 960 t may be more congruent with one end of the range while a higher PSC may be more representative of the opposite end of the range. Additionally, the ratio will vary over time (Stewart et al. 2021) depending on the halibut population age-structure and the relative availability of different age groups to the directed fishery and those halibut taken as PSC. Therefore, interpretation of these results should be done by looking across the entire table and possibly interpolating beyond the ratios presented. Nevertheless, this approach provides a thought process to understand the direction and approximate magnitude of the relationship between PSC and commercial catch in the BSAI. Given the many uncertainties, these results are best used for looking *across* the table to compare the PSC limits embedded in the alternatives to one another on a relative basis.

The IPHC analyzed the relationship between bycatch and yield in the directed halibut fishery by comparing results of the coastwide assessment with and without coastwide bycatch, concluding that "potential yield to the directed fishery was generally larger than a simple reallocation from non-directed discards (115% on average), [and] that the rate of exchange is variable over time (range of 86–139%)" (Stewart et al. 2021). The analysts note that the ratios presented in the table above are attempting to be more specific to "yield" to the Area 4 commercial fishery (by proxy of the model's "BSAI" definition), so it makes sense that the "rate of exchange" reported here is lower than what a coastwide study would find.

These difference between the ratios in Stewart et al. (2021) and the results presented above are important to clarify. A majority of the directed halibut fishery occurs outside of the BSAI and a majority of the PSC bycatch occurs within the BSAI. Stewart et al. focused only on the coastwide impact estimates, which might not be as directly applicable to the proposed action. Additionally, that approach was based on history and thus misses feedback impacts over time of how lower (or variable) bycatch in one year would

[71] Also note that the modeled directed fishery catch limits is eliding some aspects of the IPHC policy process by which TCEY ultimately results in a directed fishery catch limit (allocation pounds for IFQ and CDQ) – particularly in Area 4. Figure 4-5 in Section 4.3 illustrates the IPHC process of distributing final TCEY as catch limits for Areas 4A, 4B, and 4CDE. Expected 026 bycatch, expected subsistence use, and expected directed fishery discard mortality are accounted for when converting TCEY to directed commercial catch limits. The relationship between final TCEY and area directed fishery catch limits is ultimately a policy decision made by the IPHC. The IPHC may also diverge from a static TCEY:area-catch-limit relationship if its overall management goals are better met by stabilizing catch opportunities in a given area.

propagate and affect the population dynamics in subsequent years. In a review of their method, the IPHC's Scientific Review Board stated that this analysis should "be interpreted with caution, as there are multiple methods for evaluating how bycatch in non-directed fisheries impact stock productivity and biomass over time" and that '*what if' questions about past behaviour are not appropriate for stock assessment models because those analyses do not adequately reflect the information available at the time or information feedbacks to future decisions over time. An MSE analysis, on the other hand is specifically designed to answer 'what if' questions under particular future scenarios while properly accounting for stock assessment errors in response to changing information*." (IPHC–2019–SRB015–R, IPHC-2018-SRB012-R, para. 23). A key outcome of Stewart et al. (2021) is that the rate of exchange – sometimes referred to in the ABM context as yield gain or the PSC-to-directed-catch ratio – is variable over time. A key difference from the results above is that the modeled PSC is based on BSAI Pacific halibut that are markedly smaller/younger than those from the coastwide PSC analysis. Also, the ABM closed-loop simulation model includes variable recruitment and movement (consistent with IPHC tag data) that reflects the observed trends in both the IPHC setline survey and bottom trawl survey.

Table 5-8, below, calculates a range of revenues associated with the potential changes in the net pounds of BSAI directed catch limits reported in Table 5-7. The ex-vessel values are reported in 2018-dollar adjusted ex-vessel values for Area 4 as reported in Section 4. The ex-vessel value represents the amount paid to fishermen by a primary processor for raw fish. Ex-vessel prices are the most appropriate value to represent halibut fishery revenues given that this is the most common halibut supply chain in Alaska, particularly in the BSAI or IPHC Area 4 (see Section 4). In an attempt to demonstrate a more direct comparison between fleets, halibut revenues are also reported in wholesale values in Table 5-8. The wholesale values in this table are estimates of first wholesale production values for head and gut fish as reported in the Economic SAFE report (Table 4-10). The wholesale values are based on COAR data that rely on the accuracy of processor reporting and are aggregated at the statewide level. COAR data for processors located in the BSAI region that primarily purchase Area 4 halibut come from a small set of reporting entities and are sometimes excluded due to identified reporting gaps. The estimates in Table 5-8 might not be a reliably precise indicator of value-added production at the primary processing level in the BSAI/Area 4 region, or the Area 4CDE region in particular. As noted in Section 4.4.1, ex-vessel values in Area 4 consistently trail statewide values.

The analysts attempted to estimate wholesale values that are more specific to Area 4, however this is not a straightforward calculation due to limited data sources, as alluded to above and in Section 4.4.1.1. Unlike for the A80 sector, there is no link from round weights to product weights by product type and processing facility for the halibut fishery. Without this link, the only available method to connect purchases and sales for each processor is to compare the annual sum of the processed product weights (sold) and the unprocessed weights (purchased) in COAR tables. Those weights will not match exactly due to volume lost during processing and year-to-year differences if a processor purchases the fish in one year and sells the fillets the next year (e.g., holdover inventory). The analysts applied a "screen" to filter out annual data from processors whose sales include too much holdover product from the previous year.[72] The screen is the ratio of the annual purchased weight divided by the annual sold product weight. Due to the fact that a majority of product in Area 4 are gutted and glazed (head-on), an additional scaling is used to adjust to "head-and-gut" prices (weight bought multiplied by 0.903 – or 0.75/0.83 – the head-and-gut to gut ratio). When setting the screen value to accept data that falls between 0.6 and 1.5 and only including processors operating in the BSAI region, the estimated wholesale value is $6.02 in 2019 (2018$) with a 5-year average of $7.90 (2015-2019). This range comes out slightly higher than the estimates taken from the Economic SAFE. These data issues and limitations are not uncommon in fishery analyses. For that reason, the analysts encourage the reader to understand Table 5-8, below, as a series of catch volumes that

[72] That screen also filters out cases where data reporting gaps could skew local average weights or unit values. For example, a specific processing facility might be known to have received a substantial percentage of the Area 4 halibut catch but did not report any halibut production in its COAR submission.

is multiplied through by a set of informed unit-value estimates. A reader could multiply through by a different unit-value based on information that he or she has, or based on an entirely different value-scope if they wanted to reflect additional downstream values that are not included here due to data limitations or concerns about data quality and the appropriateness of certain cross-sector comparisons.

Setting aside the uncertainty surrounding future halibut ex-vessel and wholesale value estimates, the numbers in Table 5-8 may overestimate potential changes in revenue as they assume 100% usage of the additional catch limit. The Area 4 TAC utilization rate was roughly 91% from 2011 through 2020, and was roughly 85% in 2020. The reader can compare the values in the table to historical Area 4 ex-vessel revenues shown in Table 4-3. Area 4 gross ex-vessel revenue in 2018-dollars ranged from $32.6 million to $54.4 million from 2010 to 2012 but has been between $16.9 million (2018) and $24.9 million (2016) in more recent years. Section 4.4.1 highlights the reasons why recently observed per-unit values for gross ex-vessel halibut revenues might not be a reliable predictor of future value in the near term due to significant market disruptions.

Table 5-9 shows the range of potential changes in “BSAI” directed catch limits, relative to status quo, that are associated with each survey state across the alternatives. The “status quo” “BSAI” catch limit used for the comparison across alternatives is 4.09 million net weight pounds.[73] That value is taken from the ABM closed-loop simulation model result for 2019 (Table 6-14 in the errata Revised Section 6.4.4, October 2020 DEIS draft). The slight definitional difference of BSAI versus IPHC Area 4 means that there is no analog to pull from the actual fishery catch limits. If Table 5-9 is used primarily to make comparisons across alternatives, the absolute value input for status quo should not affect the reader’s conclusions. Basing results on a different status quo input value would not affect the ranking of the alternatives against each other, though it could change the relative magnitude of the changes (i.e., a larger status quo would make the relative changes appear smaller; a smaller status quo would make the relative changes appear larger). The revenues reported in Table 5-8 are calculated by multiplying a constant price so the percent-change is equivalent across revenue estimates.

Currently, both the setline and trawl surveys are in the Low category, which corresponds to PSC limits that represent immediate reductions from the status quo limit of 1,745 t. The corresponding PSC limit under Alternative 2 (1,396 t) would result in an increase in BSAI directed catch limit of 1% to 9%; the PSC limit under Alternative 3 (1,309 t) would result in an increase of 2% to 11%; and the PSC limit under Alternative 4 (1,047 t) would result in an increase of 3% to 17%.

The modeled probabilities of future survey states are shown in Section 2.4, Figure 2-7 and Table 2-13. In the short-term (through 2030) these estimates result in a 17% probability of staying in a Low/Low state. The highest probability outcome (25%) is to be in a Low/Very Low combination of survey states resulting in the lowest PSC limit under each alternative, and potential catch increases of 1% to 9% under Alternative 2, 2% to 13% under Alternative 3, and 3% to 19% under Alternative 4. It is almost as likely (22% probability) to be in a High trawl survey state and a Low setline survey state. That would result in potential catch changes ranging from 1% to 6% under Alternative 2, 1% to 9% under Alternative 3, and 2% to 13% under Alternative 4. Estimates over longer time horizons show improved survey states – i.e., higher abundance of halibut in general. Setting any effect of PSC aside, higher abundance should increase the directed fishery catch limits set by the IPHC. PSC mortality is incorporated into the IPHC commercial limit-setting process in terms of actual PSC use, not the limit as it exists as a number on paper. In a scenario where abundance is high and the PSC *limit* is also high – e.g., 2,007 t – one should really infer “yield gain” to the halibut fishery based on changes in PSC use. Crucially, Table 5-8 is showing negative values under the “High/High” PSC limit of 2,007 t, but this is assuming 100% use of the limit. That is likely a poor assumption. It is possible that greater halibut abundance could increase halibut encounter, but one must also account for the pressure and incentives for constant halibut avoidance and mortality mitigation (e.g., deck sorting, excluder use, etc.). In other words, it is possible that if halibut abundance indices reach high levels then the year-on-year increase in available directed halibut fishery catch limits would become increasingly driven by the stock assessment as opposed to the yield gain flowing from lower A80 PSC use.

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[73] For reference, the 2019 IFQ + CDQ commercial catch limits for IPHC Area 4 totaled approximately 4.92 million net weight pounds (source: https://www.fisheries.noaa.gov/sites/default/files/akro/19ifqland.htm).

Table 5-8 Potential change in revenue from status quo based on PSC limit (2018$)

				960	1047	1222	1309	1396	1483	1571	1745	2007
Ex-Vessel Values	2019	$4.33	min	529,693	470,988	352,903	294,199	235,494	176,789	117,410	0	-176,789
			med	1,836,865	1,633,289	1,223,797	1,020,221	816,645	613,068	407,152	0	-613,068
			max	3,421,134	3,041,976	2,279,303	1,900,146	1,520,988	1,141,831	758,315	0	-1,141,831
	Average 2015-19	$5.54	min	677,713	602,603	451,521	376,411	301,302	226,192	150,219	0	-226,192
			med	2,350,170	2,089,705	1,565,782	1,305,317	1,044,852	784,388	520,929	0	-784,388
			max	4,377,155	3,892,044	2,916,245	2,431,133	1,946,022	1,460,910	970,223	0	-1,460,910
Wholesale Head-and-Gut	2019	$6.37	min	779,248	692,885	519,167	432,805	346,443	260,080	172,725	0	-260,080
			med	2,702,271	2,402,784	1,800,366	1,500,879	1,201,392	901,904	598,975	0	-901,904
			max	5,032,938	4,475,148	3,353,155	2,795,365	2,237,574	1,679,783	1,115,581	0	-1,679,783
	Average 2015-19	$7.04	min	861,209	765,763	573,774	478,328	382,882	287,435	190,892	0	-287,435
			med	2,986,497	2,655,510	1,989,730	1,658,742	1,327,755	996,767	661,975	0	-996,767
			max	5,562,306	4,945,846	3,705,842	3,089,382	2,472,923	1,856,464	1,232,919	0	-1,856,464

Table 5-9 Estimated percent change in BSAI directed catch limit from status quo by survey state and alternative

EBS Trawl Survey	Low			High			Low			High			Low			High			Low			High		
Setline survey	Very Low			Very Low			Low			Low			Medium			Medium			High			High		
ratio	low	med	max	low	med	max	low	med	max	low	med	max	low	med	max	low	med	max	low	med	max	low	med	max
Alternative 2	**1396**			**1483**			**1396**			**1483**			**1483**			**1571**			**1571**			**1745**		
	1%	5%	9%	1%	3%	6%	1%	5%	9%	1%	3%	6%	1%	3%	6%	1%	2%	4%	1%	2%	4%	0%	0%	0%
Alternative 3	**1222**			**1309**			**1309**			**1396**			**1396**			**1745**			**1745**			**2007**		
	2%	7%	13%	2%	6%	11%	2%	6%	11%	1%	5%	9%	1%	5%	9%	0%	0%	0%	0%	0%	0%	-1%	-3%	-6%
Alternative 4	**960**			**1047**			**1047**			**1222**			**1222**			**1396**			**1396**			**1745**		
	3%	10%	19%	3%	9%	17%	3%	9%	17%	2%	7%	13%	2%	7%	13%	1%	5%	9%	1%	5%	9%	0%	0%	0%
Legend	-50%	-25%	0%	25%	50%																			

5.6 Social and Environmental Justice

Appendix 1, the Social Impact Assessment (SIA), evaluates community and regional participation patterns in BSAI Amendment 80 groundfish fishery and the Area 4 halibut commercial fishery as well as potential community level impacts from (1) the no-action alternative (Alternative 1) and (2) the three action alternatives as a group (Alternatives 2-4). Potential impacts to regional subsistence and sport halibut fisheries are also evaluated. This section summarizes those SIA evaluations and provides additional evaluation of the individual action alternatives.

5.6.1 BSAI groundfish fishery engagement, dependency, and vulnerability to community-level Impacts of the proposed action alternatives

5.6.1.1 Alaska communities

The screening criteria for the selection of Alaska communities for inclusion in the BSAI groundfish component of the SIA were designed to identify Alaska communities that had at least a minimal, ongoing level of engagement in the relevant BSAI groundfish fisheries, as measured by an annual average of one or more active Amendment 80 sector groundfish trawl catcher/processor(s) with a local ownership address that participated in the BSAI groundfish fisheries 2010-2019 inclusive and/or being the location of catcher/processor product transfers. The latter criterion selected for those BSAI communities where, on an annual average basis 2010-2019, 5.0 percent or more of combined state shared fisheries tax revenue (i.e., Fisheries Business Tax revenue [associated with landings at shore-based or stationary floating processing operations] and Fisheries Resource Landing Tax Revenue [associated with product transfers by catcher/processors]) was attributable to Fisheries Resource Landing Tax revenue.

Using these screening criteria, five Alaska communities have been selected for analysis as potentially substantially engaged in, and/or potentially substantially dependent on, the BSAI groundfish Amendment 80 sector that would be directly affected by one or more of the proposed action alternatives. These Alaska communities are shown graphically in Table 5-10. Also shown in this table for reference is the level of engagement of these same five communities in the Area 4 halibut catcher vessel and shore-based processing sectors. Not shown in this table is the level of engagement of Pacific Northwest communities, including the greater Seattle area, which has the highest level of engagement among all communities in all categories (except being the location of Area 4 halibut shore-based processing).

Table 5-10 Graphic representation of potentially affected Alaska BSAI groundfish communities relative annual average engagement in BSAI groundfish and halibut fisheries, 2010-2019 (table legend is provided in lower panel)

		BSAI Groundfish Engagement		Area 4 Halibut Engagement	
Alaska Community	Relative Community Size	Local Ownership Address Amendment 80 CPs	CP Product Transfer Location	Local Ownership Address CVs	Shore-Based Processing Location
Adak		(none)		(< 0.5)	
Atka		(none)			
Sand Point		(none)		(none)	
Togiak		(none)			(< 0.5)
Unalaska/Dutch Harbor		(none)			

Table Legend

Type/Level of Engagement			
Community Size	2010 Population = less than 1,000	2010 Population = 1,000-9,999	2010 Population = 10,000 or more
BSAI Amendment 80 Participation	2010-2019 annual avg = 0.5 -- 0.9 CPs	2010-2019 annual avg = 1.0 -- 2.9 CPs	2010-2019 annual avg = 3.0 or more CPs
BSAI Product Transfer Location Tax Revenues	2010-2019 annual avg. FRLT = 5.0-24.9% of FBT+FRLT total	2010-2019 annual avg. FRLT = 25.0-49.9% of FBT+FRLT total	2010-2019 annual avg. FRLT = 50.0% or more of FBT+FRLT total
Area 4 Halibut Catcher Vessel Participation	2010-2019 annual avg = 1.0 -- 4.9 CVs	2010-2019 annual avg = 5.0 -- 9.9 CVs	2010-2019 annual avg = 10.0 or more CVs
Area 4 Halibut Shore-Based Processor Participation	2010-2019 annual avg = 0.5 -- 0.9 SBPRs	2010-2019 annual avg = 1.0 -- 1.9 SBPRs	2010-2019 annual avg = 2.0 or more SBPRs

Vulnerability of communities to adverse community-level impacts from the proposed action alternatives is in part a function of dependence of the community on the potentially affected BSAI groundfish Amendment 80 sector fisheries and the economic resiliency and diversity of the community. Dependency is influenced by the relative importance of the relevant BSAI groundfish Amendment 80 fisheries to vessels participating directly in the fisheries in comparison to all area, species, and gear fisheries in which those same vessels participate (community Amendment 80 sector vessel diversity); the relative importance of the relevant BSAI groundfish fisheries to all local ownership address catcher/processor vessels participating in all area, species, and gear fisheries combined (community catcher/processor fleet diversity); and the relative importance of the overall community fishery sector(s) within the larger community economic base both in terms of private sector business activity and public revenues (community economic diversity). Also important to adverse community-level impact outcomes and community resilience is the specific nature of local engagement in the potentially affected BSAI groundfish Amendment 80 fishery sector and alternative employment, income, business, and public revenue opportunities available within the community because of the location, scale, and relative economic diversity of the community.

The relative importance of the BSAI Amendment 80 groundfish fisheries likely to be affected by the proposed alternatives within the larger local fisheries sector and within the larger local economic base varies widely among the engaged Alaska communities. Similarly, the socioeconomic structure of the engaged communities varies widely along with the relative diversity of their respective local economies. These conditions over the period 2010-2019 are summarized by region and community in the following sections, along with potential community level impacts associated with the proposed action alternatives and associated environmental justice concerns, as relevant.

5.6.1.1.1 Unalaska/Dutch Harbor

Unalaska/Dutch Harbor, with its relatively well-developed fishery support service sector and its role as the major shipping port of the BSAI area, could experience indirect impacts from the proposed alternatives through a decline in economic activity related to the Amendment 80 catcher/processor fleet if port calls were to decline because of the proposed action. Unalaska/Dutch Harbor, unique among Alaska communities, also derives substantial public revenues from BSAI groundfish catcher/processors offloading/transferring processed product in the port. Unalaska/Dutch Harbor accounted for two-thirds of all Amendment 80 Alaska port calls during the years 2010-2019. Unalaska/Dutch Harbor could experience indirect impacts from the proposed action alternatives through a decline in economic activity related to the Amendment 80 catcher/processor fleet if product transfers and/or other port calls were to decline because of the proposed action; however, there is no straightforward way to quantitatively estimate these impacts.

While Unalaska/Dutch Harbor is clearly the Alaska community most closely associated with activity of the Amendment 80 fleet and therefore potentially the most vulnerable to adverse impacts under the proposed action alternatives, it is also substantially engaged in the commercial directed BSAI/Area 4 halibut fishery, both in terms of its local catcher vessel fleet and local shore-based processing operations and therefore potentially vulnerable to adverse impacts during halibut low abundance conditions under the no-action alternative. Although it is an Alaska Native Claims Settlement Act (ANCSA) village and is home to a federally recognized tribe, Unalaska did not qualify as a CDQ community and its local small boat fleet does have access to CDQ halibut as an underpinning of local operations, unlike most halibut-dependent local fleets in the BSAI region.

5.6.1.1.1.1 Potential Environmental Justice Concerns

The demographics of the owners and crew of the specific halibut vessels that would potentially be most likely to experience adverse impacts under the no-action alternative in halibut low abundance conditions are unknown, but a general knowledge of the fleet would suggest that its demographics are largely reflective of the general/residential population of the community. In contrast, processing workers in Unalaska/Dutch Harbor have tended to be relatively demographically distinct from the rest of the local population. Processing workers are overwhelmingly recruited from outside the community and have tended to include a high proportion of minority workers. Impacts to processing workers could occur as the result of implementation of the no-action alternative during halibut low abundance conditions in the form of reduced income or employment opportunities, depending on how specific plants and, importantly, their delivering fleets, adapt to changing conditions. It is not likely, however, that implementation of the no-action alternative would result high and adverse impacts to processing workers in the form of substantial processor workforce reductions, given the relatively modest level of dependency of the shore-based processing plants in Unalaska/Dutch Harbor on BSAI/Area 4 halibut deliveries compared to those from other BSAI fisheries in which these plants are engaged.

5.6.1.1.2 Atka and Adak

Direct engagement of both Atka and Adak in the Amendment 80 fishery is limited to locally occurring product transfers, which contribute to local public revenues, and port calls of Amendment 80 vessels that generate local economic activity among support service suppliers, at least in Adak. Like Unalaska/Dutch Harbor, Atka and Adak could experience indirect impacts from the proposed action alternatives if Amendment 80 product transfers were to decline in either community and/or other port calls were to decline in Adak because of the proposed action; however, there is no straightforward way to quantitatively estimate these impacts, which could be locally important, if modest in scale in comparison to Unalaska/Dutch Harbor. Atka, as a member of the Aleutian Pribilof Islands Development Association CDQ group, benefits indirectly from the leasing of CDQ quota to the Amendment 80 sector for harvesting. Adak, in contrast, is not a CDQ community.

Both Atka and Adak were the site of locally operating shore-based processors that accepted deliveries of Area 4 halibut in most years 2010-2019. While Adak has had challenges in recruiting and retaining a local residential fleet, Atka has historically had a local halibut fleet. However, both communities have had challenges in the processing sector in recent years, with the plant in Adak closing intermittently (most recently in June 2020) and the plant in Atka not having operated since 2017. Under the no-action alternative, adverse impacts to the Area 4 directed halibut fishery under low abundance conditions could make the restart of the Atka and Adak plants and the reestablishment of active local fleets more challenging than would otherwise be the case. Adak shore-based processing has also faced, from the local perspective, several fishery management related challenges over the years, compounded by the basic logistical and economic challenges of operating in a local economy that remains in transition from that of relatively large military community to a small civilian community.

Both communities are particularly vulnerable at present to cumulative impacts related to losing working age residents as the local halibut fishery represented, especially in Atka, one of the few private sector income and employment opportunities in the community. The schools in both communities are near minimum enrollment levels needed to qualify for state funding, which complicates residential retention and increases the consequences of not being able to do so.

5.6.1.1.2.1 Potential environmental justice concerns

According to the 2010 census, Atka and Adak have populations that are 95 and 82 percent minority, respectively, and both have populations that, as of 2019, had 14.0 and 16.4 percent of their respective populations living below the poverty threshold, which are both considerably higher figure than the Alaska state-wide figure (10.7 percent). Additionally, Atka is also the location of a federally recognized Alaska Native tribe. While Adak is not home to a federally recognized tribe and is not an ANCSA village, it does have multiple ties to the Aleut Corporation, the ANCSA regional corporation for the Aleutian Pribilof region, and a number its subsidiaries. Given the nature of potential impacts to both communities summarized above, disproportionate high and adverse impacts to minority and/or low-income populations in both communities are theoretically possible, under both the action alternatives and, under halibut low abundance conditions, the no-action alternative.

Most of Adak's minority residents at the time of the census, however, were processing workers living in group housing and it is likely that processing workers accounted for most of the community's low-income population as well. With the processing plant currently shuttered, those individuals are no longer present in the community. If that situation continues to the time of the ultimate implementation of a selected alternative, both the minority population and the low-income population of Adak may more closely resemble that of the general population of Alaska, meaning that environmental justice may be less of an issue of a concern.

5.6.1.1.3 Togiak

Direct engagement of Togiak in the Amendment 80 fishery is limited to locally occurring product transfers, which contribute to local public revenues, and port calls of Amendment 80 vessels. The contribution to public revenues is relatively modest compared to other sources of general fund revenue and port calls reportedly generate little in the way of support service economic activities as, like Atka, Togiak does not have facilities of the size and scale to regularly support larger vessel operations. Togiak could experience indirect impacts from the proposed action alternatives if Amendment 80 product transfers and/or other port calls were to decline because of the proposed action; however, it is assumed that any such impacts would be minor. Togiak is the home of a federally recognized tribe and, as a member of the Bristol Bay Economic Development CDQ group, benefits indirectly from the leasing of CDQ quota to the Amendment 80 sector for harvesting.

With respect to engagement in and dependency on the Area 4 commercial halibut fishery, catcher vessels with Togiak ownership addresses active in the Area 4 halibut fishery derived about 83 percent of their total ex-vessel gross revenues 2010-2019 from fisheries other than the BSAI/Area 4 halibut fishery; all commercial fishing vessels with Togiak ownership addresses derived approximately 93 percent of their total ex-vessel gross revenues from fisheries other than the BSAI halibut fishery during this same time period. Given this lack of dependence, Togiak as not as acutely vulnerable in economic terms to community level adverse impacts under the no-action alternative during periods of low halibut abundance as are several other halibut communities. This is not to say that the Area 4 halibut fishery is unimportant to Togiak harvesters and/or the shore-based processors in Togiak (and nearby Twin Hills) as resource that is available during an otherwise slow time and a diversification opportunity in an area that has otherwise been largely dependent on the herring and salmon fisheries.

5.6.1.1.4 Other CDQ communities

CDQ entities and their constituent communities could be impacted by potential changes to the BSAI groundfish Amendment 80 sector fisheries related to the proposed action alternatives in multiple ways, two of the most direct of which are (1) through their quota holdings in the potentially affected BSAI groundfish multispecies fisheries and (2) through CDQ group investments in direct participation in the potentially affected Amendment 80 sector.

Four of the six CDQ groups routinely have their multispecies groundfish CDQ quota by industry partners in the Amendment 80 sector. To the extent that the proposed action alternatives have the potential to reduce royalty payments by Amendment 80 entities to CDQ groups due to increased harvest expenses and/or leave

CDQ fish in the water, the harvest of which has been contracted to Amendment 80 entities, CDQ groups, and their constituent communities are at potential risk of adverse impacts under these alternatives. How effectively these risks would be mitigated by adaptive fishing behaviors on the part of the Amendment 80 partners is unknown and it is otherwise not possible to quantify these risks with available data.

A fifth CDQ group holds partial ownership interest in multiple vessels in the Amendment 80 sector and thus is at some financial risk under the proposed action alternatives, but again this risk is not quantifiable with available data. This CDQ group, as well as the sixth CDQ group, does not routinely use Amendment 80 entities to harvest their multispecies groundfish quota. While potential adverse impacts resulting from the amounts of quota at potential risk are not quantifiable with available data, they are understood to be minimal.

St. Paul has averaged the fourth highest number of port calls of Amendment 80 vessels among Alaska communities on an annual average basis 2010-2019. Available data suggest, however, that these port calls do not involve an amount of revenue from taxable product transfers that is substantial compared to other fishery tax revenue sources. St. Paul also does not appear to experience substantial private sector economic benefits from these port calls, based on a lack of port facilities and support service businesses of a scale capable of supporting relatively large vessels on a routine basis. As a result, no substantial adverse impacts to St. Paul related to any changes to patterns of Amendment 80 port calls resulting from implementation of any of the action alternatives are anticipated.

5.6.1.2 Pacific Northwest communities

Given the degree of centralization of ownership of the BSAI groundfish Amendment 80 sector in the Seattle Metropolitan Statistical Area (Seattle MSA), the centralization of the support services provided by Seattle-based firms, and the concentration of Amendment 80 crew member residence in the state of Washington, potential adverse economic impacts associated with proposed action alternatives described in Section 5.5 of this DEIS would largely accrue to the Seattle MSA in particular and the Pacific Northwest in general, with the limited exceptions described above.

As noted in Section 2 of this DEIS, under both Alternative 2 and Alternative 4: the PSC limit would: (1) remain the same as the status quo PSC limit under combined “high setline index + high trawl index” halibut abundance conditions (only) and (2) under all other combinations of abundance conditions PSC limit reductions would occur. In contrast, under Alternative 3: (1) the alternative PSC limit would be higher than the status quo PSC limit under combined “high setline index + high trawl index” abundance conditions (the only circumstance under any alternative not modified by an option that this would occur); (2) the alternative PSC limit would remain the same as the status quo PSC limit under “high setline index + low trawl index” and “medium setline index + high trawl index” conditions; and (3) under all other halibut abundance conditions the alternative PSC limit would be lower than the status quo PSC limit. When reductions in PSC limits would occur, the amounts of those reductions for any combination of conditions would vary by alternative, as detailed in Section 2. As noted in Section 5.5 of this DEIS, numerous variables would influence the impacts of PSC limit reduction on the Amendment 80 sector, including environmental, regulatory, and behavioral variables. While sector participants cannot directly modify environmental or regulatory variables, they can alter behavioral variables through halibut avoidance strategies, all of which come with avoidance costs. These costs are incurred regardless of whether the PSC limit becomes a constraint and cannot be quantified with available data. Other costs associated with PSC reduction include foregone groundfish revenues if halibut becomes constraining. These costs impact gross revenues but quantifying costs of foregone groundfish revenue resulting from PSC reductions is not straightforward. Estimates of revenue impacts within the constraints of available data are provided in Section 5.5 of this DEIS.

5.6.1.2.1 Potential environmental justice concerns

Although more recent data are not available for the entire sector, to facilitate the social impact assessment for an earlier BSAI halibut PSC limit revisions analysis, employee demographic information-based 2014 Equal Employment Opportunity Commission data were supplied by four firms with catcher/processors operating in the Amendment 80 catcher/processor sector. Together, these firms accounted for more than half of (10 of 18) trawl catcher/processors operating that year (2015) in the BSAI groundfish fisheries. As shown in the supplied data, 66 percent of all employees working on the 10 catcher/processors represented in these data are minority employees. Given these data, if disproportionate high and adverse impacts were to accrue to the Seattle MSA ownership address BSAI Amendment 80 catcher/processor workforce due to implementation of a proposed action alternative, environmental justice would potentially be an issue of concern.

Of potential concern would be loss of income opportunities for crew, with increased expenses in operations with additional halibut avoidance measures, and/or more time away from home with time-consuming and/or labor-intensive measures. Although there are theoretically many more alternate employment and income opportunities for workers in a large urban area than in smaller communities or rural settings, there may not be comparable employment and earning potential ashore as is available to workers aboard these vessels, even in an otherwise robust job market, especially for employees who have worked their way up from entry level positions.

5.6.2 Area 4 halibut fishery engagement, dependency, and vulnerability to community-level impacts of the proposed action alternatives

5.6.2.1 Alaska communities

5.6.2.1.1 Overview

The initial screening criteria for the selection of Alaska communities for inclusion in this portion of the analysis were designed to identify those Alaska communities that had at least a minimal, ongoing level of engagement in the relevant BSAI/Area 4 halibut fishery, as measured by an annual average harvest engagement of 2.0 or more catcher vessels with local ownership addresses and/or communities with an annual average BSAI halibut processing engagement of 0.5 or more locally operating shore-based processors that accepted BSAI halibut deliveries over the years 2010-2019, inclusive.

Using these initial screening criteria, 29 Alaska communities, 20 of which are in the BSAI region, were selected for analysis as potentially substantially engaged in, and/or potentially substantially dependent on, the BSAI/Area 4 halibut fishery sectors most likely to be directly affected by one or more of the proposed action alternatives communities. Ultimately, a total of 17 of these Alaska communities were considered halibut-dependent for the purposes of this analysis and are shown graphically in Table 5-11. Of the 17 Alaska communities shown in the table, 16 are home to federally recognized Alaska Native tribes. Not shown in this table is the level of engagement of Alaska communities outside of the BSAI region or Pacific Northwest communities.

Table 5-11 Graphic representation of potentially affected Alaska Area 4 halibut-dependent communities annual average engagement in Area 4 halibut fisheries (table legend is provided in lower panel)

Alaska Community	CDQ Group	Demographic Characteristics: Community Size	Proportion of Total Population: Alaska Native	Proportion of Total Population: Minority	Proportion of Total Population: Low-Income	Shore-Based Halibut Processing Location	Catcher Vessel Characteristics: Number of Halibut CVs with Local Ownership Addresses	Halibut Ex-Vessel Gross Revenues as Percentage of Total Ex-Vessel Revenues: Halibut CVs Only	Halibut Ex-Vessel Gross Revenues as Percentage of Total Ex-Vessel Revenues: All Local CVs
Adak	(none)						(< 1.0)		
Atka	APICDA								
Akutan	APICDA								
St. George	APICDA					(none)			
Unalaska/Dutch Harbor	(none)								
St. Paul	CBSFA								
Hooper Bay	CVRF					(< 0.5)			confidential
Kipnuk	CVRF					(< 0.5)			
Mekoryuk	CVRF					(< 0.5)			
Toksook Bay	CVRF					(< 0.5)			
Chefornak	CVRF					(< 0.5)			
Newtok	CVRF					(none)			
Nightmute	CVRF					(none)			
Quinhagak	CVRF					(none)			
Tununak	CVRF					(none)			
Nome*	NSEDC								
Savoonga	NSEDC								

*Note: Nome catcher vessel revenues combined with "all other NSEDC" (excluding Savoonga) to protect data confidentiality. Where halibut ex-vessel gross revenues are shown as lumped for more the one community, data confidentiality restrictions preclude showing data for the individual communities

Table Legend

Type/Level of Engagement	(light)	(medium)	(dark)
Community Size	2010 Population = less than 1,000	2010 Population = 1,000-9,999	2010 Population = 10,000 or more
Alaska Native and Minority Population Proportion	2010 Population = less than 50%	2010 Population = 50.0-74.9%	2010 Population = 75.0% or more
Low-Income Population Proportion	2014-2019 Population = less than 15%	2014-2019 Population = 15.0-24.9%	2014-2019 Population = 25.0% or more
Area 4 Halibut Catcher Vessel Participation	2010-2019 annual avg = 1.0 -- 4.9 CVs	2010-2019 annual avg = 5.0 -- 9.9 CVs	2010-2019 annual avg = 10.0 or more CVs
Area 4 Halibut Shore-Based Processor Participation	2010-2019 annual avg = 0.5 -- 0.9 SBPRs	2010-2019 annual avg = 1.0 -- 1.9 SBPRs	2010-2019 annual avg = 2.0 or more SBPRs
Area 4 Halibut Ex-Vessel Gross Revenue Proportion	2010-2019 annual avg = less than 25%	2010-2019 annual avg = 25.0 - 49.5%	2010-2019 annual avg = 50.0% or more

The problematic nature of the no-action alternative for directed halibut fishery participants under halibut low abundance conditions is inherently recognized in the Council's purpose and need statement. The potential for Area 4 halibut-related community-level impacts from the proposed action alternatives in any given community is in part a function of present and future dependence of the community on the potentially affected Area 4 halibut fisheries. Like what was described for BSAI Amendment 80 groundfish fisheries, dependency on the Area 4 halibut fishery is influenced by the relative importance of Area 4 halibut fisheries in the larger community fisheries sector(s), as well as the relative importance of the overall community fishery sector(s) within the larger community economic base (both in terms of private sector business activity and public revenues). Also important to community-level impact outcomes is the specific nature of local engagement in the potentially affected Area 4 halibut fisheries and alternative employment, income, business, and public revenue opportunities available within the community because of the location, scale, and relative economic diversity of the community.

It is assumed that the Area 4 commercial halibut fishery would potentially benefit in low halibut abundance conditions from implementation of the action alternatives due to what could effectively (if indirectly) be a reallocation of access to halibut between the BSAI groundfish and Area 4 directed halibut fisheries that would potentially occur to greater or lesser degrees under the different action alternatives. The beneficial impacts of these incidental allocative effects, were they to occur, would be realized in the near-term following action alternative implementation (assuming low abundance conditions relevant to the design of the alternative were occurring at the time of implementation) and potentially in the long-term, if low abundance conditions were to persist over time.

The conditions under which the potential for incidental allocative effects beneficial to the directed halibut fishery could occur vary by action alternative. Table 5-12 provides a simplified view of the alternatives showing, by action alternative and without modifying options, the halibut abundance conditions under which the Amendment 80 halibut PSC limits would be lower than, the same as, or higher than status quo/Alternative 1 conditions (highlighted in green, yellow, and orange, respectively).

Table 5-12 Simplified look-up table of Alternatives 2, 3, and 4 showing Amendment 80 halibut PSC limits lower, same as, or higher relative to status quo (Alternative 1)

	Alternative 2		Alternative 3		Alternative 4	
	Low Trawl Index	**High Trawl Index**	**Low Trawl Index**	**High Trawl Index**	**Low Trawl Index**	**High Trawl Index**
High Setline Index	PSC Limit **LOWER** than Status Quo	PSC Limit **SAME** as Status Quo	PSC Limit **SAME** as Status Quo	PSC Limit **HIGHER** than Status Quo	PSC Limit **LOWER** than Status Quo	PSC Limit **SAME** as Status Quo
Medium Setline Index	PSC Limit **LOWER** than Status Quo	PSC Limit **LOWER** than Status Quo	PSC Limit **LOWER** than Status Quo	PSC Limit **SAME** as Status Quo	PSC Limit **LOWER** than Status Quo	PSC Limit **LOWER** than Status Quo
Low Setline Index	PSC Limit **LOWER** than Status Quo	PSC Limit **LOWER** than Status Quo	PSC Limit **LOWER** than Status Quo	PSC Limit **LOWER** than Status Quo	PSC Limit **LOWER** than Status Quo	PSC Limit **LOWER** than Status Quo
Very Low Setline Index	*(Note: Alt 2 does not have a separate Very Low category)*		PSC Limit **LOWER** than Status Quo	PSC Limit **LOWER** than Status Quo	PSC Limit **LOWER** than Status Quo	PSC Limit **LOWER** than Status Quo

As shown, under both Alternative 2 and Alternative 4: (1) the alternative PSC limit would not be higher than the status quo PSC limit under any halibut abundance conditions; (2) the PSC limit would remain the same as the status quo PSC limit under combined "high setline index + high trawl index" halibut abundance conditions (only); and (3) under all other halibut abundance conditions the alternative PSC limit would be lower than the status quo PSC limit. The *amount* of PSC limit reductions under all but "high setline index + high trawl index" abundance conditions (and therefore the potential *level* of incidental allocative effects beneficial to the directed halibut fishery) would vary between the two alternatives, as described in Section 2, but combinations of abundance *conditions* under which at least some level of incidental allocative effects could potentially occur would be the same under Alternative 2 and Alternative 4. (Under "high setline index + high trawl index" abundance conditions, Alternative 2 and Alternative 4 would both be neutral in terms of incidental allocative effects relative to Alternative 1.)

As shown in the same table, the pattern is different for Alternative 3, as: (1) the alternative PSC limit would be higher than the status quo PSC limit under combined "high setline index + high trawl index" abundance conditions; (2) the alternative PSC limit would remain the same as the status quo PSC limit under "high setline index + low trawl index" and "medium setline index + high trawl index" conditions; and (3) under all other halibut abundance conditions the alternative PSC limit would be lower than the status quo PSC limit (and therefore potential incidental allocative effects beneficial to the directed halibut fishery could occur). All things being equal, the increase in the Amendment 80 PSC limit under "high setline index + high trawl index" halibut abundance conditions would result in fewer opportunities for the directed halibut fishery under these conditions than would be the case under status quo PSC limits (Alternative 1). This could be characterized as a loss to the directed halibut fishery, as the directed fishery not fully realizing otherwise expected gains under high abundance conditions, and/or as Amendment 80 halibut PSC use and directed fishery halibut opportunities both increasing based on high abundance conditions.

The provision of additional opportunities for the directed halibut fishery that may accompany PSC limit reductions would be determined by IPHC management processes and, as described in Section 5.5, would not likely result in those additional directed halibut fishery opportunities occurring on a pound-for-pound basis. Additionally, the potential options that maybe applied to any of the action alternatives would influence the level of additional directed halibut fishery opportunities available in a given year. It is also important to note that some communities are substantially engaged in or substantially dependent on both the Amendment 80 fishery and the Area 4 directed halibut fishery to varying degrees and a simple characterization of potential incidental reallocative effects to halibut dependent communities does not capture the complexity of overall impacts to those communities, much less the range of potential impacts to individual harvesters, processors, and/or fishery support businesses in those communities that may ultimately result from changes in Amendment 80 PSC limits.

It is further assumed that directed Area 4 commercial halibut fishery could potentially benefit from implementation of the proposed action alternatives relative to the degree that the BSAI halibut stock itself would potentially benefit from the promotion of the conservation of the halibut stock as a result of the implementation of the individual action alternatives. Previous modeling efforts, however, have suggested that direct benefits to the halibut stock from decreased halibut mortality accompanying PSC reductions like those contemplated under the proposed action alternatives would be minor if not negligible for multiple reasons. These potential benefits, were they to occur, would not be immediately apparent in the relevant halibut fisheries and the full extent of their impact would not be realized for several years.

5.6.2.1.2 Potential impacts to communities engaged in the commercial halibut fishery

Dependence of the total resident-owned catcher vessel fleet for these communities varied widely, as the fleets of some communities are more exclusively focused on the halibut fishery than are others. St. Paul, the BSAI region community with easily the highest 2010-2019 annual average catcher vessel Area 4 halibut ex-vessel gross revenues, was also one of three communities with virtually complete community fleet dependency on BSAI halibut ex-vessel gross revenues, along with St. George and Savoonga, which have smaller scale community fleets. Among the other communities or small groups of communities for which ex-vessel gross revenue totals can be disclosed, three other communities (Adak/Atka, Akutan, and Mekoryuk) have local ownership address catcher vessels fleets that were 85 percent or more dependent on BSAI halibut ex-vessel gross revenues on an annual average basis for the years 2010-2019, while two others were 25 percent or more dependent (Unalaska/Dutch Harbor and Toksook Bay). In terms of ex-vessel gross revenues to BSAI halibut vessels specifically, among the potentially substantially engaged or substantially dependent halibut communities for which revenues can be disclosed on an individual community or aggregated community basis, nine have dependencies of 90 percent or greater and one is more than 85 percent dependent.

In all but two cases (Adak and Unalaska/Dutch Harbor), potentially substantially engaged or substantially dependent BSAI halibut communities located in the BSAI region itself are member communities of CDQ entities. One of the CDQ entities has partial ownership interest in Amendment 80 vessels and four others routinely lease CDQ quota for harvest to Amendment 80 industry partners. These CDQ entities and their constituent communities would be vulnerable to potential decreases in CDQ groundfish revenues during low abundance halibut conditions under the proposed alternatives being considered. Ultimately, the level of direct impact to an individual CDQ entity and level of direct or indirect impact to its member communities cannot be quantitatively estimated given the role of individual entity business decision making, among many other factors.

While each CDQ entity pursues individual strategies, one primary goal of the CDQ program is to encourage individual entities to use the returns from their engagement in commercial fishing to support regional economic growth, including the direct reinvestment in commercial fisheries, the support of community development activities, and the creation/maintenance of commercial fishing support infrastructure in member communities. Different CDQ groups have faced different circumstances and pursued different strategies regarding the establishment or sustainment of an in-region small boat commercial halibut fishery. For those CDQ groups whose experience in, or assessment of, supporting an in-region small boat commercial halibut fishery would indicate that the effort is not or would not be sustainable, especially under low abundance conditions, it is unknown whether the beneficial impacts that may accrue from implementation of one or more of the proposed alternatives would be sufficient to pass a threshold whereby in-region halibut fisheries would be considered sustainable even in low abundance conditions. For this reason, it is not possible to predict whether implementation of any one of the proposed alternatives would potentially result in a different pattern of in-region CDQ community commercial small boat direct BSAI/Area 4 halibut fishery engagement than is seen at present.

5.6.2.1.2.1 Potential environmental justice concerns

In terms of minority populations in general, of the 17 Alaska communities considered BSAI halibut-dependent for the purposes of this analysis, in 2010 minority residents (including Alaska Native residents) accounted for more than 90 percent of the population in 13 communities, between 80 and 90 percent of the population in two communities, and more than 65 percent of the population in the remaining two communities. Additionally, of the 17 Alaska potentially BSAI halibut dependent communities, 16 have federally recognized Alaska Native tribes and 15 are members of CDQ groups.

In terms of low-income populations, of the 17 Alaska communities considered BSAI halibut-dependent for the purposes of this analysis, as of the 2015-2019 5-Year American Community Survey: 2 had 40 percent or more of their residents living below the poverty threshold; 5 had between 30 percent and less than 40 percent of their residents living below the poverty threshold; 2 had between 20 percent and less than 30 percent of their residents living below the poverty threshold; and 5 had a higher percentage of their residents living below the poverty threshold than the State of Alaska as a whole (10.7 percent), but less than 20 percent of their residents overall. Given these demographics and the federally recognized tribal status of all but one of the communities involved, if these communities were to experience disproportionate high and adverse impacts under the no-action alternative under halibut low abundance conditions, environmental justice would be a concern. Conversely, if these communities were to experience beneficial impacts under the proposed action alternatives, environmental justice would not be an issue of concern.

5.6.2.1.3 Potential impacts to communities engaged in the subsistence halibut fishery

Subsistence harvest of halibut would not be directly affected by the proposed action alternatives. Further, unlike the commercial halibut fishery, the subsistence halibut fishery would not benefit from potential incidental reallocative effects that may occur under the proposed action alternatives and provide additional opportunities for the directed halibut fishery. The IPHC accounts for incidental halibut removals in the groundfish fisheries, recreational and subsistence catches, and other sources of halibut mortality before setting commercial halibut catch limits each year. While subsistence removals are accounted for in setting the commercial halibut catch limits, subsistence halibut harvests are not constrained by this process. There are no caps on removals from Area 4 in the subsistence halibut fishery analogous to quotas established annually for the commercial halibut fishery, nor are there size limits on halibut harvested for subsistence use.

Subsistence halibut harvests (and harvesters) could indirectly benefit from the implementation of the proposed action alternatives if the proposed action ultimately implemented were to result in changes to the spatial distribution of halibut stock or an overall increase in availability of halibut for subsistence harvest and/or an accompanying decrease in effort and expense in harvesting halibut for subsistence use over the long term. These indirect benefits could occur if the BSAI halibut stock itself benefits from additional promotion of conservation of the halibut stock under the individual action alternatives (and to the extent that whatever conservation gains that may be realized are not fully redirected into additional opportunities for the commercial halibut fishery, while recognizing that the relationship between the commercial and subsistence fisheries is complex and varies by community). Previous modeling efforts, however, have suggested that direct benefits to the halibut stock from decreased halibut mortality accompanying PSC reductions like those contemplated under the proposed action alternatives would be minor if not negligible for multiple reasons.

Beyond direct use of halibut as a subsistence resource, the proposed alternatives could have impacts on other subsistence pursuits. These types of impacts fall into two main categories: impacts to other subsistence pursuits because of loss of revenue from the BSAI groundfish fishery under the action alternatives (or the BSAI halibut fishery under the no-action alternative) and impacts to other subsistence pursuits because of the loss of opportunity to use commercial fishing gear and vessels for subsistence pursuits. In general, however, while the indirect impact of the proposed action alternatives on subsistence is difficult to assess for multiple reasons, joint production impacts in particular are likely to be concentrated among small halibut catcher vessel owners during low abundance conditions under the no-action alternative.

5.6.2.1.4 Potential impacts to communities engaged in the sport halibut fishery

Sport harvest of halibut would not be directly affected by the proposed action alternatives. Further, unlike the commercial halibut fishery, the sport halibut fishery would not benefit from potential incidental reallocative effects that may occur under the proposed action alternatives and provide additional opportunities for the directed halibut fishery. Due to the relatively small volume of recreational use in Area 4 and the management under a daily bag limit rather than an area/sector allocation, IPHC accounts for recreational removals using a projection. There are no caps on removals from Area 4 in the sport halibut fishery analogous to quotas established annually for the commercial halibut fishery, but sport effort is constrained in Area 4 by a sport fishing season that extends from February 1 to December 31 and a bag limit of two halibut of any size per person per day unless otherwise specified.

Sport halibut harvests (and the guided and unguided sport halibut fisheries) could indirectly benefit from the implementation of the proposed action alternatives if reducing BSAI halibut PSC limits under low abundance conditions were to ultimately result in an overall improvement in availability of halibut for sport harvest, an accompanying decrease in effort and expense in harvesting halibut for sport use, and/or an increase in interest in halibut sport fishing in the region prompted by an increasing abundance of larger halibut. These indirect benefits could occur if the BSAI halibut stock itself benefits from additional promotion of conservation of the halibut stock under the individual action alternatives (and to the extent that those gains are not fully redirected into additional opportunities for the commercial halibut fishery). Previous modeling efforts, however, have suggested that direct benefits to the halibut stock from decreased mortality accompanying halibut PSC reductions like those contemplated under the proposed action alternatives would be minor if not negligible for multiple reasons.

5.6.2.1.5 Potential cumulative small/rural community and cultural context issues

The SIA is largely focused on community impacts associated with the implementation of proposed BSAI halibut PSC limit revisions using quantitative fishery information and through characterizations of several Alaskan regions and communities that describe the magnitude of engagement and dependency on those fisheries. This approach provides an analysis of anticipated socioeconomic impacts that may accompany implementation of the proposed action alternatives. It should be noted, however, that fishing regulatory actions can result in a wide range of sociocultural impacts in rural fishing communities. For many residents of these communities, commercial fishing is not seen as a stand-alone socioeconomic activity, but an integral part of self-identity. This relationship is compounded for those residents who come from families with multi-generational experience in commercial and/or subsistence fishing, particularly for those Alaska Native residents for whom fishing is part of a larger, integrated traditional subsistence and economic sustenance practice rooted in thousands of years of history. The cultural importance of halibut (as a species) and halibut fishing (as a traditional activity) is documented in the anthropological literature for Alaska Native tribes and ethnic groups throughout Alaska. In addition to being a primary subsistence resource for many coastal cultures, halibut feature prominently in legends and parables. It is not uncommon to see halibut iconography in carvings, paintings, and textile handicrafts throughout the region, further suggesting its traditional cultural importance. The cultural significance of halibut for fishermen and their associated communities includes but exceeds the economic value of the fishery. Key themes include how halibut fishing provides a local source of employment in a day fishery that allows individuals to remain in their community, spend time with their family and build social networks, and engage in broader, culturally meaningful practices like subsistence. Halibut fishing is also considered a meaningful vocation and way of life.

While sustained participation of fishing communities in the BSAI groundfish or BSAI halibut fisheries would not appear to be directly at risk from implementation of the proposed action alternatives, the available literature and recent NPFMC analyses underline the fact that the proposed action is not taking place in isolation. Existing trends suggest that sustained participation in a range of commercial fisheries by residents of small communities in the region has become more challenging in recent years, with less inherent flexibility to adjust to both short- and long-term fluctuations in resource availability (as well as to changing markets for seafood products).

This flexibility is widely perceived in the communities as a key element in an overall adaptive strategy practiced in subsistence and economic contexts in the region for generations. This strategy involves piecing together individual livings (and often local economies) with an employment and income plurality approach. This plurality approach is particularly important given that the availability of non-fishing alternatives for income and employment are limited and, like the natural resources (and market factors) that underpin commercial fishing opportunities, tend to be subject to both short- and long-term fluctuations. This ongoing fluctuation in non-fishing opportunities further reinforces the importance of flexibility in the pursuit of a range of commercial fishing opportunities to enable individuals and communities the ability to successfully combine fishing and non-fishing as well as commercial and subsistence pursuits considered critical to long-term socioeconomic and sociocultural survival if not stability. To the extent that the proposed action alternatives would serve to provide for more opportunities for the success of small-scale commercial halibut fisheries during periods of low resource abundance, overall sustained participation in a range of local fisheries by residents of the smaller communities would be more secure.

5.6.2.2 Pacific Northwest communities

The Seattle MSA is also substantially engaged in the Area 4 halibut commercial fishery as measured by ownership address of actively participating catcher vessels, among other indicators of engagement. Its engagement in the BSAI halibut fishery is not as dominant relative to that of Alaska communities, however, compared to its relative engagement in the BSAI groundfish fisheries likely to be most directly affected by the proposed action alternatives. No community level adverse impacts related to the BSAI halibut fishery are anticipated to the Seattle MSA under either the no-action alterative or the proposed action alternatives.

5.7 Cumulative Effects

NEPA requires an analysis of the potential cumulative effects of a proposed federal action and its alternatives. Cumulative effects are those combined effects on the quality of the human environment that result from the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions, regardless of which federal or non-federal agency or person undertakes such other actions (40 CFR 1508.7, 1508.25(a) and 1508.25(c)). Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time. The concept behind cumulative effects analysis is to capture the total effects of many actions over time that would be missed if evaluating each action individually. Concurrently, the Council on Environmental Quality (CEQ) guidelines recognize that it is most practical to focus cumulative effects analysis on only those effects that are truly meaningful. Based on the preceding analysis, the effects that are meaningful are potential effects on Pacific halibut, if the alternatives result in a change in the spatial or size distribution of halibut removals. The cumulative effects on the other resources have been analyzed in numerous documents and the impacts of this proposed action and alternatives on those resources are minimal, therefore there is no need to conduct an additional cumulative impacts analysis.

The DEIS is intended to analyze the cumulative effects of each alternative and the effects of past, present, and reasonably foreseeable future actions (RFFAs). The past and present actions are described in the previous sections of this document. This section provides a review of the RFFAs that may result in cumulative effects on Pacific halibut. Actions are understood to be human actions (e.g., a proposed rule to designate northern right whale critical habitat in the Pacific Ocean), as distinguished from natural events (e.g., an ecological regime shift). CEQ regulations require consideration of actions, whether taken by a government or by private persons, which are reasonably foreseeable. This requirement is interpreted to indicate actions that are more than merely possible or speculative. In addition to these actions, this cumulative effects analysis includes climate change.

Actions are considered reasonably foreseeable if some concrete step has been taken toward implementation, such as a Council recommendation or NMFS's publication of a proposed rule. Actions only "under consideration" have not generally been included because they may change substantially or may not be adopted, and so cannot be reasonably described, predicted, or foreseen. Identification of actions likely to impact a resource component within this action's area and time frame will allow the public and Council to make a reasoned choice among alternatives.

The following RFFAs are identified as likely to have an impact on a resource component within the action area and timeframe:

- IPHC direct fishery harvests. The catch limit process for the halibut fisheries is under the authority of the IPHC. The IPHC is in the process of reconsidering harvest rates that are part of the harvest policy. Any changes to the IPHC's harvest policy, or its implementation, will have an impact the Pacific halibut stock.

Considering the direct and indirect impacts of the proposed action when added to the impacts of past and present actions previously analyzed in other documents that are incorporated by reference and the impacts of the reasonably foreseeable future actions listed above, the cumulative impacts of the proposed action are determined to be not significant.

5.8 Management and Enforcement Considerations

5.8.1 Enforcement Considerations

A reduction in halibut PSC limits may create an incentive to bias an observer's data. The prosecution of two individuals and Unimak Fisheries in 2005 and of the vessel operator and Rebecca Irene Fisheries in 2006 for biasing observer data and underreporting of halibut PSC during groundfish fisheries demonstrates this incentive. Since that time, monitoring requirements implemented with the Amendment 80 Program have reduced the likelihood of an observer's data being biased for the Amendment 80 fisheries. These requirements include video and electronic bin monitoring, a prohibition on mixing hauls, a requirement to weigh all catch on an approved flowscale unless halibut decksorting as described at § 679.120, and an increase to 200 percent observer coverage. However, recent reporting trends identified by Alaska Division of NOAA OLE indicate a significant increase in reports of harassment, intimidation, hostile work environment, and other attempts to bias observer samples of PSC in the Amendment 80, AFA, and hook-and-line CP fleet (AFSC and AKRO 2019). A further reduction of the halibut PSC limit for these sectors may result in additional coercive behavior and attempts to bias observer samples. NOAA OLE continues to investigate complaints that include pressuring observers to expedite delivery of haul composition data to the vessel captain more frequently than the data are transmitted to NMFS, intimidating or coercive attempts to influence observer sample collection with the intent to lower PSC estimates, and other attempts to remove prohibited species from an observer's sample. If the proposed action results in a reduction to halibut PSC limits it will likely increase, among some operators, the economic incentives to attempt to bias halibut PSC data through whatever means may be available.

In contrast, if the proposed action results in an increase to halibut PSC limits, it may decrease the incentive to bias an observer's data and reduce reports of harassment, intimidation, and hostile work environments directed at observers.

5.8.2 Management

The groundfish fisheries in Federal waters off Alaska are managed under the Fishery Management Plan for Groundfish of the Bering Sea and Aleutian Islands Management Area (BSAI FMP) and the Fishery Management Plan for Groundfish of the Gulf of Alaska (GOA FMP). In the Bering Sea and Aleutian Islands (BSAI) and Gulf of Alaska (GOA), groundfish harvests are managed subject to annual limits on the amounts of each groundfish species or species group that may be taken. The annual harvest specifications also set or apportion the prohibited species catch (PSC) limits. The annual limits are referred to as "harvest specifications," and the process of establishing them is referred to as the "harvest specifications process." The intended effect of these actions is to conserve and manage the groundfish resources in the BSAI in accordance with the MSA. The U.S. Secretary of Commerce approves the harvest specifications based on the recommendations of the North Pacific Fishery Management Council (Council). The goals of the harvest specifications process are to (1) manage fisheries based on the best scientific information available, (2) provide for adequate prior public review and comment on Council recommendations, (3) provide for additional opportunity for Secretarial review, (4) minimize unnecessary disruption to fisheries and public confusion, and (5) promote administrative efficiency.

At their October meeting, the Council recommends the proposed groundfish and PSC limits for the groundfish fisheries of the BSAI, and NMFS publishes them in the Federal Register. Regulations at § 679.20(c)(3) require NMFS to consider public comment on the proposed annual groundfish limits and the proposed PSC allowances, and to publish final harvest specifications in the **Federal Register**. At their December meeting, the Council recommends the final groundfish and PSC limits for the groundfish fisheries. The final harvest specification amounts are not expected to vary greatly from the proposed harvest specification amounts. NMFS will publish the final harvest specifications after 1) considering comments received within the comment period, 2) consulting with the Council at its December meeting, 3) considering information presented in the Supplemental Information Report to the EIS that assesses the need to prepare a Supplemental EIS, and 4) considering information presented in the final SAFE reports prepared for the groundfish fisheries.

Index values generated from the EBS trawl survey would be known at the October Council meeting and could published in the proposed harvest specifications. Index values generated from the IPHC setline survey would not be available until late November at the earliest. As such, the final PSC limits would not be known until the December Council meeting at the earliest. If the IPHC survey data was available by the December Council meeting then the PSC limit could be published in the final harvest specifications.

The final harvest specifications are usually effective with publication in the Federal Register in late February to early March. The groundfish fisheries open on January 1 for non-trawl gear and January 20 for trawl gear. The PSC limits from the previous two year harvest specifications are used to open the fisheries until superseded by the final harvest specifications PSC limits. If the PSC limits increase from the previous second year harvest specification, fisheries that might otherwise remain open under these PSC limits may prematurely close based on the lower PSC limits in place until the final harvest specifications are published. If the PSC limits decrease from the previous second year harvest specification, fisheries that might close directed fishing under these PSC limits may be exceeded based on the higher PSC limits in place until the final harvest specifications are published.

To cover the time between the opening of the groundfish fisheries and the publication of the final harvest specifications, the Regional Administrator may use the Inseason Adjustment authority under § 679.25 to adjust a PSC limit based on a determination that such adjustment is necessary to prevent the taking of a prohibited species that, on the basis of the best available scientific information, is found by NMFS to be incorrectly specified.

The use of the Inseason Adjustment authority may be warranted since data from the IPHC survey used to inform index values are not available until after the initial harvest specifications are presented to the Council at their October meeting.

6 Other Resource Categories

6.1 Marine Mammals

6.1.1 Status

Alaska supports one of the richest assemblages of marine mammals in the world. Twenty-two species are present from the order Carnivora, superfamilies Pinnipedia (seals, sea lions, and walrus), Ursoidea (polar bears), and Musteloidea (sea otters), and from the order Artiodactyla, infraorder Cetacea (whales, dolphins, and porpoises). Some marine mammal species are resident in waters off Alaska throughout the year, while others migrate into or out of Alaska fisheries management areas. Marine mammals occur in diverse habitats, including deep oceanic waters, the continental slope, and the continental shelf, including inshore waters. The National Marine Fisheries Service (NMFS) maintains management authority for all marine mammal species in Alaska, while the U.S. Fish and Wildlife Service (USFWS) is the designated management authority for northern polar bears, Pacific walrus, and northern sea otter.

The Marine Mammal Protection Act (MMPA), the Endangered Species Act (ESA), and the Fur Seal Act are the relevant statutes for managing marine mammal interactions with human activities, including commercial fishing operations. The MMPA was enacted in 1972 with the ideal of ensuring that marine mammal populations continue to be functioning elements of the ecosystems of which they are a part. One of the incentives for enacting the MMPA was to reduce take of marine mammals incidental to commercial fishing operations. While marine mammals may be lawfully taken incidentally in the course of commercial fishing operations, the 1994 MMPA Amendments established a requirement for commercial fishing operations to reduce incidental mortalities and serious injuries (M/SI) of marine mammals to insignificant levels approaching a zero rate, commonly referred to as the Zero Mortality Rate Goal (ZMRG). ZMRG is considered to be met for a marine mammal stock when the M/SI level from all commercial fisheries is 10 percent or below the Potential Biological Removal level (PBR) of that marine mammal stock (69 FR 43338, July 20, 2004). Likewise, the ESA was enacted to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species, and to take such steps as may be appropriate to achieve such conservation. In practice, the ESA outlines a program to protect endangered species on the brink of extinction and threatened species that are likely to be on the brink of extinction in the near future and pursue their recovery. The ESA also requires designation of any habitat of endangered or threatened species, which is then considered to have physical or biological features essential to the conservation of the species and which may require special management considerations or protection.

Under the MMPA a “population stock” is the fundamental unit of legally-mandated conservation and is defined as “a group of marine mammals of the same species or smaller taxa in a common spatial arrangement, which interbreed when mature.” Stocks are identified in a manner consistent with the management goals of the MMPA which include 1) preventing stocks from diminishing such that they cease to be a significant functioning element in the ecosystem of which they are a part or below their optimum sustainable population keeping the carrying capacity of the habitat in mind; and 2) maintaining the health and stability of the marine ecosystem. Therefore, a stock is also recognized as being a management unit that identifies a demographically isolated biological population. While many types of information can be used to identify stocks of a species, it is recognized that some identified stocks may fall short of that threshold due to a lack of information.

Marine mammal Stock Assessment Reports (SARs) are published annually under the authority of the MMPA for all stocks that occur in state and federal waters of the Alaska region [NMFS 2016]. Individual SARs provide information on each stock’s geographic distribution, population estimates, population trends, and estimates of the potential biological removal (PBR) levels for each stock. The SARs identify sources of human-caused mortality, including serious injury and mortality in commercial fishery operations, by fishery, and whether the stock has met ZMRG for all fisheries. The SARs also include the stock's ESA listing status and MMPA depleted and strategic designations. Strategic stock SARs are updated annually (Steller sea lions, northern fur seals, bearded seals, ringed seals, Cook Inlet beluga whales, AT1 Transient killer whales, harbor porpoise, sperm whales, humpback whales, fin whales, North Pacific right whales, and bowhead whales). SARs for non-strategic stocks are updated every three years or when significant new information is available.

Under the ESA species, subspecies, and distinct population segments (DPS) are eligible for listing as a threatened or endangered species. The ESA defines a species as ''any subspecies of fish or wildlife or plants, and any DPS of any species of vertebrate fish or wildlife which interbreeds when mature.'' The joint USFWS /NMFS DPS policy (61 FR 4722; February 7, 1996) establishes two criteria that must be met for a population or group of populations to be considered a DPS: (1) The population segment must be discrete in relation to the remainder of the species (or subspecies) to which it belongs; and (2) the population segment must be significant to the remainder of the species (or subspecies) to which it belongs.

A population segment of a vertebrate species may be considered discrete if it satisfies either one of the following conditions: 1) it is markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, or behavioral factors; or 2) it is delimited by international governmental boundaries within which differences in control of exploitation, management of habitat, conservation status, or regulatory mechanisms exist that are significant in light of section 4(a)(1)(D) of the ESA. Significance determinations are made using available scientific evidence of the population's biological and ecological importance to the taxon to which it belongs. This may include, but is not limited to, one or more of the following: 1) Persistence of the discrete population segment in an ecological setting unusual or unique for the taxon; 2) evidence that loss of the discrete population segment would result in a significant gap in the range of the taxon; 3) evidence that the discrete population segment represents the only surviving natural occurrence of a taxon that may be more abundant elsewhere as an introduced population outside its historic range; or 4) evidence that the discrete population segment differs markedly from other populations of the species in its genetic characteristics. It is important to note that the MMPA stock designations and ESA DPS designations for a given species do not necessarily overlap due to differences in the defining criteria for each.

Marine mammals have been given various levels of protection under the current fishery management plans of the Council, and several species are the subjects of continuing research and monitoring to further define the nature and extent of fishery impacts on them. A number of conservation concerns and/or management determinations may be related to marine mammals and the potential impacts of fishing. For individual species, these concerns or determinations may include—

- Protection under the ESA:
    - listed as endangered or threatened
    - placed on NMFS' list of "species of concern" or designated as a "candidate species" for ESA listings;
- Protection under the MMPA:
    - designated as depleted or strategic;
    - focus of a Take Reduction Plan;
- Other:
    - declining or depressed populations in a manner of concern to State or Federal agencies;
    - large bycatch or other mortality related to fishing activities; or
    - vulnerability to direct or indirect adverse effects from some fishing activities.

The Alaska Groundfish Fisheries Programmatic Supplemental Environmental Impact Statement (PSEIS) (NMFS 2004) provides descriptions of the range, habitat, and diet for marine mammals found in waters off Alaska. The 2015 PSEIS Supplemental Information Report (NMFS 2015) provides updates on changes to marine mammal stock or species-related management and status, as well as new information regarding impacts on marine mammal stocks and new methods to assess impacts. The information from the PSEIS and the SARs is incorporated by reference.

Marine mammal stocks, including those currently listed as endangered or threatened under the ESA or depleted or strategic under the MMPA that may be present in the action area are listed in Table 6-1. ESA section 7 formal and informal consultations with respect to the actions of the Federal groundfish fisheries have been completed for all of the ESA-listed species, either individually or in groups (NMFS 2010 and NMFS 2014a). Of the species listed under the ESA or stocks designated as depleted or strategic under the MMPA and present in the action area, several species may be more vulnerable than others to being adversely affected by commercial groundfish fishing. These include Steller sea lions, bearded seals, humpback whales, fin whales, and sperm whales. Stocks designated as depleted or strategic under the MMPA, but not listed as threatened or endangered under the ESA, that may be vulnerable to being adversely affected by commercial groundfish fishing include northern fur seals and harbor porpoise.

Table 6-1 Marine mammals known to occur in the Bering Sea and Aleutian Islands.

Infraorder or Superfamily	Species	MMPA Stock	ESA or MMPA Status	ZMRG Status (all fisheries)
Pinnipedia	Steller sea lion *(Eumatopias jubatus)*	Western U.S	Endangered, Depleted, Strategic	Not Met
	Northern fur seal *(Callorhinus ursinus)*	Eastern Pacific	Depleted, Strategic	Met
	Harbor seal *(Phoca vitulina)*	Pribilof Islands	None	Met
		Bristol Bay	None	Met
	Ribbon seal *(Phoca fasciata)*	Alaska	None	Met
	Bearded seal *(Erignathus barbatus nauticus)*	Alaska[a]	Threatened, Depleted, Strategic	Met
	Spotted seal *(Phoca largha)*	Alaska[b]	None	Met
	Ringed seal *(Phoca hispida)*	Alaska[c]	Threatened, Depleted, Strategic	Met
	Pacific Walrus *(Odobenus rosmarus divergens)*	Alaska[d]	Strategic	Met
Cetacea	Killer whale *(Orcinus orca)*	Eastern North Pacific Alaska Resident	None	Met
		Eastern North Pacific GOA, Aleutian Islands, and Bering Sea transient	None	Met
		Offshore***	None	Unknown*
	Pacific White-sided dolphin (*Lagenorhynchus obliquidens*)	North Pacific	None	Met
	Harbor porpoise *(Phocoena phoecena)*	Bering Sea	None	Met
	Dall's porpoise (*Phocoenoides dalli*)	Alaska	None	Met
		Beaufort Sea	None	Met

	Beluga whale *(Delphinapterus leucas)*	Eastern Chukchi Sea	None	Met
		Eastern Bering Sea	None	Unknown*
		Bristol Bay	None	Unknown**
	Baird's beaked whale (*Berardius bairdii*)	Alaska	None	Unknown*
	Cuvier's beaked whale (*Ziphius cavirostris)*	Alaska	None	Unknown*
	Stejneger's beaked whale (*Mesoplodon stejnegeri*)	Alaska	None	Unknown*
	Sperm whale (*Physeter macrocephalus*)	North Pacific	Endangered, Depleted, Strategic	Unknown*
	Bowhead whale *(Balaena mysticetus)*	Western Arctic (Also known as Bering-Chukchi-Beaufort stock)	Endangered, Depleted, Strategic	Met
	Humpback whale *(Megaptera novaeangliae)* †	Western North Pacific‡	WNP DPS-Endangered, Depleted, Strategic	Not Met
		Central North Pacific ‡‡	Mexico DPS-Threatened, Depleted, Strategic Hawaii DPS - None	Not Met
	Fin whale *(Balaenoptera physalus)*	Northeast Pacific	Endangered, Depleted, Strategic	Met
	Minke whale *(Balaenoptera acutorostrata)*	Alaska	None	Unknown*
	North Pacific right whale *(Eubalaena japonica)*	Eastern North Pacific	Endangered, Depleted, Strategic	Unknown*
	Blue whale *(Balaenoptera musculus)*	Eastern North Pacific***	Endangered, Depleted, Strategic	Met
	Sei whale *(Balaenoptera borealis)*	Eastern North Pacific***	Endangered, Depleted, Strategic	Met
Mustelidae	Northern sea otter *(Enhydra lutris)*	Southwest Alaska	Threatened, Depleted, Strategic	Unknown*
Ursoidea	Polar Bear *(Ursus maritimus)*	Chukchi/Bering Sea	Threatened, Depleted, Strategic	Unknown*

Sources: Muto et al 2019; Carretta et al 2019; List of Fisheries for 2020 (April 16, 2020 85 FR 21079)
* Unknown due to unknown abundance estimate and PBR.
** Unknown due to inadequate observer coverage or unreliable SI/M estimate.
*** This stock is found in the Pacific SAR, rather than in the Alaska SAR.
**** The PBR for the North Pacific right whale is calculated, but considered unreliable. However, there are no known fishery-related SI/M.
† On September 8, 2016, NMFS published a final decision revising the status of humpback whales under the ESA (81 FR 62259), effective October 11, 2016. In the 2016 decision, NMFS recognized the existence of 14 DPSs, classified several as endangered and one as threatened, and determined that the remaining DPSs do not warrant protection under the ESA. Three DPSs of humpback whales occur in waters off the coast of Alaska: the Asia/2nd Western North Pacific (WNP) DPS, which is endangered, the Mexico DPS, which is threatened, and the Hawaii DPS, which is not protected under the ESA. Whales from these three DPSs overlap to some extent on feeding grounds off Alaska. As of October 2016, the MMPA stock designations of humpback whales found in Alaska have not been updated to reflect the newly-designated DPSs. Proposed critical habitat was published on October 9, 2019 (84 FR 54354).
‡ Corresponds to the new Asia/ 2nd WDPS (endangered).
‡‡ Includes the new Mexico (threatened) and Hawaii DPSs (not protected under the ESA).
[a] Bearded seals: Two DPSs are identified for this subspecies, but only the Beringia DPS occurs in US waters. Therefore, the Alaska stock identified under the MMPA SAR consists entirely of the Beringia DPS. The Beringia DPS was most recently listed as threatened under the ESA in October 2016. Critical habitat for the Beringia DPS was proposed in January 2021.
[b] Spotted seals: Three DPSs are identified, but only the Bering DPS occurs in US waters. Therefore, the Alaska stock identified under the MMPA SAR consists entirely of the Bering DPS.
[c] Ringed seals were listed as threatened under the ESA in December 2012. In March 2016 the U.S. District Court vacated the listing. In May 2016 NMFS appealed the March 2016 decision. Critical habitat for ringed seals was proposed in January 2021

[d] Walrus – A petition to list walrus under the ESA was determined to be warranted, but precluded by higher priorities (76 FR 7634, February 10, 2011). The USFWS is under court order to make a decision on the listing in 2017. As of October 5, 2017, NMFS determined that listing is no longer warranted for the Pacific walrus.

Table 6-2 Status of Pinnipedia and Carnivora stocks potentially affected by the action.

Pinnipedia and Carnivora species and stock or DPS	Status under the ESA	Status under the MMPA	Population trends	Distribution in action area
Steller sea lion –Western (W) Distinct Population Segment (DPS)	Endangered	Depleted & strategic	Using survey counts from 1987-2018, western Steller sea lion pup and non-pup counts in Alaska in 2018 were modeled to be 53,624. Modeled count data collected from 1978 through 2018 indicates that pup and non-pup counts of western stock Steller sea lions in Alaska were at their lowest levels in 2002 and have increased at 1.52% y-1 and 2.05% y-1, respectively, between 2002 and 2018. However, there are strong regional differences across the range in Alaska, with positive trends in the GOA and the eastern Aleutian Is region and generally negative trends to the west of Samalga Pass. Survey effort was focused in the Aleutian Is in 2018. Non-pup and pup counts in the western Aleutians have been in a steep decline overall. However, modeled realized counts show a period of stability in this region from 2014 to 2016 (and potentially an increase in pup counts), followed by a decline between 2016 and 2018.	WDPS inhabits Alaska waters from Prince William Sound westward to the end of the Aleutian Island chain and into Russian waters. EDPS inhabit waters east of Prince William Sound to Dixon Entrance. Occur throughout AK waters, terrestrial haulouts and rookeries on Pribilof Islands, Aleutian Islands, St. Lawrence Island, and off the mainland. Use marine areas for foraging. Critical habitat designated around major rookeries, haulouts, and foraging areas.
Northern fur seal Eastern Pacific	None	Depleted &strategic	Recent pup counts show a continuing decline in the number of pups surviving in the Pribilof Islands. From 1998 to 2016, pup production declined 4.12% per year (SE = 0.40%; P < 0.01) on St. Paul Island and showed no significant trend (SE = 0.57%; P = 0.13) on St. George Island. Between 1997 and 2015, pup production at Bogoslof Is increased 10.1% per year.	Fur seals occur throughout Alaska waters, but their main rookeries are located in the Bering Sea on Bogoslof Isd and the Pribilof Islands. Approximately 55% of the worldwide abundance of fur seals is found on the Pribilof Is . Forages in the pelagic area of the Bering Sea during summer breeding season, but most leave the Bering Sea in the fall to spend winter and spring in the N. Pacific.
Harbor seal – Pribilof Islands, Bristol Bay and Aleutian Islands	None	None	Pribilof Is – trend unknown; Bristol Bay – approx. 2.5 % increase oer year over 8 years; Aleutian Is – approx. 2% per year decrease over eight years;	Pribilof Islands - Saint Paul and Saint George Islands, Otter and Walrus Islands; Bristol Bay– range from Nunivak Island south to the west coast of Unimak Island and extending inland(east) to Kvichak Bay and Lake Iliamna; Aleutian Is - entire Aleutian chain from Attu Island to Ugamak Island;
Ribbon seal Alaska	None	None	Reliable data on population trends are unavailable.	Widely dispersed throughout the Bering Sea and Aleutian Islands in the summer and fall. Associated with ice in spring and winter and may be associated with ice in summer and fall.
Northern sea otters – SW Alaska	Threatened	Depleted & strategic	The overall population trend for the southwest Alaska stock is believed to be increasing, with except for along the western AK Peninsula and the Aleutian Is.	Coastal waters from Central GOA to W Aleutians within the 40 m depth contour. Critical habitat designated in primarily nearshore waters with few locations into federal waters in the GOA.

Sources: Muto et al 2019; List of Fisheries for 2020 (May 16, 2019 84 FR 22052)

Table 6-3 Status of Cetacea stocks potentially affected by the action.

Cetacea species/stock	Status under the ESA	Status under the MMPA	Population trends	Distribution in action area
Killer whale - Eastern North Pacific Alaska resident	None	None	The minimum population estimate (N_{MIN}) for the Alaska Resident stock of killer whales is 2,084 animals.	Alaska resident whales are found from southeastern Alaska to the Aleutian Islands and Bering Sea. Intermixing of Alaska residents have been documented among the three areas, at least as far west as the eastern Aleutian Islands.
Killer whale - Eastern North Pacific Northern resident	None	None	N_{MIN} for the Northern Resident stock is 302 whales, including whales found in Canadian waters. From the mid-1970s to the 1990s, the Northern Resident killer whale population increased at an annual rate of 2.6% (i.e., from 122 whales in 1974 to 218 in 1997). A decline was reported from 1998 to 2001 at a rate of 7% per year. The increased mortality that drove this decline coincided with a period of reduced range-wide Chinook salmon abundance, their primary prey. After 2001 growth was positive with the population increasing at an average rate of 2.9% per year from 2002 to 2014. This represents an average annual increase of 2.2% over the 40-year time series. However, annual Northern Resident killer whale population growth rates have slowed over the past five census years, from 5.1% in 2014 to -0.3% in 2018.	The Eastern North Pacific Northern Resident stock is a transboundary stock and includes killer whales that frequent British Columbia, Canada, and Southeast Alaska. They have been seen infrequently in Washington State waters. Members of the Northern Resident population have been documented in Southeast Alaska; however, they have not been seen to intermix with Alaska Residents.
Dall's porpoise Alaska	None	None	Reliable data on population trends are unavailable.	Dall's porpoise are widely distributed across the entire North Pacific Ocean (Fig. 1). They are found over the continental shelf adjacent to the slope and over deep (2,500+ m) oceanic waters (Hall 1979). They have been sighted throughout the North Pacific as far north as 65°N (Buckland et al. 1993) and as far south as 28°N in the eastern North Pacific (Leatherwood and Fielding 1974). The only apparent distribution gaps in Alaska waters are upper Cook Inlet and the shallow eastern flats of the Bering Sea.
Pacific white-sided dolphin	None	None	Reliable data on population trends are unavailable.	In the eastern North Pacific, the species occurs from the southern Gulf of California, north to the Gulf of Alaska, west to Amchitka in the Aleutian Islands, and is sometimes encountered in the southern Bering Sea.
Harbor porpoise BSAI	None	None	Reliable data on population trends are unavailable.	Primarily in coastal waters in the BSAI, usually less than 100 m.
Humpback whale – Western, Mexico, and Hawaii DPS	WNP DPS-Endangered Mexic DPs-Threatened Hi DPS-None	WNP and Mexico DPS Depleted & strategic	Increasing. The Structure of Populations, Levels of Abundance, and Status of Humpbacks (SPLASH) abundance estimate for the North Pacific represents an annual increase of 4.9% since 1991–1993. SPLASH abundance estimates for Hawaii show annual increases of 5.5% to 6.0% since 1991–1993.	

North Pacific right whale Eastern North Pacific	Endangered	Depleted & strategic	This stock is considered to represent only a small fraction of its pre-commercial whaling abundance and is arguably the most endangered stock of large whales in the world. A reliable estimate of trend in abundance is currently not available.	Before commercial whaling on right whales, concentrations were found in the GOA, eastern Aleutian Islands, southcentral Bering Sea, Sea of Okhotsk, and Sea of Japan. During 1965–1999, following large illegal catches by the U.S.S.R., there were only 82 sightings of right whales in the entire eastern North Pacific, with the majority of these occurring in the Bering Sea and adjacent areas of the Aleutian Islands. Critical habitat near Kodiak Island in the GOA.
Fin whale Northeast Pacific	Endangered	Depleted & strategic	Abundance may be increasing but surveys only provide abundance information for portions of the stock in the Central-eastern and southeastern Bering and coastal waters of the Aleutian Islands and the Alaska Peninsula. Much of the North Pacific range has not been surveyed.	Found in the GOA, Bering Sea and coastal waters of the Aleutian Islands.
Beluga whale- Beaufort Sea, Eastern Chukchi Sea, Eastern Bering Sea, Bristol Bay stocks	None	None	Beaufort Sea – unknown, but possibly stable or increasing, Eastern Chukchi Sea - unknown, Eastern Bering Sea – unknown, Bristol Bay - population increased by 65% from 1993 through 2005.	The Beaufort Sea and Eastern Chukchi Sea stocks migrate between the Bering and Beaufort seas. Beaufort Sea beluga whales depart the Bering Sea in early spring, through the Chukchi Sea and into the Beaufort Sea where they remain in the summer and fall, returning to the Bering Sea in late fall. Eastern Chukchi Sea migrate out of the Bering Sea in late spring and early summer, into the Chukchi Sea and western Beaufort Sea where they remain in the summer, returning to the Bering Sea in the fall. The Eastern Bering Sea stock remains in the Bering Sea but moves south near Bristol Bay in winter and returns north to Norton Sound and the mouth of the Yukon River in summer. Beluga whales found in Bristol Bay remain in that area throughout the year, showing only small seasonal shifts in distribution.
Minke whale Alaska	None	None	There are no data on trends in Minke whale abundance in Alaska waters.	Common in the Bering and Chukchi Seas. Not common in the Aleutian Islands.
Sperm whale North Pacific	Endangered	Depleted & strategic	Abundance and population trends in Alaska waters are unknown.	Inhabit waters 600 m or more depth, south of 62°N lat. Widely distributed in North Pacific. During summer, males are found in the Gulf of Alaska, Bering Sea, and waters around the Aleutian Islands. Females may be found in the western Aleutian Is in summer months.
Baird's, Cuvier's, and Stejneger's beaked whale	None	None	Reliable data on population trends are unavailable.	Baird's beaked whale - Bering Sea north to St. Matthew Island, Pribilof Is, and western Aleutian Is., Cuvier's, beaked whale - Aleutian Is., Stejneger's beaked whale – Aleutian Is., Bering Sea, incl Pribilof Is.

Sources: Muto et al 2019; List of Fisheries for 2020 (May 16, 2019 84 FR 22052)

The Alaska Groundfish Harvest Specifications EIS provides information on the effects of the groundfish fisheries on marine mammals (NMFS 2007), and has been updated with Supplemental Information Reports (SIRs) (NMFS 2015). These documents are also incorporated by reference. Direct and indirect interactions between marine mammals and groundfish fishing vessels may occur due to overlap in the size and species of groundfish harvested in the fisheries that are also important marine mammal prey, and due to temporal and spatial overlap in marine mammal occurrence and commercial fishing activities. This discussion focuses on those marine mammals that may interact with or be affected by the BSAI groundfish fisheries (Table 6-2 and Table 6-3).

6.1.2 Effects on Marine Mammals

Incidental Take

Marine mammals can be taken in groundfish fisheries by entanglement in gear (e.g., trawl, longline, and pot) and, rarely, by ship strikes for some cetaceans. The effects of the status quo fisheries on incidental takes of marine mammals are detailed in the 2007 harvest specifications EIS (NMFS 2007) and Allen et al. (2014). The annual Stock Assessment Report lists the species of marine mammals taken in the BSAI groundfish fisheries using observer data (Allen et al. 2014). In addition, the List of Fisheries for 2020 (85 FR 21079, April 16, 2020), describes known incidental takes of marine mammals in the groundfish fisheries. The BSAI flatfish, pollock, and rockfish trawl fisheries are listed as category II, with occasional interactions with some marine mammals. The BSAI Pacific cod longline fishery is listed as Category II, with a remote likelihood of interaction with Dall's porpoise and northern fur seal. Based on the annual stock assessment reports, the potential take of marine mammals in the BSAI groundfish fisheries is well below the PBRs or a very small portion of the overall human caused mortality for those species for which a PBR has not been determined (Allen and Angliss 2014). Therefore, the incidental takes under Alternative 1 have an insignificant effect on marine mammals in the BSAI.

Some PSC limits as a result of lookup tables for Alternatives 2, 3, and 4 may result in no change to the status quo. Some PSC limits as a result of lookup tables for Alternatives 2, 3, and 4 may result in constraining PSC limits under which industry may change fishing patterns in order to maximize species with the greatest economic value. This could result in reduced fishing effort, as the industry chooses not to pursue less valuable fisheries in order to conserve halibut PSC, or it could result in greater fishing effort at lower catch per unit effort, as vessels change fisheries patterns or seasonal changes in the timing of the fishing, to increase halibut avoidance.

In contrast, PSC limits as a result of lookup tables for Alternatives 2, 3, and 4 could result in increased PSC limits. This could result in a response of increased fishing effort, as industry is less constrained by halibut PSC limits. Any change to fishing effort levels or temporal or spatial shifts in harvest effort resulting from adoption of any of the alternatives and its options would not be expected to impact levels of incidental take of marine mammals, unless such change resulted in the fishery being prosecuted in a way that significantly increased exposure of marine mammals to fishing gear. However, there is already considerable interannual variability in the patterns of fishing across the BSAI groundfish sectors, as environmental conditions and avoidance of PSC species have caused vessels to adjust their fishing patterns. Any spatial or temporal shift in fishing is unlikely to occur outside of the existing spatial or temporal footprint of the groundfish fishery as none of the proposed alternatives alter the number of fishery participants or propose changing the location or timing of the fishery.

The potential for incidental take of marine mammals may change from status quo and will be dependent on the options selected by the Council. However, the fisheries are unlikely to increase their take of marine mammals above the PBR, because they are currently well below that level in BSAI groundfish fisheries, and no roposed PSC limits under Alternative 2, 3 and 4 are expected to result in significant increases in total fishing effort in the BSAI. TAC and other restrictive harvest measures for the Amendment 80 sector will not be changed as a result of this action, and no marine mammal protection measures will change as a result of this proposed action. Therefore, the incidental takes under Alternatives 2, 3, and 4 are not expected to have a significant effect on marine mammals.

Prey Availability Effects

Harvests of marine mammal prey species in the BSAI groundfish fisheries may limit foraging success through localized depletion, overall reduction in prey biomass, and dispersion of prey, making it more energetically costly for foraging marine mammals to obtain necessary prey. Overall reduction in prey biomass may be caused by removal of prey or disturbance of prey habitat. The timing and location of fisheries relative to foraging patterns of marine mammals and the abundance of prey species may be a more relevant management concern than total prey removals.

The interaction of the BSAI groundfish fisheries with Steller sea lions, which potentially compete for prey, is comprehensively addressed in the Final Environmental Impact Statement for Steller Sea Lion Protection Measures for Groundfish Fisheries in the Bering Sea and Aleutian Islands Management Area (2014 Steller Sea Lion Protection Measures FEIS; NMFS 2014b.). The BSAI groundfish fisheries may impact availability of key prey species of Steller sea lions, harbor seals, northern fur seals, ribbon seals; and fin, minke, humpback, beluga, and resident killer whales. Animals with more varied diets (humpback whales) are less likely to be impacted than those that eat primarily pollock and salmon, such as northern fur seals. Table 6-4 shows the BSAI marine mammal species and their prey species that may be impacted by BSAI groundfish fisheries.

Table 6-4 Prey species used by BSAI marine mammals that may be impacted by the BSAI groundfish fisheries.

Species	Prey
Fin whale	Zooplankton, squid, fish (herring, cod, capelin, and pollock), and cephalopods
Humpback whale	Zooplankton, schooling fish (pollock, herring, capelin, saffron, cod, sand lance, Arctic cod, and salmon)
Beluga whale	Wide variety of invertebrates and fish including salmon and pollock
Killer whale	Marine mammals (transients) and fish (residents) including herring, halibut, salmon, and cod.
Ribbon seal	Cod, pollock, capelin, eelpout, sculpin, flatfish, crustaceans, and cephalopods.
Harbor seal	Crustaceans, squid, fish (including salmon), and mollusks
Steller sea lion	Pollock, Atka mackerel, Pacific herring, Capelin, Pacific sand lance, Pacific cod, and salmon

Several marine mammals may be impacted indirectly by any effects that fishing gear may have on benthic habitat. Table 6-5 lists marine mammals that may depend on benthic prey and known depths of diving. Diving activity may be associated with foraging. The essential fish habitat (EFH) EIS provides a description of the effects of groundfish fishing on benthic habitat (NMFS 2005). In the BSAI, estimated reductions of epifaunal and infaunal prey due to fishing are less than 1 percent for all substrate types. For living structure, overall impacts ranged between 3 percent and 7 percent depending on the substrate. In some local areas where pollock aggregate, effects are greater.

Sperm whales are not likely to be affected by any potential impacts on benthic habitat from fishing because they generally occur in deeper waters than where the groundfish fishery is conducted (Table 6-5). Harbor seals and sea otters are also not likely to have any benthic habitat affected by the groundfish fishery because they occur primarily along the coast where fishing is not conducted. Cook Inlet beluga whales also are not likely to have benthic habitat supporting prey species affected by the groundfish fishery because they do not range outside of Cook Inlet and do not overlap spatially with the trawl fisheries although other beluga whale stocks in the BSAI may have some overlap.

Table 6-5 Benthic dependent BSAI marine mammals, foraging locations, and diving depths

Species	Depth of diving and location
Ribbon seal	Mostly dive < 150 m on shelf, deeper off shore. Primarily in shelf and slope areas.
Harbor seal	Up to 183 m. Generally coastal.
Sperm whale	Up to 1,000 m, but generally in waters > 600 m.
Northern sea otter	Rocky nearshore < 75 m
Gray whale	Benthic invertebrates

Sources: Allen and Angliss 2010; Burns et al. 1981; http://www.adfg.state.ak.us/pubs/notebook/marine/rib-seal.php; http://www.afsc.noaa.gov/nmml/species/species_ribbon.php; http://www.adfg.state.ak.us/pubs/notebook/marine/harseal.php; http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/spermwhale.htm

The Harvest Specifications EIS determined that competition for key prey species under the status quo fishery is not likely to constrain the foraging success of marine mammals or cause population declines (NMFS 2007). The 2014 Steller Sea Lion Protection Measures FEIS (NMFS 2014b) provided an updated review of BSAI groundfish fishery interactions with respect to prey availability. Based on a review of marine mammal diets, and an evaluation of the status quo harvests of potential prey species in the BSAI groundfish fishery, the effects of Alternative 1 on prey availability for marine mammals are not likely to cause population level effects.

Options under Alternatives 2, 3 and 4 may result in no change to the status quo, or may result in constraining PSC limits under which industry may change fishing patterns in order to maximize species with the greatest economic value. This could result in a response of reducing fishing effort, as the industry chooses not to pursue less valuable fisheries in order to conserve halibut PSC, or it could result in greater fishing effort at lower catch per unit effort, as vessels change fisheries patterns or seasonal changes in the timing of the fishing, to increase halibut avoidance. In contrast, some options under Alternatives 2, 3 and 4 could result in increased PSC limits. This could result in a response of increased fishing effort, as industry is less constrained by halibut PSC limits.

Shifts in the location or timing of fishing may change the availability of prey species to marine mammals in particular areas. However, there is already considerable interannual variability in the patterns of fishing across the BSAI groundfish sectors, as environmental conditions and avoidance of PSC species have caused vessels to adjust their fishing patterns. Any spatial or temporal shift in fishing is unlikely to occur outside of the existing spatial or temporal footprint of the groundfish fishery as none of the proposed alternatives alter the number of fishery participants or propose changing the location or timing of the fishery. Therefore it is unlikely that Alternatives 2, 3, or 4 would introduce a shift in fishing patterns to such an extent that it would constrain the availability of prey to marine mammals in such a way as to cause a population-level decline or impede recovery for more vulnerable populations.

Disturbance Effects

The Harvest Specifications EIS contains a detailed description of the disturbance of marine mammals by the groundfish fisheries (NMFS 2007). The interaction of the BSAI groundfish fisheries with Steller sea lions, which potentially compete for prey, is comprehensively addressed in the Steller Sea Lion Protection Measures EIS (NMFS 2014b). The EISs concluded that the status quo fishery does not cause disturbance to marine mammals at a level that may cause population level effects. Fishery closures limit the potential interaction between fishing vessels and marine mammals (e.g., 3-nm no groundfish fishing areas around Steller sea lion rookeries and walrus protection areas). Because disturbances to marine mammals under the status quo fishery are not likely to cause population level effects, the impacts of Alternative 1 are not significant.

The effects of the proposed reductions to halibut PSC limits under Alternative 2, 3, and 4 on disturbance of marine mammals would be similar to the effects on incidental takes. If a groundfish fishery reduces fishing effort in specific fisheries to conserve halibut PSC for a more valuable fishery, then less potential exists for disturbance of marine mammals. If a groundfish fishery increases the duration of fishing in areas, there may be more potential for disturbance if this increased fishing activity overlaps with areas used by marine mammals. None of the disturbance effects on other marine mammals under Alternative 2, 3, or 4 are expected to result in population level effects on marine mammals. Disturbance effects are likely to be localized and limited to a small portion of any particular marine mammal population. The potential disturbances to marine mammals under Alternatives 2, 3, and 4 are not likely to result in population level effects.

Cumulative Effects on Marine Mammals

Based on the preceding analysis, the impacts of this proposed action and alternatives on marine mammals are either non-existent or *de minimus*; therefore, there is no need to conduct an additional cumulative impact analysis.

6.2 Seabirds

6.2.1 Status

Alaska's waters support extremely large concentrations of seabirds. Over 80 million seabirds are estimated to occur in Alaska annually, including 40 million to 50 million individuals from the numerous species that breed in Alaska (Table 6-6; USFWS 2009). An additional 40 million to 50 million individuals do not breed in Alaska but spend part of their life cycle there. These include short-tailed and sooty shearwaters and three albatross species: the black-footed albatross, the Laysan albatross, and the endangered short-tailed albatross (Table 6-6; USFWS 2009).

As noted in the PSEIS (NMFS 2004 and 2015), seabird life history includes low reproductive rates, low adult mortality rates, long life span, and delayed sexual maturity. These traits make seabird populations extremely sensitive to changes in adult survival and less sensitive to fluctuations in reproductive effort. The problem with attributing population changes to specific impacts is that, because seabirds are long-lived animals, it may take years or decades before relatively small changes in survival rates result in observable impacts on the breeding population.

Table 6-6 Seabird species in Alaska

Type	Common name	Status
Albatrosses	Black-footed	
	Short-tailed	Endangered
	Laysan	
Fulmars	Northern fulmar	
Shearwaters	Short-tailed	
	Sooty	
Storm petrels	Leach's	
	Fork-tailed	
	Pelagic	
	Red-faced	
	Double-crested	
Gulls	Glaucous-winged	
	Glaucous	
	Herring	
	Mew	
	Bonaparte's	
	Slaty-backed	
Murres	Common	
	Thick-billed	
Jaegers	Long-tailed	
	Parasitic	
	Pomarine	
Guillemots	Black	
	Pigeon	
Eiders	Common	
	King	
	Spectacled	Threatened
	Steller's	Threatened
Murrelets	Marbled	
	Kittlitz's	
	Ancient	
Kittiwakes	Black-legged	
	Red-legged	
Auklets	Cassin's	
	Parakeet	
	Least	
	Whiskered	
	Crested	
Terns	Arctic	
Puffins	Horned	
	Tufted	

More information on seabirds in Alaska's EEZ may be found in several NMFS, Council, and USFWS documents:

- The URL for the USFWS Migratory Bird Management program is at https://www.fws.gov/birds/management.php
- Section 3.7 of the PSEIS (NMFS 2004) provides background on seabirds in the action area and their interactions with the fisheries. This may be accessed at https://alaskafisheries.noaa.gov/sites/default/files/pseis0604-chpt_3_7.pdf.
- Section 6.3 of the PSEIS (NMFS 2015) provides background on seabirds in the action area and their interactions with the fisheries. This may be accessed at https://www.npfmc.org/wp-content/PDFdocuments/fmp/Final_SIR_2015.pdf.
- The annual Ecosystem Status Reports have a chapter on seabird bycatch: https://access.afsc.noaa.gov/reem/ecoweb/index.php.
- The Seabird Fishery Interaction Research webpage of the Alaska Fisheries Science Center: http://www.afsc.noaa.gov/REFM/REEM/Seabirds/Default.php.
- The NMFS Alaska Region's Seabird Bycatch webpage: https://www.fisheries.noaa.gov/alaska/bycatch/seabird-bycatch-alaska.

- The BSAI and GOA groundfish FMPs each contain an "Appendix I" dealing with marine mammal and seabird populations that interact with the fisheries. The FMPs may be accessed from the Council's home page at http://www.alaskafisheries.noaa.gov/npfmc/default.htm.
- Washington Sea Grant has several publications on seabird takes, and technologies and practices for reducing them: https://wsg.washington.edu/seabird-bycatch-prevention-in-fisheries/.
- The seabird component of the environment affected by the groundfish FMPs is described in detail in Section 3.7 of the PSEIS (NMFS 2004), and updated in the PSEIS Supplemental Information Report (NMFS 2015).
- Seabirds and fishery impacts are also described in Chapter 9 of the Alaska Groundfish Harvest Specifications EIS (NMFS 2007).
- USFWS. 2015. Biological Opinion for the Effects of the Fishery Management Plans for the Gulf of Alaska and Bering Sea/Aleutian Islands Groundfish Fisheries and the State of Alaska Parallel Groundfish Fisheries. Anchorage, AK: 52 pp. Document available at: https://alaskafisheries.noaa.gov/sites/default/files/analyses/usfws-biop-122315.pdf
- NMFS. 2015. Programmatic Biological Assessment on the Effects of the Fishery Management Plans for the Gulf of Alaska and Bering Sea/Aleutian Islands Groundfish Fisheries and the State of Alaska Parallel Groundfish Fisheries on the Endangered Short-tailed Albatross (*Phoebastria albatrus*) and the Threatened Alaska-breeding Population of the Steller's Eider (*Polysticta stelleri*). Document available at: https://alaskafisheries.noaa.gov/sites/default/files/analyses/seabirdba0815.pdf
- Seabird Bycatch and Mitigation Efforts in Alaska Fisheries Summary Report: 2007 through 2015 (Eich et al. 2016). Document available at: https://repository.library.noaa.gov/view/noaa/12695
- Seabird Bycatch Estimates for Alaska Groundfish Fisheries 2016 through 2017 (Eich et al. 2018). Document available at: https://doi.org/10.25923/vb9g-s503
- Seabird Bycatch Estimates for Alaska Groundfish Fisheries: 2019 (Krieger et al. 2020). Document available at: https://www.fisheries.noaa.gov/national/bycatch/seabirds

6.2.2 Effects on Seabirds

The PSEIS identifies how the BSAI groundfish fisheries activities may directly or indirectly affect seabird populations (NMFS 2004 and 2015). Direct effects may include incidental take (lethal) in fishing gear and vessel strikes. Indirect effects may include reductions in prey (forage fish) abundance and availability, disturbance to benthic habitat, discharge of processing waste and offal, contamination by oil spills, presence of nest predators on islands, and disposal of plastics, which may be ingested by seabirds.

The impacts of the Alaska groundfish fisheries on seabirds were analyzed in the Harvest Specifications EIS (NMFS 2007) which evaluated the impacts of the alternative harvest strategies on seabird takes, prey availability, and seabird ability to exploit benthic habitat. The focus of this analysis is similar, as any changes to the groundfish fisheries in the BSAI could change the potential for direct take (death) of seabirds. Potential changes in prey availability (seabird prey species caught in the fisheries) and disruption of bottom habitat via the intermittent contact with non-pelagic trawl gear under different levels of harvest are examples of indirect effects on seabirds and are discussed in NMFS (2007). However, prey availability changes could also be closely associated with changes in seabird take levels. Therefore, all impacts to seabirds are addressed by focusing on potential changes in seabird takes (direct effects).

Of particular concern is the impact on seabirds listed under the ESA. Three species of seabirds are currently listed as either threatened or endangered; the short-tailed albatross (endangered), Alaska-breeding population of Steller's eider (threatened), and Spectacled eider (threatened). The USFWS consulted with NOAA Fisheries Alaska Region under section 7 of the ESA on the effects of the groundfish fisheries on these species. In its 2021 biological opinion, the USFWS determined the groundfish fisheries off Alaska are likely to adversely affect short-tailed albatross, spectacled eider, and the Alaska-breeding population of Steller's eider, but they are not likely to jeopardize their continued existence (USFWS 2021). It was also determined that the groundfish fisheries off Alaska are not likely to adversely affect designated critical habitat of the Alaska-breeding population of Steller's eider and Spectacled eider. This 2021 biological opinion included an incidental take limit of six short-tailed albatross every two years, 25 spectacled eider every 4 years, and 3 Steller's eider every 4 years, in the groundfish fisheries off Alaska.

Impact Analysis

Incidental Take of Seabirds in Trawl Fisheries

Seabirds can interact with trawl fishing vessels in several ways. Birds foraging at the water surface or in the water column are sometimes caught in the trawl net as it is brought back on board. These incidental takes of seabirds are recorded by fisheries observers as discussed below. In addition to getting caught in the fishing nets of trawl vessels, some species strike cables attached to the infrastructure of vessels or collide with the infrastructure itself. Large-winged birds such as albatrosses are most susceptible to mortalities from trawl-cable strikes. Third wire cables have been prohibited in some southern hemisphere fisheries since the early 1990s due to substantial albatross mortality from cable strikes. No short-tailed albatross or black-footed albatross have been observed taken with trawl gear in the BSAI, but mortalities to Laysan albatrosses have been observed.

The average annual estimate of incidental take of birds in trawl gear in the BSAI was 697 birds per year from 2010 through 2019 (Krieger et al. 2020). Northern fulmars comprised the majority of this take, with shearwaters and gulls also taken in almost every year. An estimate of 93 Laysan albatross is attributed to the BSAI trawl fisheries in 2018. Storm petrels, murres, auklets, and cormorants were also taken in small number in trawling operations in the BSAI from 2010 through 2019. The estimated takes of gulls, fulmars, and shearwaters in the entire BSAI groundfish fishery are very small percentages of these species' populations, with the exception of a large number of shearwaters incidentally taken in 2019 (1,487 birds; Krieger et al. 2019). The increase in shearwater bycatch was attributed to a shearwater mortality event that occurred throughout Alaska in 2019.

Seabird takes in the BSAI trawl fisheries are relatively low, based on standard observer sampling and NMFS estimation. However, standard species composition sampling of the catch does not account for additional mortality due to gear interactions such as net entanglements or cable strikes. Special data collections of seabird gear interactions have been conducted, and preliminary information indicates that mortalities can be greater than the birds accounted for in the standard species composition sampling (Melvin et al. 2011). The probability of ESA-listed seabird collisions with third wires or other trawl vessel gear in the EEZ off Alaska cannot be assessed; however, given the available observer data and the observed at-sea locations of short-tailed albatrosses relative to trawling effort, the likelihood of ESA-listed seabird collisions are remote, but the possibility of such collisions cannot be completely discounted.

Impacts under the alternatives

Estimated takes in the BSAI trawl groundfish fisheries average 697 birds per year, and in the hook-and-line fishery, 5,000 birds per year; in both, they primarily consist of northern fulmars (Krieger et al. 2020). These seabird take estimates are small in comparison to seabird population estimates, and under the status quo alternative, it is reasonable to conclude that the impacts would continue to be similar. However, observers are not able to monitor all seabird mortality associated with trawl vessels. Several research projects are currently underway to provide more information on these interactions.

Various spatial restrictions on the trawl fisheries in the BSAI have been established as part of the groundfish management program, and these closures decrease the potential for interactions with seabirds in these areas. These restrictions are not anticipated to change, so this protection would continue to be provided under any of the alternatives in this analysis.

For the remainder of this section, the terms trawl and non-trawl will be used to describe gear types and groups of vessels which may impact seabirds under the described alternatives. Trawl includes vessels using both pelagic and non-pelagic trawl gear. Non-trawl includes vessels using demersal hook-and-line, and pot gear. This section does not include discussion of seabird bycatch in fisheries using gillnets, seine, troll, or jig gear because NOAA Fisheries does not have independent observer data from these fisheries.

PSC limits as a result of lookup tables for Alternatives 2, 3, and 4 may result in no change to the status quo, or may result in constraining PSC limits under which industry may change fishing patterns in order to maximize species with the greatest economic value. For trawl vessels, this could result in reduced fishing effort as the industry chooses not to pursue less valuable fisheries in order to conserve halibut PSC, or it could result in greater fishing effort at lower catch per unit effort, as vessels change fishing patterns or seasonal changes in the timing of the fishing, to increase halibut avoidance. If a groundfish fishery reduces fishing effort in specific fisheries to conserve halibut PSC for a more valuable fishery, then less potential exists for incidental take of seabirds. If a groundfish fishery increases the duration of fishing in areas with lower concentrations of halibut, there may be more potential for seabird incidental take, compared to the status quo, if this increased fishing activity overlaps temporally and geographically with areas used by seabirds. In contrast, PSC limits as a result of lookup tables for Alternatives 2, 3, and 4 could result in increased PSC limits. This could result in a response of increased fishing effort, as industry is less constrained by halibut PSC limits.

Shifts in the location or timing of fishing may occur as a result of Alternative 2, 3, or 4. However, there is already considerable interannual variability in the patterns of fishing across the BSAI groundfish sectors, as environmental conditions and avoidance of PSC species have caused vessels to adjust their fishing patterns. Any shift in fishing location or timing is unlikely to occur outside of the existing footprint of the groundfish fisheries. Seabird take estimates in the BSAI groundfish fisheries are already small, compared to seabird population estimates, and are unlikely to increase to a level that would have a population-level effect on seabird species. The exception to this is incidental take of ESA-listed seabirds, but the take of these species in BSAI groundfish fisheries are already closely monitored with respect to the incidental take statements in the 2020 Biological Opinion.

Prey Availability Disturbance of Benthic Habitat

As noted in Table 6-7, prey species of seabirds in the BSAI are not usually fish that are targeted in the groundfish fisheries. However, seabird species may be impacted indirectly by effects of fishing gear on the benthic habitat of seabird prey, such as clams, bottom fish, and crab. The EFH EIS provides a description of the effects of the groundfish fisheries on bottom habitat in the appendix (NMFS 2005), including the effects of the commercial fisheries on the BSAI slope and shelf.

It is not known how much seabird species use benthic habitat directly, although research funded by the North Pacific Research Board has been conducted on foraging behavior of seabirds in the Bering Sea in recent years. Thick-billed murres easily dive to 100 m, and have been documented diving to 200 m; common murres also dive to over 100 m. Since cephalopods and benthic fish compose some of their diet, murres could be foraging on or near the bottom (K. Kuletz, USFWS, personal communication, October 2008).

A description of the effects of prey abundance and availability on seabirds is found in the PSEIS (NMFS 2004 and 2015) and the Harvest Specifications EIS (NMFS 2007). Detailed conclusions or predictions cannot be made regarding the effects of forage fish bycatch on seabird populations or colonies. NMFS (2007) found that the potential impact of the entire groundfish fisheries on seabird prey availability was limited due to little or no overlap between the fisheries and foraging seabirds based on either prey size, dispersed foraging locations, or different prey. The majority of bird groups feed in vast areas of the oceans, are either plankton feeders or surface or mid-water fish feeders, and are not likely to have their prey availability impacted by the nonpelagic trawl fisheries. There is no directed commercial fishery for those species that compose the forage fish management group, and seabirds typically target juvenile stages rather than adults for commercial target species. Most of the forage fish bycatch is smelt, taken in the pollock fishery, which is not included in this action.

Table 6-7 Seabirds in the Bering Sea: foraging habitats and common prey species.

Species	Foraging habitats	Prey
Short-tailed albatross	Surface seize and scavenge	Squid, shrimp, fish, fish eggs
Black-footed albatross	Surface dip, scavenge	Fish eggs, fish, squid, crustaceans, fish waste
Laysan albatross	Surface dip	Fish, squid, fish eggs and waste
Spectacled eider	Diving	Mollusks and crustaceans
Steller's eider	Diving	Mollusks and crustaceans
Black-legged kittiwake	Dip, surface seize, plunge dive	Fish, marine invertebrates
Murrelet (Kittlitz's and marbled)	Surface dives	Fish, invertebrates, macroplankton
Shearwater spp.	Surface dives	Crustaceans, fish, squid
Northern fulmar	Surface fish feeder	Fish, squid, crustaceans
Murres spp.	Diving fish-feeders offshore	Fish, crustaceans, invertebrates
Cormorants spp.	Diving fish-feeders nearshore	Bottom fish, crab, shrimp
Gull spp.	Surface fish feeder	Fish, marine invertebrates, birds
Auklet spp.	Surface dives	Crustaceans, fish, jellyfish
Tern spp.	Plunge, dive	Fish, invertebrates, insects
Petrel spp.	Hover, surface dip	Zooplankton, crustaceans, fish
Jaeger spp.	Hover and pounce	Birds, eggs, fish
Puffin spp.	Surface dives	Fish, squid, other invertebrates

Source: USFWS 2006; Dragoo et al. 2010

Seabirds that feed on benthic habitat, including Steller's eiders, cormorants, and guillemots, may feed in areas that could be directly impacted by nonpelagic trawl gear (NMFS 2004). A 3-year otter trawling study in sandy bottom of the Grand Banks showed either no effect or increased abundance in mollusk species after trawling (Kenchington et al. 2001), but clam abundance in these studies was depressed for the first 3 years after trawling occurred. McConnaughey et al. (2000) studied trawling effects using the Bristol Bay area Crab and Halibut Protection Zone. They found more abundant infaunal bivalves (not including *Nuculana radiata*) in the highly fished area compared to the unfished area. In addition to abundance, clam size is of huge importance to these birds (Richman and Lovvorn 2003). However, handling time is very important to birds foraging in the benthos, and their caloric needs could change if a stable large clam population is converted to a very dense population of small first year clams. Additional impacts from nonpelagic trawling may occur if sand lance habitat is adversely impacted. This would affect a wider array of piscivorous seabirds that feed on sand lance, particularly during the breeding season, when this forage fish is also used for feeding chicks (Bertram and Kaiser 1993, Golet et al. 2000).

Cumulative Effects on Seabirds

Reasonably foreseeable future actions for seabirds include ecosystem-sensitive management; rationalization; traditional management tools; actions by other federal, state, and international agencies; and private actions, as described in Sections 8.4 and 9.3 of the Harvest Specifications EIS (NMFS 2007). Ecosystem-sensitive management, rationalization, and traditional management tools are likely to increase protection to seabirds by considering these species more in management decisions, and by improving the management of fisheries through the restructured Observer Program, catch accounting, seabird avoidance measures, and vessel monitoring systems. Changes in the status of species listed under the ESA, the addition of new listed species or critical habitat, and results of future ESA Section 7 consultations may require modifications to groundfish fishing practices to reduce the impacts of these fisheries on ESA-listed species and critical habitat. Additionally, since future TACs will be set with existing or enhanced protection measures, we expect that the effects of the fishery on the harvest of prey species and disturbance will not increase in future years.

Any action by other entities that may impact seabirds will, if determined to be necessary through ESA section 7 consultation, be offset by additional protective measures for the federal fisheries to ensure ESA-listed seabirds are not likely to experience jeopardy or adverse modification of critical habitat. Direct mortality by subsistence harvest is likely to continue, but these harvests are tracked and considered in the assessment of seabirds.

6.3 Habitat

6.3.1 Status

Fishing operations may change the abundance or availability of certain habitat features used by managed fish species to spawn, breed, feed, and grow to maturity. These changes may reduce or alter the abundance, distribution, or productivity of species. The effects of fishing on habitat depend on the intensity of fishing, the distribution of fishing with different gears across habitats, and the sensitivity and recovery rates of specific habitat features.

In 2005, NMFS and the Council completed the EIS for EFH Identification and Conservation in Alaska (NMFS 2005). The EFH EIS evaluates the long-term effects of fishing on benthic habitat features, as well as the likely consequences of those habitat changes for each managed stock, based on the best available scientific information. The EFH EIS also describes the importance of benthic habitat to different groundfish species and the past and present effects of different types of fishing gear on EFH. Based on the best available scientific information, the EIS analysis concludes that despite persistent disturbance to certain habitats, the effects on EFH are minimal because the analysis finds no indication that continued fishing activities at the current rate and intensity would alter the capacity of EFH to support healthy populations of managed species over the long term. The EIS concludes that no Council managed fishing activities have more than minimal and temporary adverse effects on EFH for any FMP species, which is the regulatory standard requiring action to minimize adverse effects under the Magnuson-Stevens Act (50 CFR 600.815(a)(2)(ii)). Additionally, the analysis indicates that all fishing activities combined have minimal, but not necessarily temporary, effects on EFH.

The Council and NMFS have updated available habitat information, and their understanding of the impacts of fishing on habitat, in periodic 5-year reviews of the EFH components in the Council fishery management plans (NPFMC and NMFS 2012) and (Simpson et al. 2017). These 5-year reviews have not indicated findings different from those in the 2005 EFH EIS with respect to fishing effects on habitat, although new and more recent information has led to the refinement of EFH for a subset of Council-managed species (Simpson et al. 2017). Maps and descriptions of EFH for groundfish species are available at: https://www.fisheries.noaa.gov/alaska/habitat-conservation/essential-fish-habitat-efh-alaska

6.3.2 Effects on Habitat

The 2005 EFH EIS (NMFS 2010), 2010 EFH Review (NMFS 2011) , and 2015 EFH Review (Simpson et al. 2017) concluded that fisheries do have long term effects on habitat, but these impacts were determined to be minimal and not detrimental to fish populations or their habitats. Similarly, the 2005 EFH EIS, 2010 EFH Review, and 2015 EFH Review (NMFS 2005) found no substantial adverse effects to habitat in the BSAI caused by fishing activities. The analysis in the EFH EIS concludes that current fishing practices in the BSAI groundfish fisheries have minimal or temporary effects on benthic habitat and essential fish habitat. These effects are likely to continue under Alternative 1.

Options under Alternative 2, 3, and 4 may result in no change to the status quo, or may result in constraining PSC limits under which industry may change fishing patterns in order to maximize species with the greatest economic value. This could result in a response of reducing fishing effort, as the industry chooses not to pursue less valuable fisheries in order to conserve halibut PSC, or it could result in greater fishing effort at lower catch per unit effort, as vessels change fisheries patterns or seasonal changes in the timing of the fishing, to increase halibut avoidance. In contrast, some options under Alternatives 2, 3, and 4 could result in increased PSC limits. This could result in a response of increased fishing effort, as industry is less constrained by halibut PSC limits.

Shifts in the location or timing of fishing may occur as a result of Alternatives 2, 3, and 4. However, there is already considerable interannual variability in the patterns of fishing across the BSAI groundfish sectors, as environmental conditions and avoidance of PSC species have caused vessels to adjust their fishing patterns. Any shift in fishing is unlikely to occur outside of the existing footprint of the groundfish fishery in the BSAI, and therefore these impacts are not likely to be substantial. To the extent that Alternatives 2, 3, and 4 change effort in the BSAI groundfish fishery, those alternatives would change impacts on habitat relative to the status quo.

6.4 Ecosystem

6.4.1 Status

Ecosystems consist of communities of organisms interacting with their physical environment. Within marine ecosystems, competition, predation, and environmental disturbance cause natural variation in recruitment, survivorship, and growth of fish stocks. Human activities, including commercial fishing, can also influence the structure and function of marine ecosystems. Fishing may change predator-prey relationships and community structure, introduce foreign species, affect trophic diversity, alter genetic diversity, alter habitat, and damage benthic habitats.

The BSAI groundfish fisheries potentially impact the BSAI ecosystem by relieving predation pressure on shared prey species (i.e., species that are prey for both target groundfish and other species), reducing prey availability for predators of the target groundfish, altering habitat, imposing PSC and bycatch mortality, or by ghost fishing caused by lost fishing gear. Ecosystem considerations for the groundfish fisheries are summarized annually in the SAFE report (available from: https://www.fisheries.noaa.gov/alaska/population-assessments/north-pacific-groundfish-stock-assessments-and-fishery-evaluation). These considerations are summarized according to the ecosystem effects on the groundfish fisheries, as well as the potential fishery effects on the ecosystem.

6.4.2 Effects on Ecosystem

As explained in Chapter 3, Section 3.3.1 of the Harvest Specifications EIS (NMFS 2007), NMFS and the Council continue to develop their ecosystem management measures for groundfish fisheries. The Council has created a committee to inform the Council of ecosystem developments and to assist in formulating positions with respect to ecosystem-based management. The Council's Scientific and Statistical Committee holds regular ecosystem scientific meetings, and the Council has recently reviewed and approved a Bering Sea Fishery Ecosystem Plan (available at: https://www.npfmc.org/bsfep/). In addition to these efforts to explore how to develop its ecosystem management efforts, the Council and NMFS continue to initiate efforts to take account of ecosystem impacts of fishing activity by designating EFH protection areas and habitat areas of particular concern. Ecosystem protection is supported by an extensive program of research into ecosystem components and the integrated functioning of ecosystems, carried out at the AFSC.

Under the status quo, the BSAI groundfish fleet is constrained in the location and timing of the fishery by directed fishing allowances, PSC and bycatch limits, and Steller sea lion protection measures. PSC limits as a result of lookup tables for Alternatives 2, 3, and 4 may result in no change to the status quo, or may result in constraining PSC limits under which industry may change fishing patterns in order to maximize species with the greatest economic value. This could result in a response of reducing fishing effort, as the industry chooses not to pursue less valuable fisheries in order to conserve halibut PSC, or it could result in greater fishing effort at lower catch per unit effort, as vessels change fishing patterns or seasonal changes in the timing of the fishing, to increase halibut avoidance. In contrast, PSC limits as a result of lookup tables for Alternatives 2, 3, and 4 could result in increased PSC limits. This could result in a response of increased fishing effort, as industry is less constrained by halibut PSC limits.

Shifts in the location or timing of fishing may occur as a result of Alternatives 2, 3, and 4. However, there is already considerable interannual variability in the patterns of fishing across the BSAI groundfish sectors, as environmental conditions and avoidance of PSC species have caused vessels to adjust their fishing patterns. To the extent that Alternative 2 through 4 change effort in the BSAI groundfish fisheries, those changes are not likely to have impacts on ecosystem components and considerations beyond those summarized in the annual Stock Assessment and Fishery Evaluation report for the BSAI groundfish fisheries (NPFMC 2020).

7 Magnuson-Stevens Act and Pacific Halibut Act Considerations

Note that draft responses are provided in this section based upon the analysis to date and will be updated in a subsequent version of this analysis with the identification of a Preferred Alternative at final action.

7.1 Magnuson-Stevens Act National Standards

Below are the 10 National Standards as contained in the MSA. In recommending a preferred alternative, the Council must consider how to balance the national standards. For each of the national standards, a reference is provided to areas in the analysis that are particularly relevant to the consideration of the national standard, although they may not be the only information that is relevant to the issue.

National Standard 1 — Conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery.

The proposed action indexes Amendment 80 halibut PSC limits annually to fluctuating levels of halibut based on halibut abundance in the BSAI as estimated by the EBS trawl survey and IPHC setline survey. The BSAI groundfish stocks are generally considered stable and are not at a level that would correspond to being overfished and harvest is not at a level that would correspond to overfishing under the status determination criteria used for BSAI groundfish fisheries. The halibut PSC limits identified in the Alternative look up tables may prevent Amendment 80 from harvesting TACs under conditions of extremely low PSC limits, unless fishermen can utilize available tools to minimize halibut PSC beyond what is currently being achieved. The intent of indexing the Amendment 80 sector's PSC limit to levels of abundance is that when estimated halibut abundance (and therefore PSC limits) decline to very low levels, encounter rates amongst the A80 sector would likely also be low. If that is the case then the fleet may still be able to catch their full TACs and thus achieve OY even under low PSC limits. This action is not expected to interfere with the achievement of optimum yield on a continuing basis. The cooperative structure of Amendment 80 provides tools for vessels to control their PSC. The analysis shows that there appears to be considerable variability within the vessels and companies of the sector with respect to PSC rates. This variability, along with other flexible tools offered by the cooperative structure, provides an opportunity for Amendment 80 vessels to maximize the groundfish harvest to the extent practicable under potentially reduced halibut PSC limits.

Additionally, the "optimum yield" from the fishery reflects ecological, social, and economic considerations. Ecological impacts of the proposed action are discussed in the DEIS in conjunction with the estimates survey states based on ecological conditions in the Bering Sea amongst other factors in estimating halibut abundance. Impacts to Pacific halibut are covered in Section 5.3 and impacts to groundfish species are covered in Section 5.5.3. With information that is currently available, neither the total "cost" of halibut PSC taken in the Amendment 80 sector, nor the total "value" of halibut savings can be precisely quantified for the various user groups however as discussed in the analysis there is not a direct pound to pound (i.e. 1:1) linkage between PSC reduction and Area 4 commercial harvest. The estimated annual savings of halibut may represent a cost to groundfish harvesters, processors, and consumers that is realized either as a reduction in the amount of groundfish harvested, or in the increased cost in the harvest of groundfish resulting from methods to avoid halibut or minimize halibut mortality. Halibut that might be taken as PSC in the groundfish fisheries has value to the commercial, sport, and subsistence harvesters of halibut, as well as being prey for other species. A general description of each of these user groups was also provided in Chapters 3 and 4. It is not currently known how PSC of juvenile halibut is affecting the halibut spawning biomass coastwide. Many groups utilize the halibut resource, demonstrating the breadth and variety of values associated with this species (See Appendix 1). There are additional benefits to these user groups beyond the value of the direct market transaction. The lack of a market price for non-commercial use makes comparing the value derived from various users more difficult, but nonetheless important.

National Standard 2 — Conservation and management measures shall be based upon the best scientific information available.

Information in this analysis represents the most current, comprehensive set of information available to the Council, recognizing that some information (such as operational costs) is unavailable. It represents the best scientific information available.

National Standard 3 — To the extent practicable, an individual stock of fish shall be managed as a unit throughout its range, and interrelated stocks of fish shall be managed as a unit or in close coordination.

Section 4.1 describes the range of the Pacific halibut stock, which extends coastwide, and the analysis takes into account effects throughout the range. With the exception of sablefish, which is not subject to this action, all groundfish species are assessed at the scale of the BSAI FMP (Section 3.1), which is the geographic scope of the proposed action (Chapter 1 Section 1.5). The groundfish stocks will continue to be managed as single stocks throughout their range under the proposed action.

National Standard 4 — Conservation and management measures shall not discriminate between residents of different states. If it becomes necessary to allocate or assign fishing privileges among various U.S. fishermen, such allocation shall be (A) fair and equitable to all such fishermen, (B) reasonably calculated to promote conservation, and (C) carried out in such a manner that no particular individual, corporation, or other entity acquires an excessive share of such privileges.

Nothing in the proposed alternatives considers residency as a criterion for the Council's decision. Residents of various states, including Alaska and the states of the Pacific Northwest, participate in the sectors that are directly and indirectly affected by the proposed action, including both groundfish and halibut fisheries. A description of participants in each fishery and sector, including vessel and LLP license ownership address by community for the Amendment 80 sector is presented in Appendix 1 to the extent feasible within confidentiality constraints. Similar information on community and state of ownership for Area 4 halibut vessels and halibut quota is provided in that same appendix.

While the Council does not have direct authority over setting halibut catch limits, the proposed action may provide additional opportunities for directed halibut fishing if the IPHC increases the commercial catch limit for the directed halibut fishery in response to this action. However, under the current set of alternatives considered, no direct allocation or assignment of fishing privileges to the directed halibut participants is considered. Thus, considerations under National Standard 4 pertain to the Amendment 80 fleet as directly affected by the proposed action. The proposed action may, however, have incidental allocative effects. Appendix 1 contains detailed information for both the Amendment 80 and directed halibut fisheries on community engagement, dependency, and federally recognized tribal status and encompasses all states in which those communities are located, as well as an analysis of potential incidental allocative effects of the proposed action. This information and analysis is summarized in Section 5.5.

The Council could examine how management measures that provide additional access to halibut catch may be considered with the understanding that such an action is not presently being managed by the Council. If the Council intends to directly provide additional opportunities to participants in IPHC Area 4CDE, the Council is authorized to develop limited access regulations under the Halibut Act as long as all applicable requirements in the Halibut Act are met.

National Standard 5 — Conservation and management measures shall, where practicable, consider efficiency in the utilization of fishery resources, except that no such measure shall have economic allocation as its sole purpose.

Efficiency in the context of the proposed action refers to economic efficiency. The analysis presents information on the relative importance of economic efficiency versus other considerations, and provides information on the economic risks associated with the proposed PSC measures.

National Standard 6 — Conservation and management measures shall take into account and allow for variations among, and contingencies in, fisheries, fishery resources, and catches.

The analysis for the proposed action is consistent with this standard. Interannual variability in catch is described in Section 3.3.

National Standard 7 — Conservation and management measures shall, where practicable, minimize costs and avoid unnecessary duplication.

The proposed action is consistent with this standard. Chapter 5 describes the potential impacts from the Alternatives and options, including costs of PSC limits as a management measure.

National Standard 8 — Conservation and management measures shall, consistent with the conservation requirements of this Act (including the prevention of overfishing and rebuilding of overfished stocks), take into account the importance of fishery resources to fishing communities in order to (A) provide for the sustained participation of such communities, and (B) to the extent practicable, minimize adverse economic impacts on such communities.

These Alternatives and options are designed to minimize halibut PSC in the Amendment 80 fleet to the extent practicable. Many of the coastal communities in the BSAI, as well as coastal communities elsewhere in Alaska and the Pacific Northwest, participate in the BSAI groundfish fisheries in one way or another, such as homeport to participating vessels, the location of processing activities, the location of support businesses, the home of employees in the various sectors, or as the base of ownership or operations of various participating entities. An analysis of community engagement in and dependency on the Amendment 80 fishery is provided in Appendix 1.

Under different halibut abundance conditions (and different alternatives), Amendment 80 halibut PSC limits could be reduced or remain the same (Alternatives 2 and 4), or could be reduced, remain the same, or be increased (Alternative 3). An analysis of the alternatives suggests that reductions in PSC limits could constrain the Amendment 80 fleet under some conditions and consequently may impact the communities that depend on those fisheries.

While the Council does not currently set halibut catch limits, the benefit to Alaska communities that may result from incidental allocative effects of halibut PSC reductions is discussed in Chapter 5 section 5.5.3. These alternatives and options have been developed to balance the need to minimize halibut PSC in the A80 fleet, consistent with National Standard 9, with the requirements of National Standards 1 and 8. To this end, options are provided to further incentivize bycatch reduction beyond what is provided by the PSC limit itself in order for the A80 fleet to mitigate their halibut PSC such that they may avoid forgone harvest opportunities throughout the sector's multispecies fishing year. As described in Section 5.5, reduced halibut PSC mortality, relative to status quo, might benefit fishing communities that depend on commercial and noncommercial halibut harvest, though the magnitude of that effect is likely attenuated by the several biological and policy steps that separate bycatch mortality savings from directed harvest opportunities. Communities that are engaged in the groundfish fisheries could be adversely impacted on a more direct basis. In selecting a Preferred Alternative, the Council must consider minimizing the risk of adverse impacts to fishing communities, while adhering to its obligations under National Standards 9 and 1.

National Standard 9 — Conservation and management measures shall, to the extent practicable, (A) minimize bycatch, and (B) to the extent bycatch cannot be avoided, minimize the mortality of such bycatch.

The proposed action is specifically intended to minimize halibut PSC in the Amendment 80 sector to the extent practicable. The necessary context for considering the practicability of PSC reduction relative to status quo is provided in the Sections 3 and 5. The range of PSC limits under each of the Alternatives are presented to provide a choice to the Council to balance between what is practicable for halibut PSC reduction and the obligations of National Standards 1 and 8. Some of the PSC limits represent levels much lower than what has been achieved by the Amendment 80 fleet to date, despite concerted efforts since the latest PSC limit reduction that was implemented in 2016. The precise extent to which these limits would constrain BSAI groundfish fisheries is unknown, though the general direction of the impact is well-understood, as is the fact that impacts on stakeholders within the Amendment 80 sector are likely to be uneven. In general, the intention of indexing the A80 PSC limit to fluctuations in halibut biomass should more closely link PSC limits with encounters on the fishing grounds especially at extremely low levels of biomass (and resulting PSC limits). Options that may be applied to these Alternatives further incentivize the fleet to avoid halibut at all levels of encounters.

National Standard 10 — Conservation and management measures shall, to the extent practicable, promote the safety of human life at sea.

The proposed action appears to be consistent with this standard. None of the alternatives or options would change safety requirements for fishing vessels. No safety issues have been identified for Amendment 80.

7.2 Section 303(a)(9) Fisheries Impact Statement

Section 303(a)(9) of the MSA requires that a fishery impact statement be prepared for each FMP amendment. A fishery impact statement is required to assess, specify, and analyze the likely effects, if any, including the cumulative conservation, economic, and social impacts, of the conservation and management measures on, and possible mitigation measures for (a) participants in the fisheries and fishing communities affected by the plan amendment; (b) participants in the fisheries conducted in adjacent areas under the authority of another Council; and (c) the safety of human life at sea, including whether and to what extent such measures may affect the safety of participants in the fishery.

The DEIS prepared for this plan amendment constitutes the fishery impact statement. The likely effects of the proposed action are analyzed and described throughout the DEIS. The effects on participants in the fisheries and fishing communities are analyzed in the following sections of the analysis (Sections 5 and appendix 1). The effects of the proposed action on safety of human life at sea are evaluated in Section 5. Based on the information reported in this section, there is no need to update the Fishery Impact Statement included in the FMP.

The proposed action directly regulates the Amendment 80 sector in the EEZ off Alaska, which are under the jurisdiction of the North Pacific Fishery Management Council. The proposed action may also affect participants in halibut fisheries, conducted both under the North Pacific Council jurisdiction, and in adjacent areas under the jurisdiction of the Pacific Fishery Management Council.

7.3 Pacific Halibut Act

The fisheries for Pacific halibut are governed under the authority of the Northern Pacific Halibut Act of 1982 (Halibut Act, 16 U.S.C. 773-773k). For the United States, the Halibut Act gives effect to the Convention between the United States and Canada for the Preservation of the Halibut Fishery of the North Pacific Ocean and Bering Sea. The Halibut Act also provides authority to the Regional Fishery Management Councils, as described in § 773c:

> *(c) Regional Fishery Management Council involvement*

> *The Regional Fishery Management Council having authority for the geographic area concerned may develop regulations governing the United States portion of Convention waters, including limited access regulations, applicable to nationals or vessels of the United States, or both, which are in addition to, and not in conflict with regulations adopted by the [International Pacific Halibut Commission]. Such regulations shall only be implemented with the approval of the Secretary, shall not discriminate between residents of different States, and shall be consistent with the limited entry criteria set forth in section 1853(b)(6) of this title. If it becomes necessary to allocate or assign halibut fishing privileges among various United States fishermen, such allocation shall be fair and equitable to all such fishermen, based upon the rights and obligations in existing Federal law, reasonably calculated to promote conservation, and carried out in such manner that no particular individual, corporation, or other entity acquires an excessive share of the halibut fishing privileges.*

While the modification of PSC limits as proposed in this analysis does not directly regulate halibut fishermen, there is nonetheless an indirect effect on halibut fisheries as a result of this action, and therefore it is prudent for the Council to consider the directions in the Halibut Act about the regulations that may result from this action. Much of the direction listed in § 773c(c) is duplicative with the MSA's National Standard 4, requiring that regulations not discriminate between residents of different States, and directing that if halibut fishing privileges are allocated or assigned among fishermen, such allocation shall be fair and equitable. The relationship between this analysis and National Standard 4 is discussed above in Section 7.1. The Halibut Act also directs regulations to be consistent with the limited entry criteria set forth in the MSA. These are criteria that the Council and the Secretary must take into account when establishing a limited access system for an MSA fishery. The criteria are listed below. For each of the criteria, a reference is provided to areas in the analysis that are particularly relevant to the consideration of that criterion, although they may not be the only information that is relevant to the issue.

(A) present participation in the fishery

- Section 0, Section 4, and the attached SIA

(B) historical fishing practices in, and dependence on, the fishery

- Section 0, Section 4, and the attached SIA

(C) the economics of the fishery

- Section 0, Section 4, and the attached SIA

(D) the capability of fishing vessels used in the fishery to engage in other fisheries

- Section 0 and the attached SIA

(E) the cultural and social framework relevant to the fishery and any affected fishing communities

- Section 4.4.4 and the attached SIA

(F) the fair and equitable distribution of access privileges in the fishery

- Section 0, Section 4, and the attached SIA, incorporating by reference the analyses that were considered when implementing BSAI Groundfish FMP Amendment 80 and the Halibut/Sablefish IFQ Program. The Amendment 80 LAPP most recently underwent a 5-year review that was published in October 2014; the IFQ Program underwent a 20-year review published in April 2017.

(G) any other relevant considered actions (to be considered at the time of final Council review).

8 Preparers and Persons Consulted

Contributors[74]

Alaska Fisheries Science Center:
Carey McGilliard
Jim Ianelli
Dana Hanselman

International Pacific Halibut Commission:
Allan Hicks

North Pacific Fishery Management Council:
Diana Stram
Sam Cunningham
Anna Henry
Sarah LaBelle

AKFIN
Mike Fey

National Marine Fisheries Service Alaska Regional Office:
Joe Krieger
Anne Marie Eich
Bridget Mansfield

Wislow Research Associates LLC
Mike Downs

Persons *(and Agencies)* Consulted
Mary Furuness (NMFS AKRO SF)
Gretchen Harrington (NMFS AKRO PR)
Steve Whitney (NMFS AKRO SF)
Rachel Baker (ADF&G)
Karla Bush (ADF&G)
Diana Evans (NPFMC)
Steve MacLean (NPFMC)
John Olson (NMFS AKRO HCD)
Ben Fissel (AFSC)
John Lepore (NOAA General Counsel)

John Gauvin
Chris Woodley
Mark Fina
Arne Fuglvog
Mary Beth Tooley
Jason Anderson
Beth Concepcion
Todd Loomis
Angel Drobnica
Heather McCarty
Linda Behnken
Ruth Christiansen
Bob Alverson
Matt Robinson
Annika Saltman
Christopher Oliver
Chad See
Gerry Merrigan
Simeon Swetzof
Andy Mezirow

[74] Contributing does not imply endorsement by the contributor's associated agency

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10 Appendices

Appendix 1: Social Impact Assessment

Appended separately

Appendix 2: Model details

Appendix 2, Model details

Summary of modeling assumptions and scenarios from 2020 analyses

In response to the SSC requests and consistent with IPHC assessment model developments since 2019, the following summarizes the model changes.

(a) A 30:20 harvest control rule for TCEY determination was added to the model. The base case model run is two runs, one using the 30:20 harvest control rule and one not using it, so as to represent two bookends of the IPHC decision-making process. The results for these two runs were not integrated to enable seeing the impacts of each assumption individually.

(b) The IPHC changed its definition and calculation of unfished spawning biomass for the 2019 assessment to a dynamic calculation. Previously, unfished spawning biomass was calculated as a static value over time assuming a low weight-at-age and high recruitment scenario. Currently, the calculation of unfished spawning biomass is calculated using the estimated parameter values of the assessment model, including estimated recruitment each year and re-running the population dynamics over time, but with no fishing. This means that in a low recruitment year, unfished spawning biomass is also lower (relative to a static unfished biomass definition), and in a high recruitment year, unfished spawning biomass is higher. Hence, changes in stock status are insensitive to changes in recruitment regimes, and other life history parameters and only sensitive to changes in fishing mortality. In these results, this means that the population is not likely to fall below 30% of unfished spawning biomass unless the TCEY or PSC limits are large.

(c) For the base case models, variability in PSC use was incorporated, centered around recent historical mean use:limit ratios and recent historical variability around the mean, leading to increased uncertainty in key quantities such as spawning biomass.

(d) The relationship used between historical spawning biomass and total mortality (used as the harvest control rule for TCEY determination) was updated to exclude some older data points (effectively downweighting an earlier period in IPHC management), which led to a more shallow slope, or less responsiveness in coastwide TCEY with changes in spawning biomass.

(e) A single future PDO scenario was modeled (rather than creating a new potential PDO scenario for each model realization). While this approach will underestimate uncertainty about future population dynamics, it allows us to see how the population may fluctuate in response to shifts in the PDO and to examine the effects of fluctuations on important quantities, such as spawning biomass and catch limits for all sectors under each alternative.

(f) A sensitivity analysis was conducted under a hypothetical scenario of low recruitment, setting recruitment to where numbers-at-age for ages up to age 6 are set to zero initially, and a low PDO phase was assumed throughout the simulation. Results for this scenario showed no difference between model runs using and excluding the 30:20 harvest control rule for TCEY determination.

(g) A sensitivity analysis was conducted by incorporating temporal autocorrelation in assessment results which led to less variability in spawning biomass over time, but identical changes from the status quo in all quantities.

(h) In another sensitivity analysis, a PSC usage scenario was modeled where PSC usage was closer to the limit as PSC limits grew small (leading to less variability in PSC usage over time and over various levels of spawning biomass). For alternatives where PSC limits were generally set to lower values, the PSC usage was higher than for the base case scenario, as this assumption sets PSC usage closer to the limit as limits become low.

(i) A set of sensitivity analyses was conducted to explore alternative BSAI trawl PSC selectivity curves. Results showed that if BSAI trawl PSC selectivity is shifted towards younger individuals, changes in directed halibut fishery catches are smaller in proportion to changes in PSC limits than in the base case scenario. If BSAI trawl PSC selectivity is shifted towards older individuals, changes in directed halibut fishery catches are larger in proportion to changes in PSC limits than in the base case scenario.

Operating Model Details

The following sections provide the equations and configuration of the simulation model. Table A2-6-8 through Table A2-6-11 provide descriptions of parameters used.

Recruitment

Pacific halibut age-2 recruitment for area l, sex s, and year y is represented as a Beverton-Holt stock-recruitment relationship occurring coastwide, and then allocated among the two areas.

(1) $$R_{l,s,y} = \delta_{l,y} \frac{SSB_y 4hR_{0,y}}{SSB_{0,y}(1-h)+SSB_y(5h-1)} e^{\varepsilon_y - \frac{\sigma_r^2}{2}}$$

where SSB_y is the coast-wide spawning stock biomass in year y, $\delta_{l,y}$ is the proportion of recruits to each area l occurring in year y, R_0 is unfished recruitment, h represents steepness (the proportion of unfished recruitment that occurs when the stock is at 20% of unfished spawning biomass), $\epsilon_y \sim N(0, \sigma_r^2)$ is a random deviate representing process error in recruitment.

The value of time-varying recruitment allocation is calculated by a function that accounts for autocorrelation in recruitment allocation among years and provides a random deviate ($\delta_{l,y}$) between 0 and 1 with a mean of 0.58, and a standard deviation of 0.6:

(2) $\delta_{l,y} = \exp(x_y)/(1+x_y)$, where $x_y = \rho(x_{y-1} + \eta_y) + (1-\rho)\tau_y$, and $\eta_y \sim N(0, \sigma_x)$, and $\tau_y \sim N(\mu_x, \sigma_x)$.

The value of $R_{0,y}$ is year-specific because it shifts between two alternative values, depending on the state of the Pacific Decadal Oscillation (PDO) in the IPHC coastwide long assessment model and in the IPHC's management strategy evaluation (Hicks et al. 2019). This process was simulated within the OM using the same methods as for the IPHC's management strategy evaluation model; it is a semi-Markov process that takes into account the value of the PDO in the previous year and the length of time that the PDO has been in the same state leading up to the previous year, and yielding an indicator function, I, that determines whether it is a PDO year ($I = 1$) or a non-PDO year ($I=0$). The indicator function I is a binomial random variable with probability p, and p is determined as a function of "run," the number of consecutive years of the same value of the indicator function, "midPt," which controls how long the average run of a particular state should be, "yInt," and k, which act to scale the value of p.

(3) $I \sim B(1,p)$, where $p = (1 - yInt)/(1 + \exp(-k(run - midPt))) + yInt$.

Recruitment parameters were taken from the most recent IPHC coastwide long assessment model.

Survival

Cohorts of halibut are tracked forward in time across ages within areas, subject to both sex-specific natural mortality, M_s, and annual fishing mortality by area, year, and fleet, g. The following fleets are modeled: (i) the directed fishery for halibut (which operates in both areas with the same selectivity-at-age in each area), (ii) the trawl PSC fishery in the BSAI, (iii) the hook-and-line PSC fishery in the BSAI, and (iv) the bycatch fishery in the other area.Total instantaneous mortality is:

(4) $$Z_{l,s,y,a} = M_s + \sum_g v_{g,s,a} F_{l,g,y}$$

where $v_{g,s,a}$ is the fleet, sex, and age-specific selectivity, and $F_{l,g,y}$ is the annual (y) fishing mortality by fleet g and area l. Natural mortality rates (M_s) are sex-specific. The fishing mortality rates that lead to the specified catches for each fleet are found using the bisection method given the fleet's selectivity-at-age and the halibut population dynamics. This year's alternatives are specific to the Amendment 80 fleet, and total trawl PSC limits are calculated by adding the static non-A80 PSC limit to that calculated by each alternative for A80 each year for the purpose of updating population dynamics within the model.

The selectivity-at-age for all fleets is given in Figure 6-1. The selectivity-at-age of the directed fishing fleet was set equal to that from the most recent coastwide long stock assessment model. The trawl PSC fishery selectivity in the BSAI was set equal to the bottom trawl survey selectivity specified in 2019 IPHC stock assessments. The HAL BSAI PSC selectivity was specified as the average of the most recently estimated 4ABCDE setline survey selectivity (using the IPHC's coastwide long assessment model) and the EBS trawl survey selectivity. The rationale behind the approach for HAL PSC selectivity is that the percent of over 32-inch (O32) fish in the HAL PSC is much lower than for the FISS survey, but higher than for the trawl PSC because the hooks for Pacific cod are smaller than for the FISS survey. The bycatch selectivity in the other area was fixed to the asymptotic selectivity specified for coastwide-multi gear bycatch in the IPHC's most recent coastwide long assessment model.

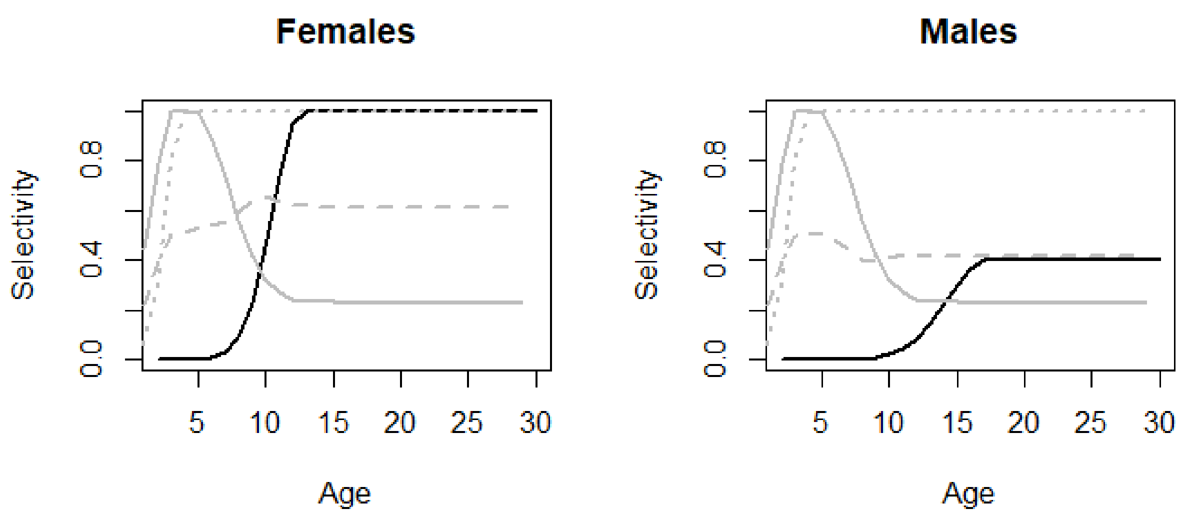

Figure 6-1. Fishery selectivity curves used in the closed-loop simulation model, as implemented in 2020 for females (left panel) and males (right panel), as follows: commercial (solid black line), BSAI trawl PSC (grey solid line), BSAI longline PSC (dashed grey line), and other area bycatch (dotted grey line).

Numbers-at-age

Halibut numbers at age are updated based upon annual recruitment and age-specific survival, with numbers at $a = 2$ calculated as:

(5) $$N_{l,s,y,a=2} = 0.5R_{l,y-1}e^{-2M_s}$$

Numbers at age for all ages $1 < a < A$ are updated by:

(6) $$N_{l,s,y,a} = N_{l,s,y-1,a-1}e^{-Z_{l,s,y-1,a-1}}$$

where A is the plus age group. The plus age group in year y is equal to the surviving individuals at age A, plus surviving entrants into the plus age group:

(7) $$N_{l,s,y,a=A} = N_{l,s,y-1,a=A}e^{-Z_{l,s,y-1,a=A}} + N_{l,s,y-1,a-1}e^{-Z_{l,s,y-1,a-1}}$$

Spawning biomass, total biomass weight-at-age, and maturity-at-age

Spawning stock biomass is product of female biomass at age and maturity at age, summed across both ages:

(8) $$SSB_{l,y} = \sum_a N_{l,s,y,a}w_{s,a}m_{s,a} = \sum_a B_{l,s,y,a}m_{s,a},$$

where $w_{s,a}$ and $m_{s,a}$ are the weight and maturity for each sex s at each age a, and equivalently $B_{l,s,y,a}$ is biomass in area l for sex s, year y, and age a. Weight-at-age in forward simulations was taken from the weight-at-age values input to the most recent IPHC assessment models and smoothed prior to being used as input in both the model validation and forward simulation process. The smoothed weight-at-age values led to the same model validation results as for the values used in the most recent IPHC stock assessment models. Likewise, maturity-at-age is set equal to values used in the most recent IPHC assessment process.

Harvest

Age-specific total catch in numbers by year is calculated as:

(9) $$C_{l,s,y,a} = \left(\frac{f_{l,s,y,a}}{Z_{l,s,y,a}}\right)N_{l,s,y,a}(1 - e^{-Z_{l,s,y,a}})$$

with $f_{l,s,y,a} = \sum_g v_{g,s,a}F_{l,g,y}$ being the sum of fishing mortality across gear types. The gear-specific annual catch is:

(10) $$c_{l,s,y,a,g} = \left(\frac{v_{g,s,a}F_{l,g,y}}{Z_{l,s,y,a}}\right)N_{l,s,y,a}\left(1 - e^{-f_{l,s,y,a}}\right)$$

Harvest in units of biomass by gear type is the product of gear-specific catch and weight at age, summed across sexes and ages:

(11) $$H_{l,y,g} = \sum_s \sum_a c_{l,s,y,a,g}w_{s,a}$$

Movement

Movement of halibut is currently assumed to occur after both natural and fishing mortality and are implemented as age-specific transition probabilities between areas such that a fixed proportion of individuals of each age move from one model area to another in each year. The number of migrants from area i to area j in each year is:

(12) $$\tau_{i,j,s,y,a} = N_{l=i,s,y,a}\pi_{i,j,a}$$

where $\pi_{i,j,a}$ is the transition probability at age a. Once the number of annual migrants is calculated, numbers-at-age by area and sex are updated to by adding the number of immigrants into an area less emigrants out of an area:

(13) $$N_{l,s,y,a} = N_{l,s,y,a} + \sum_{k \in areas} \tau_{i=k,j=l,s,y,a} - \sum_{k \in areas} \tau_{i=l,j=k,s,y,a}$$

Initial Conditions

The forward simulation model is initiated with the IPHC's most recent assessment-estimated numbers-at-age, weight-at-age, and maturity-at-age. The numbers-at-age were then distributed between the BSAI and the other area according to a proportion parameter, p_a, that was defined for three age groups (Table of parameters).

$$N_{l,s,1,a} = p_a N_{s,1,a}$$

In initial model runs using historical data it was found that distributing the same proportion of fish to the BSAI at each age at the start of the model run led to long model burn-in time and unrealistic proportions of survey biomass in the BSAI, as compared to past observations (Appendix 3).

In addition, a robustness test was formulated to explore the behavior of the alternatives under an extreme low recruitment scenario where numbers-at-age for ages 0-6 in 2019 were replaced with zeros to represent total recruitment failure for six consecutive years.

Sampling from the true population

The selectivity of the NMFS Eastern Bering Sea Trawl Survey (BTS) and IPHC Fishery Independent Setline Survey (FISS) in the model were both drawn directly from the IPHC 2019 coastwide long assessment model (although BTS survey selectivity is not actually estimated within the assessment). The BTS survey selectivity was fixed within the assessment using prior information. The survey biomass was simulated as

(14) $$B_{l,y,f}^{surv} = q_f \sum_s \sum_a N_{l,s,y,a} ssel_{s,a,f} w_{s,a} \exp\left(\gamma_f - \sigma_{\gamma_f}^2/2\right),$$

where $ssel_{s,a,f}$ is survey selectivity for sex *s*, age *a*, and survey *f*, q_f is the catchability of survey *f*, and $\gamma_f \sim N(0, \sigma_{\gamma_f}^2)$ is a random deviate to account for survey observation error.

Calculating the measures of stock status (assessment)

The assessment process is simulated within the modeling framework, producing an estimate of spawning biomass each year for use in defining directed fishery catch limits. The estimated spawning biomass is a function of the true spawning biomass, lognormal estimation error, and a parameter defining the influence of the previous year's spawning biomass estimate on the current year's estimate (θ). This may happen if the assessment model structure is similar from year to year and tends to overestimate (or underestimate) spawning biomass for similar reasons over time. A value of $\theta = 1$ indicates no influence of the previous year's estimate on the current year's estimate. A value of $\theta = 0$ indicates that this year's estimate is equal to last year's estimate. In addition to this parameter, lognormal assessment error is applied to the true spawning biomass:

(15) $$\tilde{B}_y = \tilde{B}_{y-1} + \theta\left[\left(\sum_l SSB_{l,y} \exp\left(\varphi - \frac{\sigma_\varphi^2}{2}\right)\right) - \tilde{B}_{y-1}\right],$$

where $\tilde{B}_y$ is the assessment-estimated spawning biomass in year *y*, and $\varphi \sim N(0, \sigma_\varphi^2)$.

Forward simulations for the base case scenario assumed a value of $\theta = 1$, and a sensitivity analysis was included (Chapter 6, Appendix 2) where $\theta = 0.75$.

Calculating recommended fishing restrictions using management alternatives

The modeling framework must account for two management systems (one defining PSC limits and the other defining directed fishery catch limits) to fully define catch limits and realized catches for each fleet. First, the PSC limits and use are defined, based on survey biomass, abundance-based management alternatives, and two scenarios for defining PSC use, given a limit. Second, the directed fishery catch limits (which are currently equal to the directed fishery catches) are defined.

Calculating PSC limits and usage for the BSAI

PSC limits are calculated using the generated survey biomass values (as described above) as inputs to the selected management alternatives. In recent history, PSC use has been less than the PSC limit, but is a key uncertainty in the model. Therefore, we simulate two scenarios for PSC use. The first scenario, which was used for the base case, applied an average PSC use:limit ratio to calculate PSC usage from the limit and included variability which was on the order of recent historical variability (Figure A2-6-2). The second scenario conducted as a sensitivity analysis assumed that the use would approach the limit as PSC limits becomes low (Figure A2-6-2).

Figure A2-6-2. Simulated PSC usage for the base case (top) and alternative relative to potential future A80 PSC limits. The relationship and variability were based on observed patterns in A80 PSC Pacific halibut mortality compared to limits.

Modeling the International Pacific Halibut Commission Harvest Policy

The IPHC uses the results of the halibut stock assessment, including a decision table with relevant management quantities reported for a range of F_{SPR} levels as a non-binding guide to aid in specifying catch limits for the directed fishery (IPHC 2019). The predicted catches listed in the decision table in correspondence with the F_{SPR} levels are calculated for fish over 26 inches only (O26; corresponding to the smallest halibut selected by the directed fishery gear). After a catch limit (TCEY) is decided upon for each regulatory area, the directed fishery portion of the TCEY is calculated by subtracting the expected bycatch of O26 fish in the regulatory area from the area-specific TCEY. We use the word "bycatch" generically here to refer to any halibut mortality that is not from a directed fishery sector. Bycatch in the BSAI is referred to as PSC. Typically, the expected O26 inch bycatch is set equal to the O26 inch bycatch from the previous year.

The OM includes only ages and not lengths, creating a challenge for mimicking the length specifications in the IPHC decision-making process. The ability of the PSC in the BSAI and the bycatch in the other area to exceed the directed fishery catch limit must be included in the model, and the model must be able to approximate the magnitude of catches expected in the directed fishery each year reasonably well. The general steps used in the model to mimic the directed fishery's catch limit specification process are to (i) develop a function that relates the assessed estimate of spawning biomass to expected total mortality of halibut including all sizes of fish (used as a proxy for coastwide TCEY), (ii) apply an approximated version of the IPHC 30:20 harvest control rule, where catch limits are adjusted downward when relative spawning biomass is below 30% of its unfished level (in some model runs); (iii) distribute the expected TCEY among the two areas, (iv) subtract the expected bycatch in each area from the expected total mortality to arrive at expected catch for the directed fishery in each area, noting that expected catch by area will equal 0 if the expected bycatch is greater than the TCEY for that area. Next, we describe these three steps in greater detail.

Chapter 4.3.1 describes recent shifts in the formula used to distribute TCEY among areas used by Commissioners and includes the concept of partial "U26 mitigation." As a substantial portion of the U26 mortality is from the BSAI, it would be ideal to be able to run the closed loop simulation model incorporating this concept to evaluate what it may mean for the ranking of alternatives. However, the agreement does not specify how the burden of "U26 mitigation" is distributed among the Alaskan Regulatory Areas. In addition, other factors appear to have played a role in how the TCEY was distributed among the Alaskan Regulatory Areas in 2020 such that is not clear what impact of "U26 mitigation" can be expected in the future for the BSAI TCEY, if any.

Developing a function that relates assessed spawning biomass to expected total mortality (a proxy for coastwide TCEY)

In 2018, we conducted a linear regression to understand the relationship between halibut spawning biomass as estimated in historical assessments at the start of each year and the total mortality in that year, which led to an R^2 of 0.6 (Figure A2-6-3, top panel). We used the total mortality in year y as a proxy for TCEY. The regression equation for the 2019 analysis was:

(16) $$TCEY_y^{proxy} = TM_y = 0.2291 ssb\_a_y - 2E06,$$

where ssb_a_y is the assessment model's estimate of spawning biomass at the beginning of year y, TM_y is the total mortality for year y, and $TCEY_y^{proxy}$ is a proxy for the TCEY in year y. Total mortality was used in place of TCEY in the regression because the IPHC only recently began reporting TCEY making it difficult to perform a regression, and total mortality is highly correlated with TCEY for the years in which both are available, indicating that its use for representing halibut catch limits is reasonable. We then use this equation within the model to relate the model's perception of assessed spawning biomass to expected total mortality; this quantity is not an exact match for a TCEY, and therefore we called this a TCEY proxy. Caution should be used when interpreting the directed fishery catches in model results – rather than evaluating the directed catches in absolute biomass, the direct catches should be compared and ranked among management alternatives, relative to one another.

Here we updated the linear equation, as requested by excluding data points from earlier years as a way to downweight the effect of the older management period. The equation used in this year's analysis has a more shallow slope, meaning that a change in estimated spawning biomass leads to less of a change in the TCEY proxy than for last year's analysis (Figure A2-6-3, bottom panel):

(17) $TCEY_y^{proxy} = TM_y = 0.998ssb\_a_{\ y} + 1E + 07.$

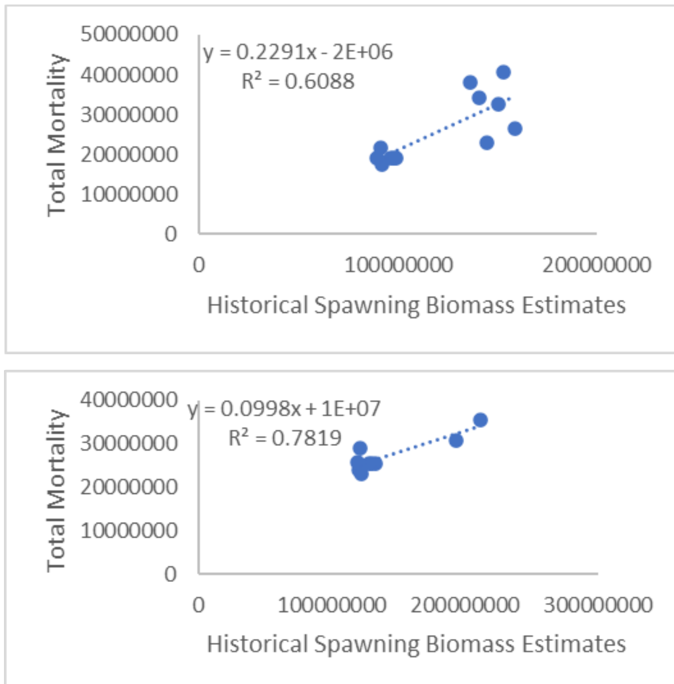

Figure A2-6-3. Relationship between recent historical IPHC spawning biomass estimates and the total mortality in the year that followed used last year (top panel) and this year (bottom panel) in the closed loop simulation model for TCEY determination.

There were two base case scenarios for these model runs: a set of runs where the IPHC harvest control rule was linear, as defined in c bottom panel for all levels of spawning biomass and a set of runs where the linear rule in Figure A2-6-3, bottom panel was used when the population was at or above 30% of unfished spawning biomass and a 30:20 harvest control rule was applied otherwise (Figure A2-6-4). This is meant to approximate the behavior of the 30:20 harvest control rule that is a part of the IPHC's non-binding harvest policy. The IPHC's harvest policy relates relative spawning biomass to a fishing intensity level, rather than an absolute catch level, so that visualizations of their 30:20 rule show a horizontal line above 30% of unfished biomass (fishing intensity remains the same above this level, but spawning biomass increases and therefore TCEY would increase under this rule). Here, TCEY is on the y-axis rather than fishing intensity, so the line increases at spawning biomass levels above 30% of unfished, mimicking the behavior of the IPHC 30:20 rule.

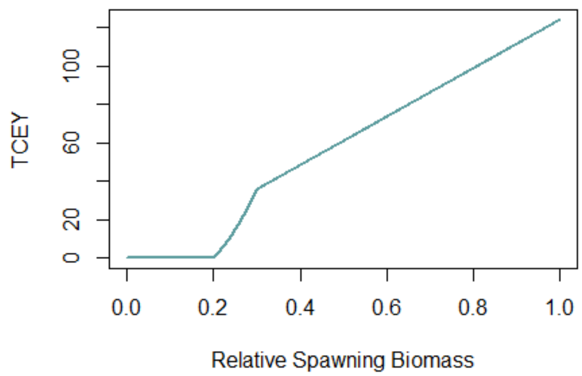

Figure A2-6-4. Implementation of a 30:20 harvest control rule in the closed loop simulation model. When relative spawning biomass is above 30% of its unfished level, the relationship pictured in the bottom panel of Figure A2-6-3 is used. Otherwise, the 30:20 harvest control rule determines TCEY coastwide.

Distributing expected total mortality among the two areas

The coastwide TCEY proxy in the model is then distributed between the BSAI and the other area according to the proportion of modeled FISS biomass in each area in each year.

(18) $TCEY_{l,y}^{proxy} = TCEY_{y}^{proxy}\ B_{1,y,FISS}^{surv}/B_{2,y,FISS}^{surv}$

Where $TCEY_{l,y}^{proxy}$ is the catch limit in area l in year y prior to accounting for PSC in the BSAI and bycatch in the other area. The IPHC currently has no long-term formal formula for distributing TCEY between the BSAI and other areas, so the distribution of modeled survey biomass seems a reasonable proxy for this task, and ensures that the catch limits set in each area are responsive to major changes in the distribution of older fish between the two areas. In addition, the TCEY in most recent five years has been distributed roughly similarly to the historical distribution of the IPHC's FISS survey biomass between the BSAI and elsewhere. The historical distribution of the IPHC's FISS survey biomass between the BSAI and the other area was calculated as follows: (i) calculate the proportion of weight-per-unit effort by IPHC regulatory area, (ii) multiply these proportions by the geographic size of each regulatory area and re-normalize these area-specific values to add to 1 among all regulatory areas, (iii) sum over regulatory areas 4A, 4B, and 4CDE, (iv) sum over 4B and 4CDE, (v) average the summed proportions including and excluding 4A for a proxy of the proportion in the BSAI (which includes approximately half of Regulatory Area 4A.

Accounting for expected PSC (BSAI) and bycatch mortality (other area) to arrive at directed fishery catch limits by area

The directed fishery catch limits within each area are calculated by subtracting the expected over-26-inch (O26) bycatch from the area-specific TCEY proxy. Expected bycatch was calculated as the bycatch from the previous year of O26 inch fish (again, in the BSAI, bycatch is synonymous with PSC; in the other area, bycatch is simply generically labeled "bycatch"). The average age of a 26-inch fish was 7 for both males and females, calculated as a function of the 2019 weight-at-age and length-weight relationships (Stewart et al. 2019). Therefore, the expected bycatch of O26 inch fish in the previous year was the bycatch of age 7+ fish in the previous year. The PSC and bycatch from the previous year (expected bycatch) may be larger than the area-specific TCEY proxy for the current year. In these cases, the catch limit for the directed fishery is set equal to 0. Additionally, the model assumes that the directed fishery catch by area is equal to the directed fishery catch limit by area, and known without error. Therefore, we define only directed fishery catches:

(19) $C_{Directed,\ BSAI,\ y} = \max(0,\ TCEY^{proxy}_{BSAI,y}$ -$PSC_{Trawl,\ y-1}$- $PSC_{HAL,\ y-1}$),

(20) $C_{Directed,\ Other,\ y} = \max(0,\ TCEY^{proxy}_{Other,y}$-$Bycatch_{y-1}$),

where $C_{Directed,BSAI,y}$ and $C_{Directed,\ Other,y}$ are the directed fishery catches in the BSAI and other area, respectively for year *y*, $PSC_{Trawl,y-1}$, $PSC_{HAL,y-1}$ are the trawl and HAL PSC in the BSAI (only) for year *y-1*, and $Bycatch_{y-1}$ is the bycatch in the other area in year *y-1*.

Forward Simulation

For each management alternative, the model dynamics were simulated over 100 future years, and replicated across 500 simulations, each with a unique set of random deviations for yearly recruitment, recruitment allocations, survey observation errors, and assessment estimation error (for both spawning biomass and dynamic unfished spawning biomass). The same set of random deviates were used for model runs across management alternatives to ensure that results were directly comparable across alternatives.

Table A2-6-8. Indexing symbols used in the model description.

Symbol	Description
l	Area or location (Bering Sea and Aleutian Islands and remaining West Coast halibut range)
y	Year
s	Sex
a	Age
g	Gear type or fishing sector
i	Area migrating **from**
j	Area migrating **to**

Table A2-6-9. Model parameters descriptions.

Parameter	Description
$R_{l,y}$	Recruitment
SSB_y	Spawning stock biomass
$N_{l,s,y,a}$	Numbers at age
$B_{l,s,y,a}$	Biomass at age
$Z_{l,s,y,a}$	Total mortality
$F_{l,g,y}$	Fishing mortality rate
$f_{l,s,y,a}$	Age and sex-specific fishing mortality rate
$C_{l,s,y,a}$	Total catch in numbers
$c_{l,s,y,a,g}$	Catch in numbers by gear type
$H_{l,y,g}$	Harvest in biomass by gear type

Table A2-6-10.Model parameters descriptions continued).

Parameter	Description
$\boldsymbol{M_s}$	Natural mortality by sex
$\boldsymbol{w_{s,a}}$	Weight at age by sex
$\boldsymbol{m_{s,a}}$	Maturity at age (note this is equal to zero for males)
$\boldsymbol{v_{g,s,a}}$	Selectivity
$\boldsymbol{p_{l,s,a}}$	Initial biomass proportions at age by area

Table A2-6-11.Model parameters, values used in the base runs of the model, along with descriptions of each parameter and the source of the chosen value.

Parameter	Value	Description	Source
σ_r	0.54	Standard deviation of recruitment process error	2019 IPHC Coastwide Long Assessment Model
h	0.75	Steepness (proportion of R0 that occurs when spawning biomass is 0.2 of its unfished value)	2019 IPHC Coastwide Long Assessment Model
$ln(R_{0,y})$ (non PDO, PDO)	11.1498, 11.517591	Unfished recruitment at age 0 in a non-PDO year and in a PDO year (PDO is Pacific Decadal Oscillation)	2019 IPHC Coastwide Long Assessment Model
μ_x, σ_x, ρ determining $\delta_{l,y}$	0.3228, 0.6, 0.85	Parameters determining proportion of recruitment occurring in the BSAI in each year and simulation	Model validation
yInt, midPt, k determining *I*	0.005, 30, 0.3	Parameters controlling the probability of a PDO or non-PDO year, which shifts the value of R_0	OM for IPHC Management Strategy Evaluation (Hicks et al. 2019).
M_s	0.22 (f), 0.21 (m)	Natural mortality for females and males	2019 IPHC Coastwide Long Assessment Model
A	30	Age of the plus group in the model	Fish at or above this age tend to have similar population dynamics and selectivity.
σ_{γ_f}	0.073, 0.1	Survey observation error for the BTS and FISS survey, respectively	1998-2018 average survey CVs
σ_φ	0.1	Assessment error in estimation of spawning biomass	Arbitrary
θ	1 (base case), 0.75 (sensitivity analysis)	Influence of the previous year's estimate of spawning biomass on the current year's spawning biomass. 1 = no influence	Arbitrary, set to 1 for initial simulations with the intention of conducting sensitivity analyses
$p_{a=2:6}$, $p_{a=7:14}$, $p_{a=15+}$	0.35, 0.25, 0.1	Proportion of numbers-at-age 2-6, 7-14, and 15+ occurring in the BSAI in the first year of the model	Model validation

Appendix 3: Model Validation

This appendix has been updated from Appendix 3 of the October 2019 DEIS

Purpose

The purpose of model validation is to make sure that the model is able to replicate population dynamics that have been observed in the past, given historical catches. This acts as a check to verify that the modeling code works as intended and sets the stage for conducting forward simulations, starting from current conditions, as estimated by the 2019 IPHC assessment (Stewart and Hicks 2020). Note that the most recent IPHC stock assessment was developed in 2019 and used data through 2019, with a document finalized in 2020. The IPHC assessment is a set of coastwide models that generates estimates of coastwide spawning biomass, recruitment, and fishing mortalities; the model used for this analysis is, in contrast, a two-area model including the BSAI as one area and the remainder of the coastwide range of the halibut stock (the Gulf of Alaska, British Columbia, and the U.S. West Coast) as the other area. Therefore, there are two parts to the model validation. The first is to match the historical coastwide population dynamics (in terms of spawning biomass, recruitment, and catches). The second part is to replicate area-specific dynamics, including replication of the historical proportion of IPHC Fishery Independent Setline Survey (FISS) biomass found in the BSAI, as well as survey trends in the BSAI from the IPHC's FISS and the NOAA Eastern Bering Sea Bottom Trawl Survey (BTS). Additionally, recent IPHC tagging studies have attempted to estimate yearly adult movement rates between the BSAI and the GOA and these are used to inform the model (Webster et al. 2013, Stewart and Webster 2019). Older IPHC tagging studies were not used in the model validation exercise due to problems with study design that prevent the estimation of yearly movement estimates from those data (Webster 2015, Valero and Webster 2011).

Below we provide details for how we configured the model to replicate historical coastwide and area-specific population dynamics, and discuss the results of the model validation exercise. We also outline application of the model validation to the forward simulations under management alternatives, and areas for further study.

Matching historical Pacific halibut population dynamics

To match historical Pacific halibut population dynamics, we ran the operating model with 26 years of historical catch data, grouped by modeled fleet and area, and initiated the model with 1994 numbers-at-age from the most recent IPHC stock assessment (Stewart and Hicks 2020). In addition, we provided the model with yearly weight-at-age and selectivity-at-age, as well as recruitment deviations, the PDO signal, estimated unfished recruitment (R_0) values associated with the state of the PDO from the most recent IPHC coastwide long assessment model (Stewart and Webster 2020), and estimates of yearly movement from Webster et al. (2013) and Stewart and Webster 2019, p. 50. Initial historical model runs assuming constant, average weight-at-age and a single average R_0 value (instead of simulating a linkage between the PDO and R_0) failed to lead to dynamics that were, on average, similar to those from the most recent IPHC assessment, indicating that these two time-varying features were necessary inclusions in the OM. The selectivity-at-age from the IPHC 2019 coastwide long assessment model was allowed to vary over time, but variation in estimates over time were very small, especially relative to the changes in weight-at-age that have been observed over time. Therefore, fluctuating selectivity-at-age over time was not included in the OM for forward simulations, but rather is specified to remain at its 2019 value for all future years.

In the October 2018 DEIS, we established that using the recruitment pattern from the 2018 coastwide long assessment model (Stewart and Hicks 2019) along with a constant proportion of recruitment to the BSAI each year led to a model that could mimic the FISS biomass index in the BSAI, as well as recruitment deviations, coastwide spawning biomass, and catch biomass by fleet reasonably well, but failed to mimic the BTS biomass index (Figure A3-; repeated from the October 2019 description). The BTS catches younger, smaller fish than the FISS, and therefore we might expect for two surveys to show different biomass trends from one another based on these different selectivities, but the lack of match between the observed BTS and the simulated BTS index indicated that the OM was failing to capture some key dynamics of the BSAI (Figure A3-, bottom right panel).

The BTS and FISS indices are simulated within the operating model by first determining the selected halibut by age and sex, calculating the total selected biomass for each sex by multiplying selected numbers of halibut-at-age by sex-specific weight-at-age, and summing across ages and sexes in each model area (section 5.2). Lognormally-distributed random observation error is added to each index in each year with a CV equal to that estimated for each survey. The fixed observation error CV for the two surveys was specified to be equal to the average used in the assessments (or from the design-based estimates in the case of the BTS; section 5.2).

The FISS biomass index and BTS biomass index historically have shown opposite trends at times and the these differences are unlikely due to lags caused by the age composition differences between the surveys, as the simulated BTS biomass index in the OM would have accounted for these lags, allowing the observed and simulated BTS biomass indices to match in Figure A3- (bottom panel).

One likely reason why the observed and simulated BTS biomass index may not have matched is that coastwide recruitment may originate from different areas in different years such that the recruitment trends in the BSAI could be quite different from the coastwide recruitment trends estimated by the IPHC assessment models. To investigate this possibility, we developed an estimation model for the BSAI only (referred to here as “the BSAI sub-model” or “the sub-model”) for the 2019 analysis, which was updated with new data for this year’s analysis. The BSAI sub-model is an assessment model for the BSAI only that uses the BTS age composition data, the BTS biomass index, and BSAI catch data to estimate halibut dynamics (Figure A3-6-6-Figure A3-6-9). McGilliard et al. (2015) show that using a single area assessment model for a sub-range of a fish stock with movement dynamics in and out of this sub-range can lead to biased estimates of biomass because movement of fish in and out of the sub-range is mis-specified as other processes. Therefore, we do not use the BSAI sub-model as an estimate of BSAI biomass (nor does the IPHC). However, it provides an estimate of the relative recruitment trends in the BSAI, as informed by the BTS age composition data. We used these estimates of recruitment for the BSAI to inform recruitment in the OM (Figure A3-6-9).

The relative recruitment estimates from the sub-model were used as inputs to the closed loop simulation model as BSAI-specific recruitment trends, where these estimates were standardized to maintain trends, but to reflect the mean scale of the recruitment estimates from the IPHC’s coastwide long assessment, multiplied by the average proportion of recruitment occurring in the BSAI. In this way, the OM maintained the coastwide trend in recruitment, but allocated the proportion of recruits occurring in the BSAI in each year according to the relative recruitment trend estimated from the sub-model, with remaining yearly coastwide recruitment assigned to the other area. This led to an OM (both in 2019 and in this year’s analysis) that was able to match both the FISS and BTS biomass indices much better than assigning coastwide recruitment trends to the BSAI, with a correlation between the observed and simulated biomass indices (updated in 2020 with the newest data from both the 2020 IPHC coastwide long stock assessment and the 2020 submodel) of 0.77 for the BTS and 0.96 for the FISS, while preserving reasonably matched coastwide population dynamics (Figure A3-6-10).

Additionally, we conducted an approximate relative comparison between ages of the proportion of fish in the BSAI between the sub-model and the 2019 IPHC coastwide long assessment model, using 3 age groupings (see Chapter 5). As the model validation started from a fished state in 1994, this helped to reduce burn-in time at the beginning of the historical model validation period.

Figure A3-6-10 was generated by fitting the simulated proportion of FISS biomass in the BSAI over the historical period to the observed proportion of FISS biomass in the BSAI by estimating the average proportion of coastwide recruitment to the BSAI and a single juvenile movement parameter (for ages 2-6) with the constraint that the total yearly coastwide recruitment of age 2 individuals in the OM match the numbers at age 2 estimated by the 2019 IPHC coastwide long recruitment estimates.

These two parameters were estimated because they are both unknown. The average proportion of recruitment occurring in the BSAI is unknown because the FISS samples only older fish and a single survey that samples young fish across the range of the halibut stock (or even across the BSAI and Gulf of Alaska) has never existed, making it hard to compare the proportion of young fish occurring between regions. Yearly juvenile movement rates between the BSAI and the other area are also unknown, as tagging studies for younger/smaller halibut have study design flaws preventing estimation of reliable movement estimates (two problems with these data were sampling of small geographic ranges that were disproportional to abundance and no recorded measure of effort at the time of recoveries; Valero and Webster 2011, Webster 2011). Webster et al. (2013) provides the most reliable estimates of movement rates for halibut, and the model developed in this paper has been used to estimate movement rates for all ages of halibut. However, the paper is based on tagging data from fish tagged on the FISS, which almost exclusively selects O26 (age 7+) fish (section 4.2, Stewart and Hicks 2020). Therefore, estimates of movement for halibut ages 2-6 are uncertain. In addition, all of the tagging studies that have been conducted for Pacific halibut have occurred over short periods, such that if movement is time-varying, we may not have reliable estimates of average yearly movement rates over time, even from well-designed studies.

This model fitting exercise led to an average proportion of recruitment to the BSAI of 0.5, and yearly movement rates of juvenile fish (ages 2-6) of 0.01 (Figure A3-6-11). An average proportion of recruitment to the BSAI that was above 0.5 led to more recruitment in the BSAI than estimated total coastwide recruitment in many years, violating the constraint that area-specific recruitment must add to coastwide recruitment estimates from the assessment model. However, with mean recruitment allocation to the BSAI of 0.5, the OM failed retain any fish in the BSAI when juvenile movement estimates from Webster et al. (2013) and Stewart and Webster 2019 (p. 50) were applied.

The OM with the sub-model recruitments and estimates of the average proportion of recruitment to the BSAI and juvenile movement rates was still unable to match the proportion of survey biomass in the BSAI in the initial year modeled (and over time) with that observed by the FISS- the OM had trouble maintaining enough biomass in the BSAI, using adult movement estimates from Stewart and Webster (2019), p.50. We revisited the assumption that the Stewart and Webster (2019) yearly movement estimates were able to represent the average movement rate of adults over the entire historical period by applying a single multiplier (0.7) to all age-specific yearly adult (age 7+) movement rates. Using this approach, we arrived at a simulation model that maintained, on average, approximately 20% of the simulated FISS biomass in the BSAI from 2008-2018 (Figure A3-6-12).

Still, the simulation model shows a dip in the proportion of survey biomass in the BSAI in the late 1990s and early 2000s, followed by an increase, while the observed proportion of survey biomass in the BSAI has been estimated to be stable at about 0.2 throughout time (Figure A3-6-12). There are several hypotheses for what may lead to the observed dynamics that could be investigated by future studies. One hypothesis is that density dependent movement may be occurring, or environmentally-driven movement. There may be differences in changes in weight-at-age, natural mortality, and/or productivity over time between the two areas that may contribute to a more stable proportion of FISS biomass in the BSAI than the simulation model can currently capture. Ideally, some of these hypotheses could be explored and used as alternative ways to condition the OM, which could then be used as scenarios for halibut dynamics in forward simulations. However, validating some of these hypotheses with data may be difficult. In addition, given many of the constraints on the alternatives evaluated, different model validation scenarios may lead to similar results with respect to the Council objectives when comparing between alternatives.

Current application to forward simulations

Based on the results of the model validation exercise, the OM modeled the average proportion of recruitment to the BSAI as 0.5 and juvenile movement from the BSAI to the other area as 0.01. The model simulates the Pacific Decadal Oscillation (PDO) in forward simulations and the state of the PDO is then linked to the value of unfished recruitment.

A major outcome of the model validation exercise is that the forward simulation incorporates time-varying recruitment allocation between the BSAI and the other area, as the recruitment in the BSAI clearly follows a different relative pattern than that coastwide. In addition, the forward simulation runs incorporate both different initial proportions of fish in the BSAI according to age groupings and a multiplier of 0.7 on the age-specific adult movement estimates (for ages 7+) from Webster et al. (2013) and Stewart and Webster (2019) to represent the hypothesis that average movement rates from the BSAI to the other area are different from those observed over the short period of the Webster et al. (2013) study, but that movement rates of each age relative to one another were captured by this study.

Additional Model Updates to Match the 2020 IPHC Stock Assessment

This year, the simulation model was updated with parameter estimates, weight-at-age, maturity-at-age, selectivity, and catches from the 2020 IPHC coastwide long stock assessment, updated BSAI trawl and longline PSC and bycatch in the other area, and relative BSAI recruitment estimates from the 2020 BSAI submodel described above. Comparison plots were made to show how well the updated model matched the 2020 IPHC stock assessment.

There were two notable changes to IPHC stock assessment methodology that were taken into account in the process of updating.

First, newly obtained sex-specific commercial data were added showing that the sex ratios in the commercial catch coastwide were 70-90% female (Stewart and Hicks 2020). This change was taken into account in the model validation by using updated parameter values and selectivity-at-age for the commercial fishery from the most recent stock assessment (Figure A3-6-9-Figure A3-6-14).

Second, the definition of unfished spawning biomass was changed from a static value assuming low weight-at-age and high recruitment to “dynamic” unfished spawning biomass. Dynamic unfished spawning biomass is calculated for each year of the model by first fitting the stock assessment model to data and then replaying the model dynamics with the fitted parameter values (including recruitment deviations), but assuming that fishing mortality was equal to zero in all years. The simulation model was updated to include dynamic unfished biomass and an extra model validation step was done to ensure that dynamic unfished spawning biomass matched between the simulation model and the most recent IPHC stock assessment (Figure A3-6-15).

The differences between last year’s and this year’s stock assessment models led to slightly larger differences in between the most recent stock assessment model and the simulation model than were present in the 2019 model validation process. The models still match fairly well, but the structural differences in the models led to some irreducible differences: the stock assessment models are coastwide, while the simulation model has two areas. In addition, the stock assessment models structure fleets differently from the way that it must be modeled in the closed-loop simulation model to evaluate abundance-based management. The IPHC stock assessment models aggregate all non-directed bycatch over areas, assigning bycatch a single, asymptotic selectivity curve. The closed-loop simulation model must include separate fleets for BSAI trawl and longline PSC, as well as a fleet for other area non-directed bycatch. The simulation model simplifies methods by combining recreational and subsistence fishing, as well as directed fishery discard mortality with commercial fishing to create one commercial fleet in each area. This led to a slightly higher impact of fishing over time in the closed-loop simulation model for 2020, as measured by catch/biomass (Figure A3-6-13) and therefore slightly lower spawning biomass and precision error in numbers-at-age that accumulates as fish grow old (Figure A3-6-14). This could not be resolved within the model validation process without restructuring the fleets in the closed-loop simulation model in a way that would not be useful for applying the model to the problem of abundance-based management of halibut PSC. Instead, sensitivity analyses were conducted in the forward simulation models by using alternative fishery selectivity curves for the fleet with the most uncertainty about selectivity, which is the BSAI trawl PSC fleet (Appendix 2). There is currently no stock assessment model that estimates a selectivity curve for this fleet. In last year's analysis and in this year's base case scenarios, the BSAI trawl PSC fleet selectivity was set equal to that for the EBS trawl survey (BTS), as both fleets tend to catch smaller halibut than for fleets using longline gear. A sensitivity analysis was done setting BSAI trawl PSC selectivity such that the fleet catches a higher proportion of younger fish than in the base case scenario and another sensitivity analysis set BSAI trawl PSC selectivity such that higher proportion of older fish were caught than I the base case scenario (see Appendix 2 for more details).

One additional note is that weight-at-age from the most recent year was smoothed prior to application to the simulation model, as requested by the SSC in October 2019. The model validation and forward simulations were conducted with and without smoothing the weight-at-age, with no visible differences in results.

Methods Note

The historical distribution of the IPHC's FISS biomass between the BSAI and the other area was calculated as follows: (i) calculate the weight-per-unit effort (WPUE) by IPHC regulatory area, (ii) multiply these WPUE values by the geographic size of each regulatory area and re-normalize these area-specific values to add to 1 among all regulatory areas, (iii) sum over regulatory areas 4A, 4B, and 4CDE, (iv) sum over 4B and 4CDE, (v) average the summed proportions including and excluding 4A for a proxy of the proportion in the BSAI (which includes approximately half of Regulatory Area 4A. Approximately 20% of the FISS biomass has occurred in the BSAI over the last 26 years

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Figures

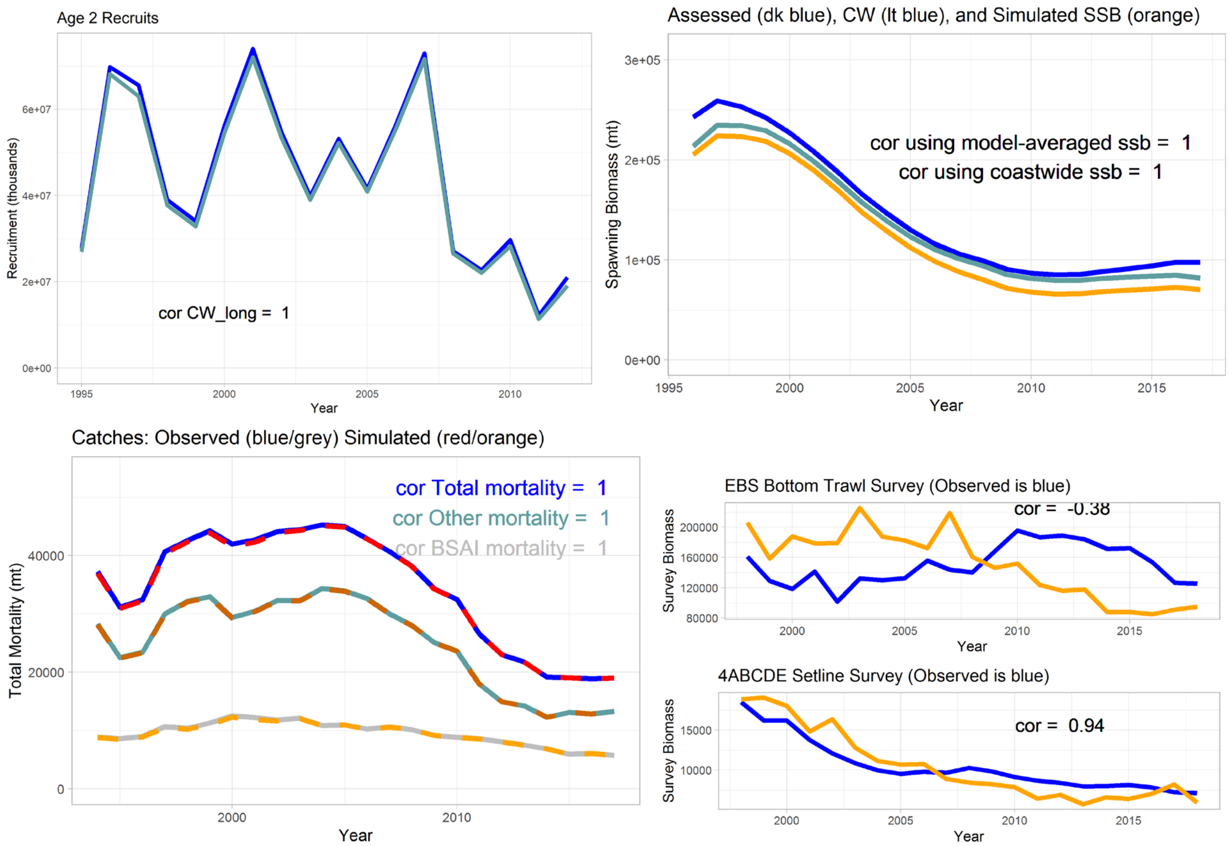

Figure A3-6-5 Figure repeated from October 2019 DEIS: A comparison of Pacific halibut population dynamics observed or estimated by the 2018 IPHC coastwide long assessment model to dynamics from the closed loop simulation model run for 25 historical years with historical catch data and historical estimates of recruitment deviations, weight-at-age, selectivity-at-age, and maturity-at-age from the 2018 coastwide long assessment model. Top left: estimated numbers-at-age 2 from the coastwide long assessment model and calculated by the closed loop simulation model. Top right: spawning biomass from the integrated 2018 IPHC assessment model, the coastwide long assessment model, and the closed loop simulation model. Bottom left: historical catches by gear type grouping data inputs (solid lines) and outputs from the closed loop simulation model (dashed lines); blue/red are halibut fishery catches, turquoise/burnt orange are PSC, and grey/orange are bycatch in the other area. Bottom right: observed (blue) and modeled (orange) survey biomass indices for the BTS (upper panel) and the FISS (bottom panel).

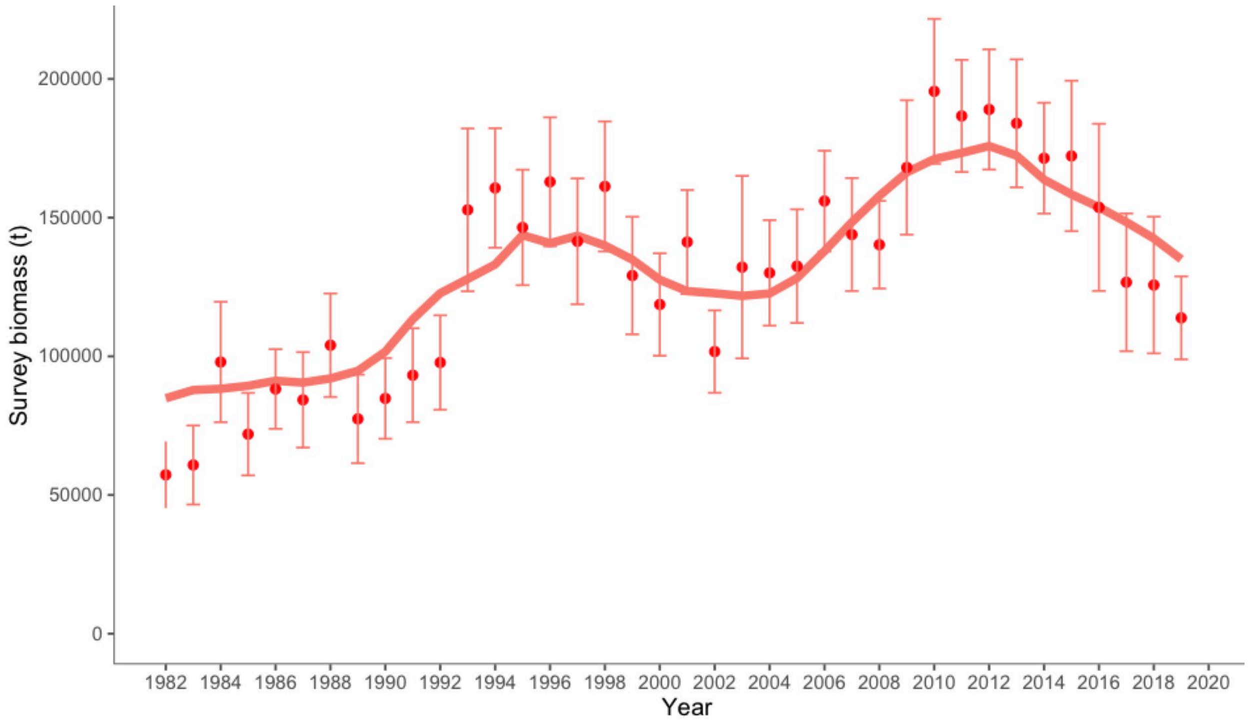

Figure A3-6-6 The 2020 BSAI sub-model (thick blue line) conditioned to fit to the observed BTS biomass index (red dots). Vertical lines show 95% asymptotic intervals about the observed BTS biomass index point estimates.

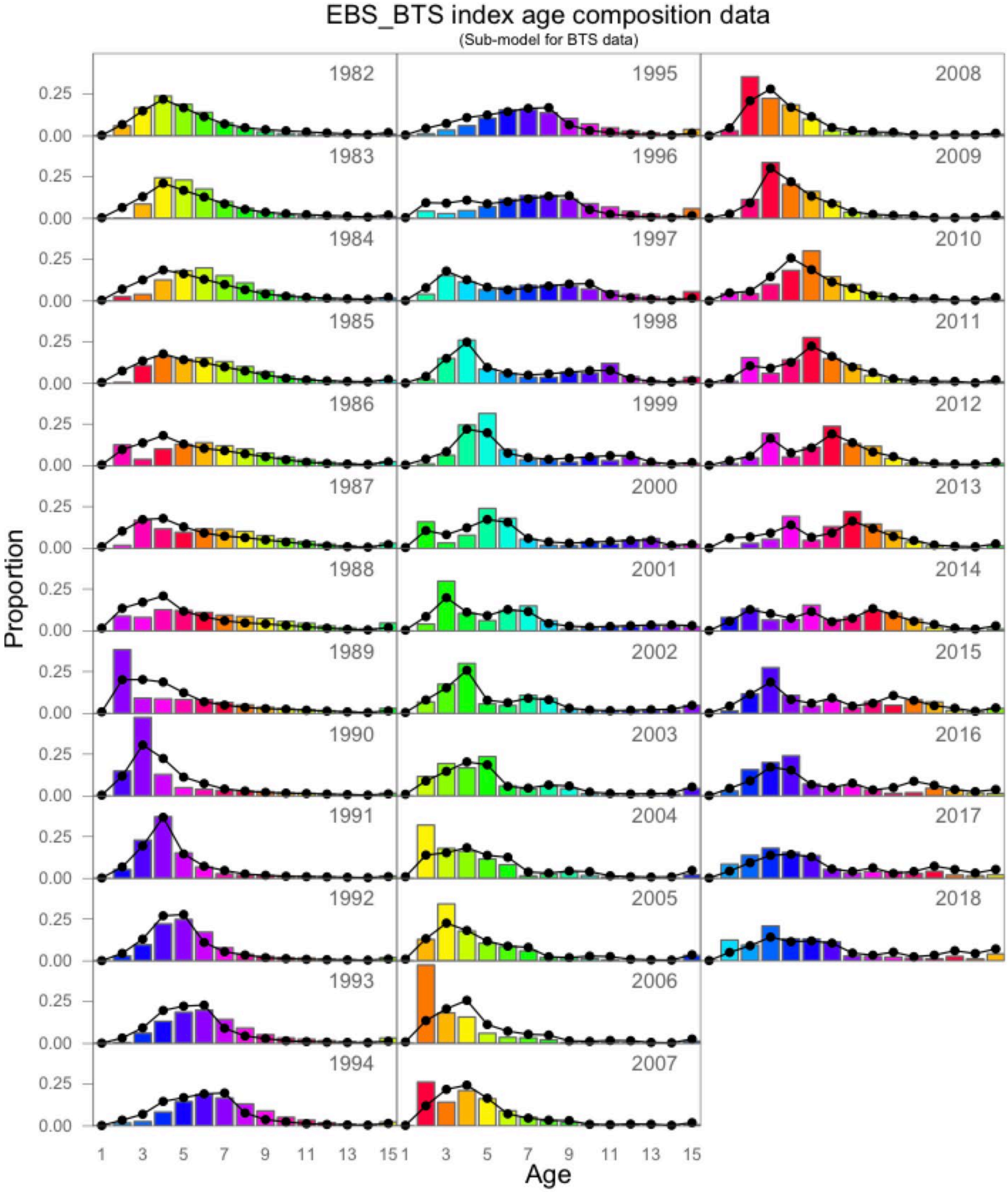

Figure A3-6-7 The 2020 BSAI sub-model conditioned to fit the available yearly BTS age composition data (data are shown as the multi-color frequency histogram, model fits to data are indicated by black dots and line).

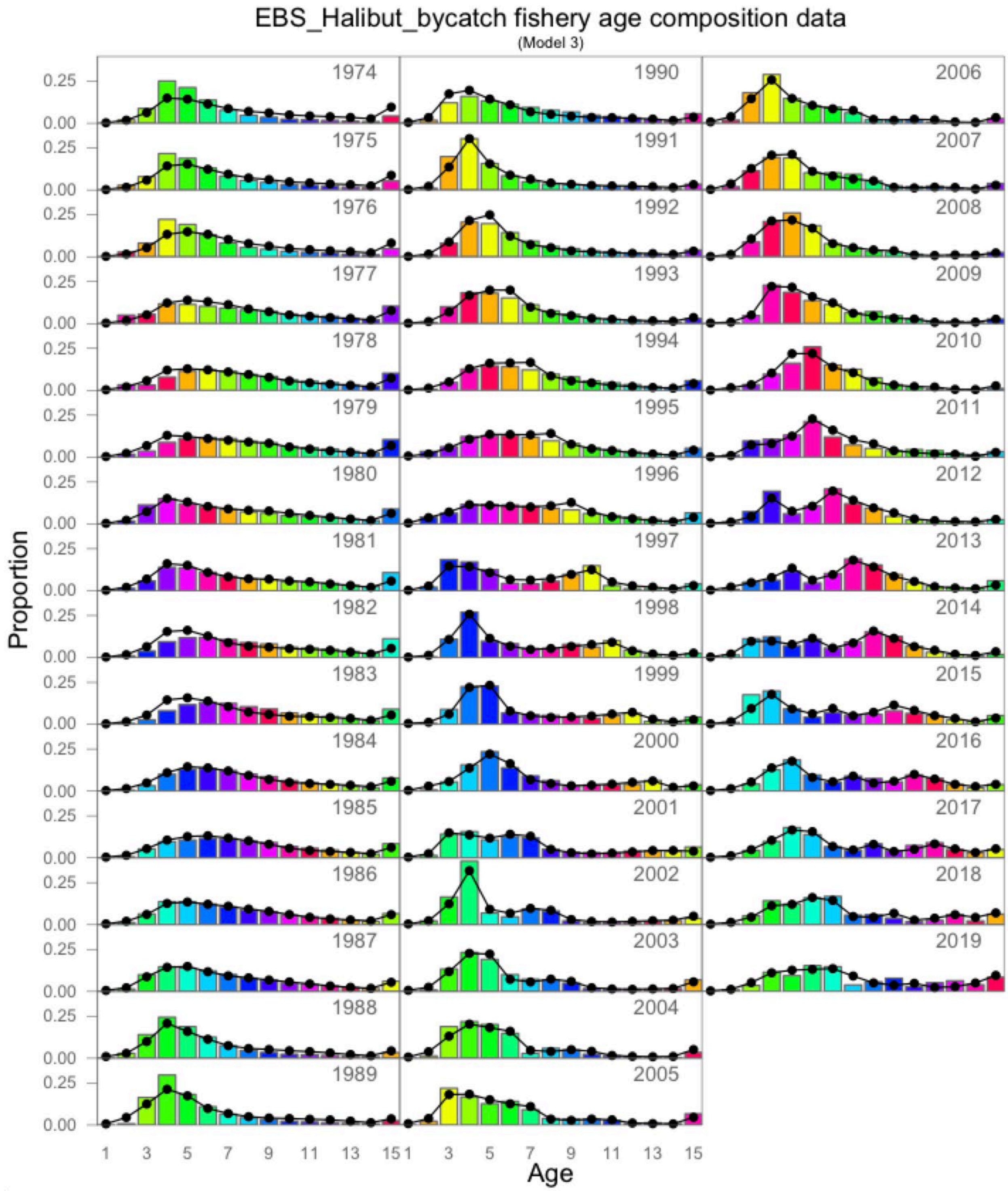

Figure A3-6-8 The 2020 BSAI sub-model conditioned to fit the available yearly bycatch fishery age composition data (data are shown as the multi-color frequency histogram, model fits to data are indicated by black dots and line).

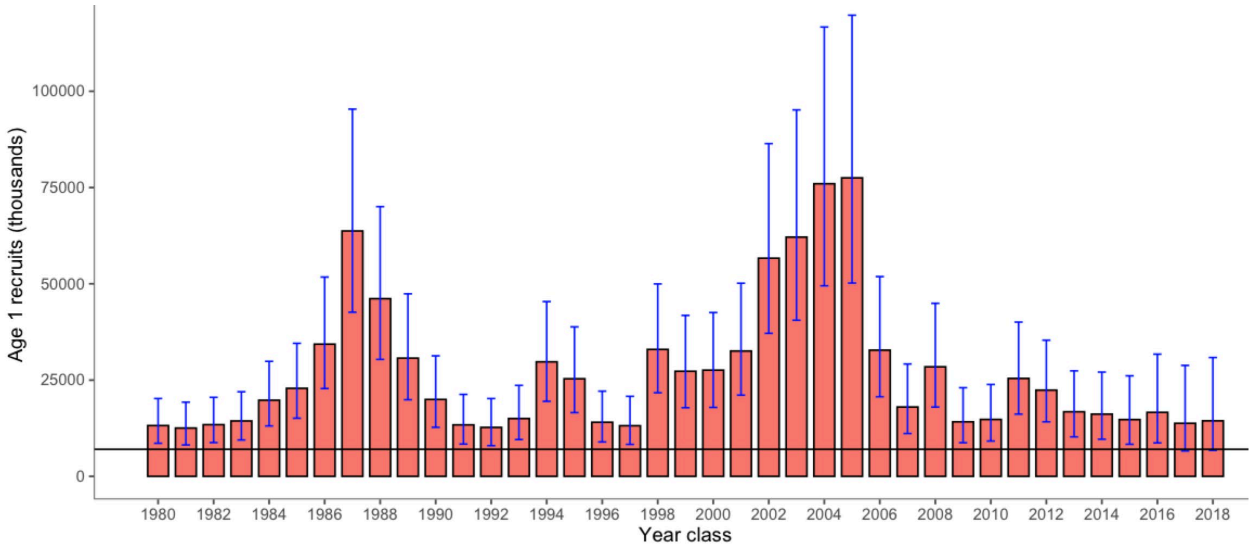

Figure A3-6-9 Age-1 Recruitment estimates from the 2020 BSAI sub-model. These relative values were used to evaluate the process error component of the BTS in OM projections relative to the OM conditioned to mimic the 2020 coastwide long assessment by the IPHC.

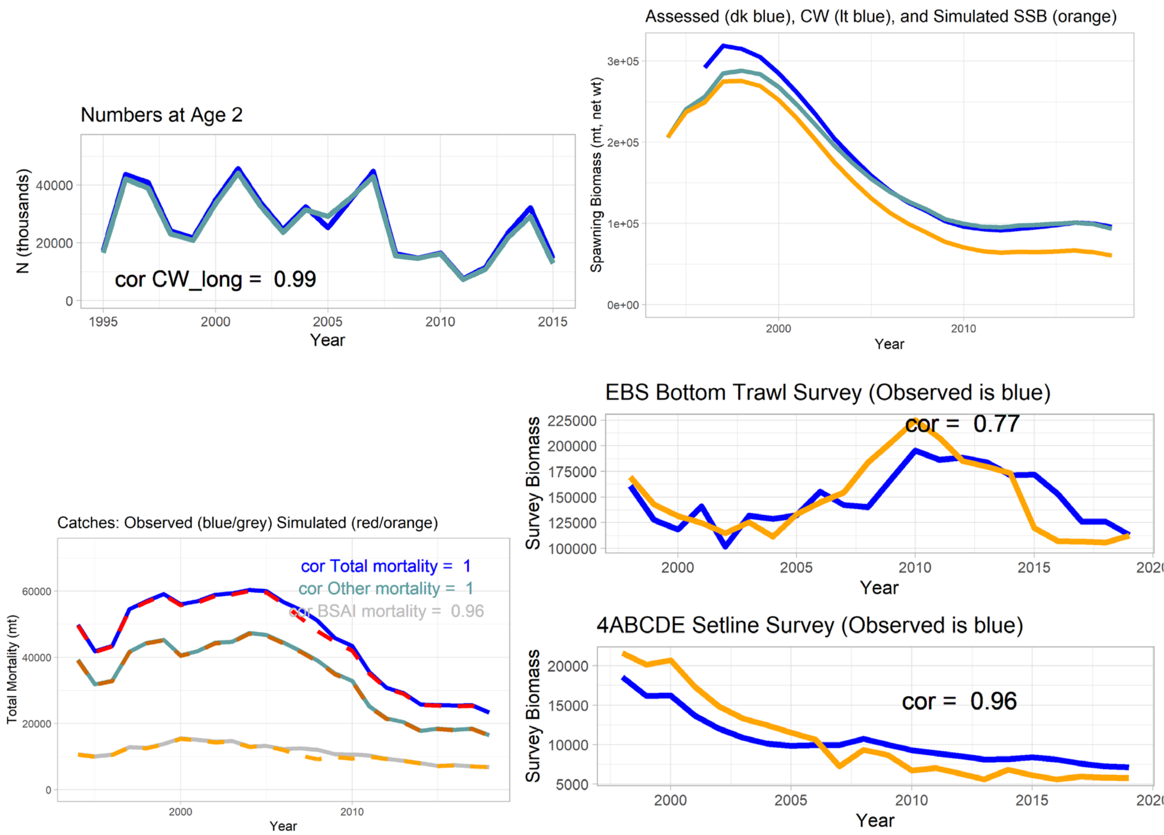

Figure A3-6-10 As for Figure A3-6-1 Relative age-2 recruitment to the BSAI from the sub-model (dark blue), the relative recruitment to the BSAI modeled by the OM, where it is standardized as a proportion of mean coastwide recruitment to the BSAI (0.5) within the model, then made relative to its mean for visualization (orange), and the relative coastwide recruitment index, standardized to its mean (light blue). Right panel: coastwide recruitment of age-2 individuals from the OM (light blue) and the 2019 IPHC coastwide assessment model (dark blue). The left and right panels were produced by the same model run with the average proportion of recruitment to the BSAI equal to 0.5 and juvenile movement from the BSAI to the other area equal to 0.01.but with an OM using recruitment trends from the BSAI sub-model to represent relative recruitment in the BSAI, with remaining coastwide recruitment assigned to the other area, and updated using 2020 IPHC and BSAI submodel estimates. Top left: estimated numbers-at-age 2 from the coastwide long assessment model and calculated by the closed loop simulation model. Top right: spawning biomass from the integrated 2019 IPHC assessment model, the coastwide long assessment model, and the closed loop simulation model. Bottom left: historical catches by gear type grouping data inputs (solid lines) and outputs from the closed loop simulation model (dashed lines); blue/red are halibut fishery catches, turquoise/burnt orange are PSC, and grey/orange are bycatch in the other area. Bottom right: observed (blue) and modeled (orange) survey biomass indices for the BTS (upper panel) and the FISS (bottom panel)

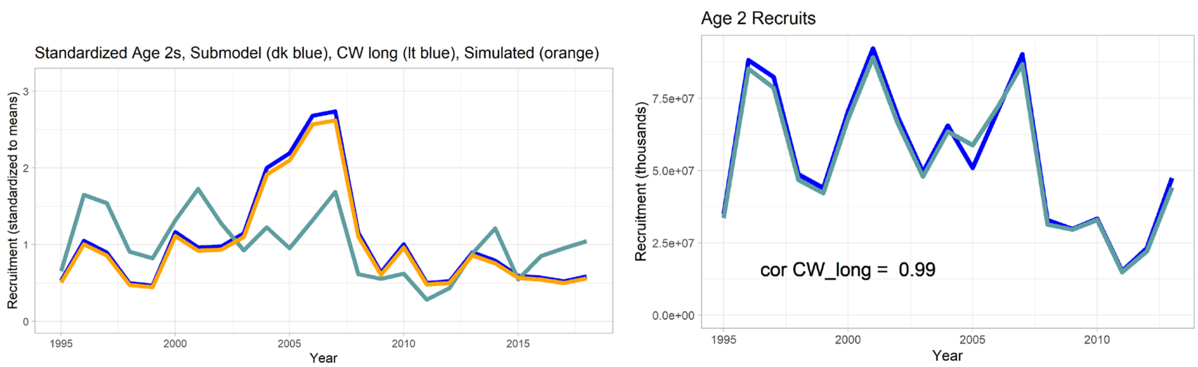

Figure A3-6-11 Relative age-2 recruitment to the BSAI from the sub-model (dark blue), the relative recruitment to the BSAI modeled by the OM, where it is standardized as a proportion of mean coastwide recruitment to the BSAI (0.5) within the model, then made relative to its mean for visualization (orange), and the relative coastwide recruitment index, standardized to its mean (light blue). Right panel: coastwide recruitment of age-2 individuals from the OM (light blue) and the 2019 IPHC coastwide assessment model (dark blue). The left and right panels were produced by the same model run with the average proportion of recruitment to the BSAI equal to 0.5 and juvenile movement from the BSAI to the other area equal to 0.01.

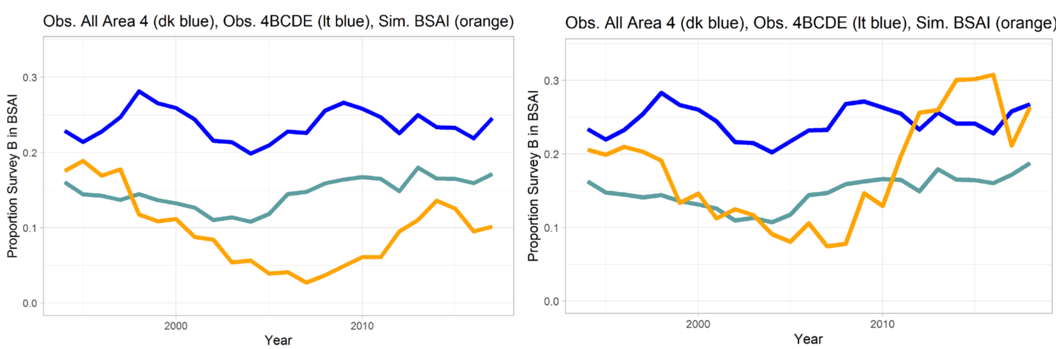

Figure A3-6-12 Observed and simulated proportion of FISS biomass in the BSAI for two model validation runs. Left panel: a run using the age-specific adult movement estimates from Webster et al. (2013). Right panel: a run using the age-specific adult movement estimates from Webster et al. (2013), with a multiplier of 0.7 applied. The observed FISS biomass was calculated including Area 4A (dark blue line) and excluding Area 4A (light blue line). The simulation proportion of FISS biomass is shown in orange. A portion of Area 4A is in the Gulf of Alaska.

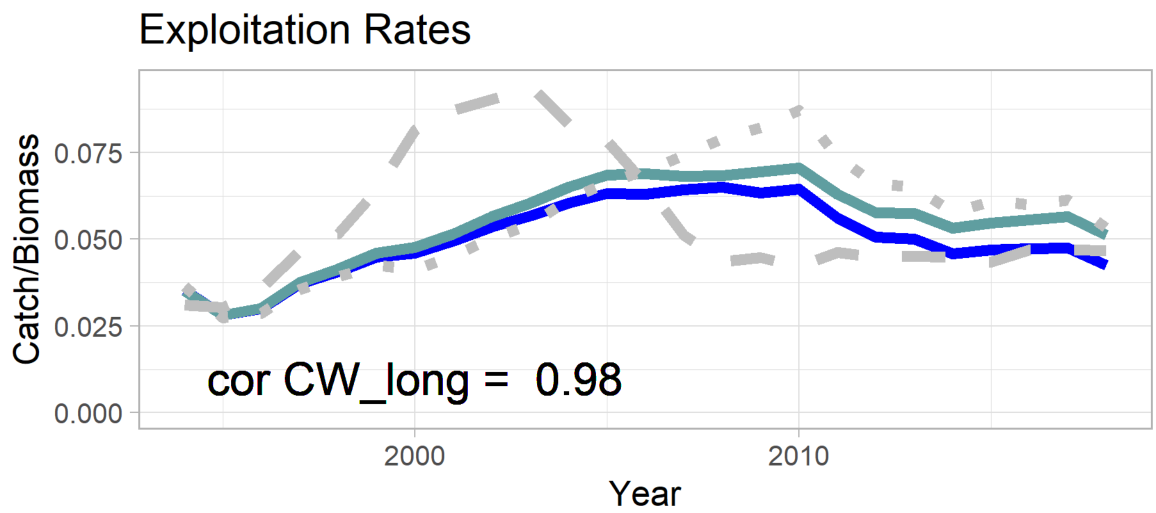

Figure A3-6-13 Exploitation rates (defined as catch/biomass) for observed coastwide (dark blue; IPHC coastwide long stock assessment), simulated coastwide (light blue), simulated BSAI (grey, dashed line), and simulated other area (grey, dotted line).

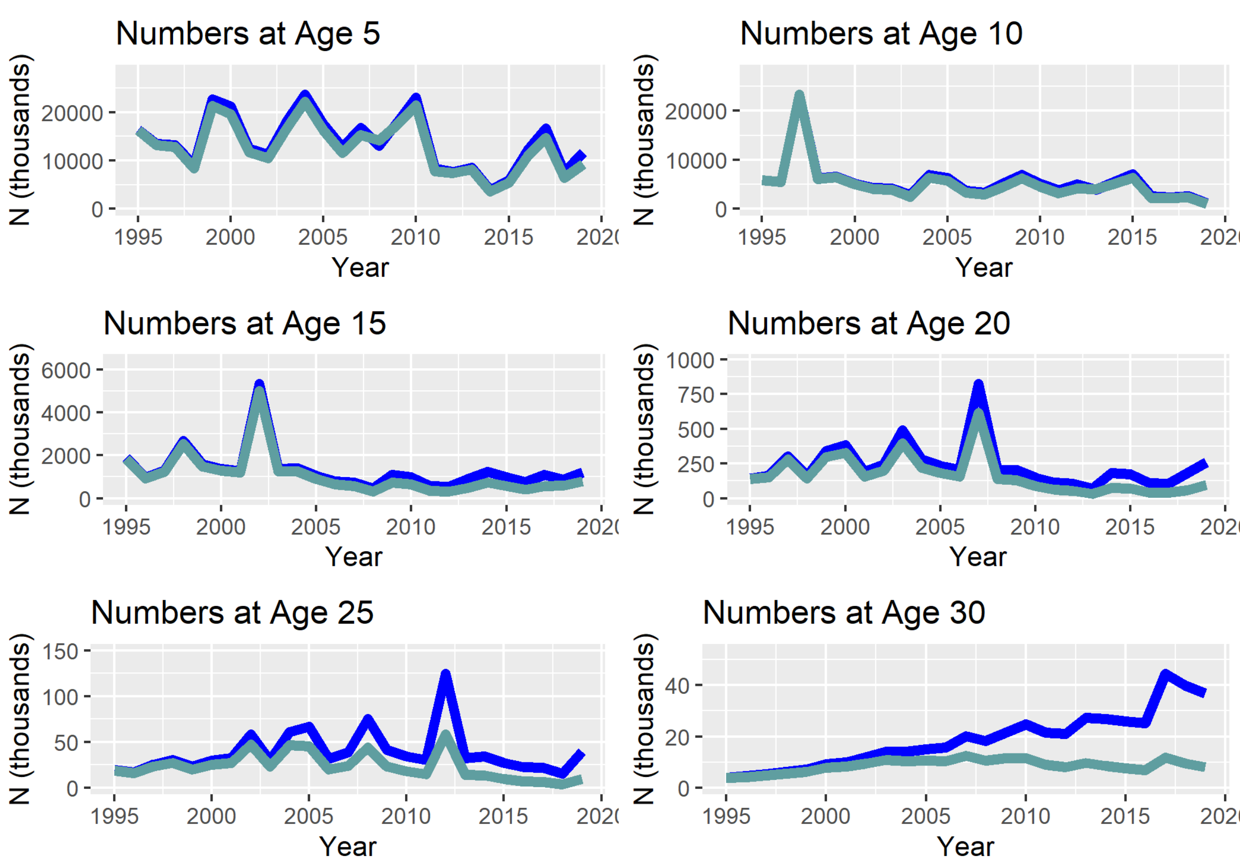

Figure A3-6-14 Estimated numbers-at-age from the 2019 coastwide long assessment model and calculated by the 2020 closed loop simulation model for ages 5, 10, 15, 20, 25, and 30 (the plus group).

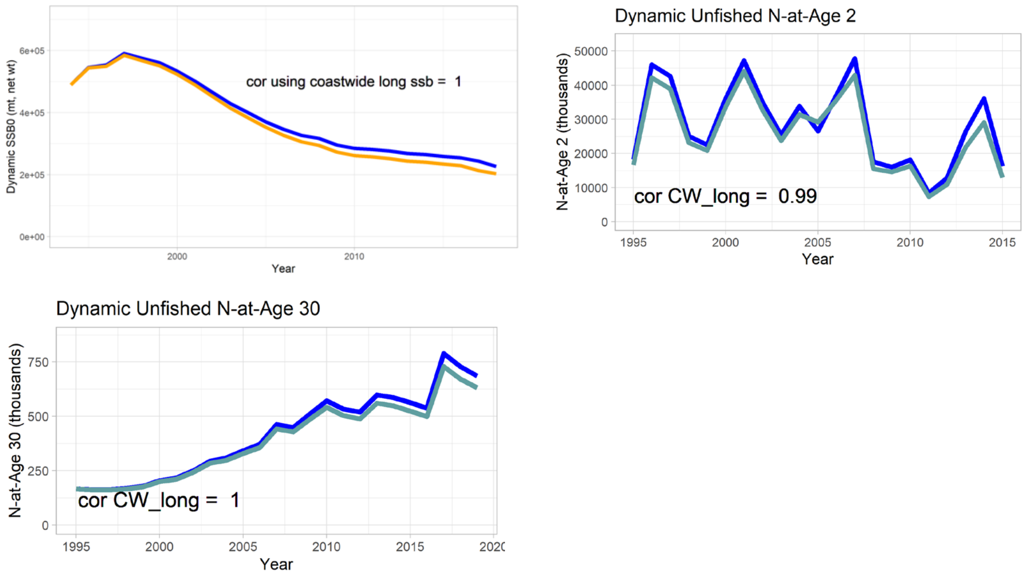

Figure A3-6-15 Top left: dynamic unfished spawning biomass from the integrated 2019 IPHC assessment model, the coastwide long assessment model, and the closed loop simulation model. Top right: estimated dynamic unfished numbers-at-age 2 from the coastwide long assessment model and calculated by the closed loop simulation model. Bottom left: estimated dynamic unfished numbers-at-age 30 (the plus group) from the 2019 coastwide long assessment model and calculated by the closed loop simulation model.